nabim

AHDB

ASSURED
FOOD STANDARDS

YEN

26 February 2019

Milling Wheat Conference

In association with **nabim** and incorporating the YEN Wheat Quality Award

CEREALS & OILSEEDS

Programme

10:40 Varieties and disease – an integrated approach; Jenna Watts, AHDB

11:00 Managing wheat crops for quality; Sarah Clarke, ADAS

11:20 Growing for the market; James Price, Perdiswell Farm

11:40 Refreshment break

12:00 Capturing and maintaining quality – storage and drying; Philip Darke, Camgrain

12:20 Miller panel discussion;

Dr Simon Penson, ADM Milling UK Ltd

Julius Deane, Carr's Flour Mills Ltd

George Mason, Heygates Ltd

Stuart Bradshaw, EB Bradshaw & Sons

13:00 Lunch

Programme

13:45 Baking and consumers; Eva Wheeler, Allied Bakeries

14:15 YEN Wheat Quality Award

- Introduction to YEN – Roger Sylvester-Bradley, ADAS
- Explanation of Award Testing – Mark Charlton, Allied Technical Centre
- Presentation of Awards – George Marriage, Marriage's Millers
- Winner Introductions – Video biographies
- Winners Question and Answer Panel

15:20 Conference close; Martin Grantley-Smith, AHDB

15:30 Depart

Varieties and disease – an integrated approach

Jenna Watts - AHDB

CEREALS & OILSEEDS

Outline

- The importance of varietal disease resistance
  - Role of disease resistance within the RL
- New winter wheat milling varieties on the RL
- Planning for the future of the RL – what are your priorities?

Important of varietal disease resistance

An integrated approach to disease control

Current methods of disease control impacted by:

- Legislative change
- Development of resistance

Pesticide input is only one aspect of crop management:

- Selection of resistant/tolerant varieties
- Good hygiene
- Cultivation techniques
- Rotations
- Monitoring
- Sowing dates

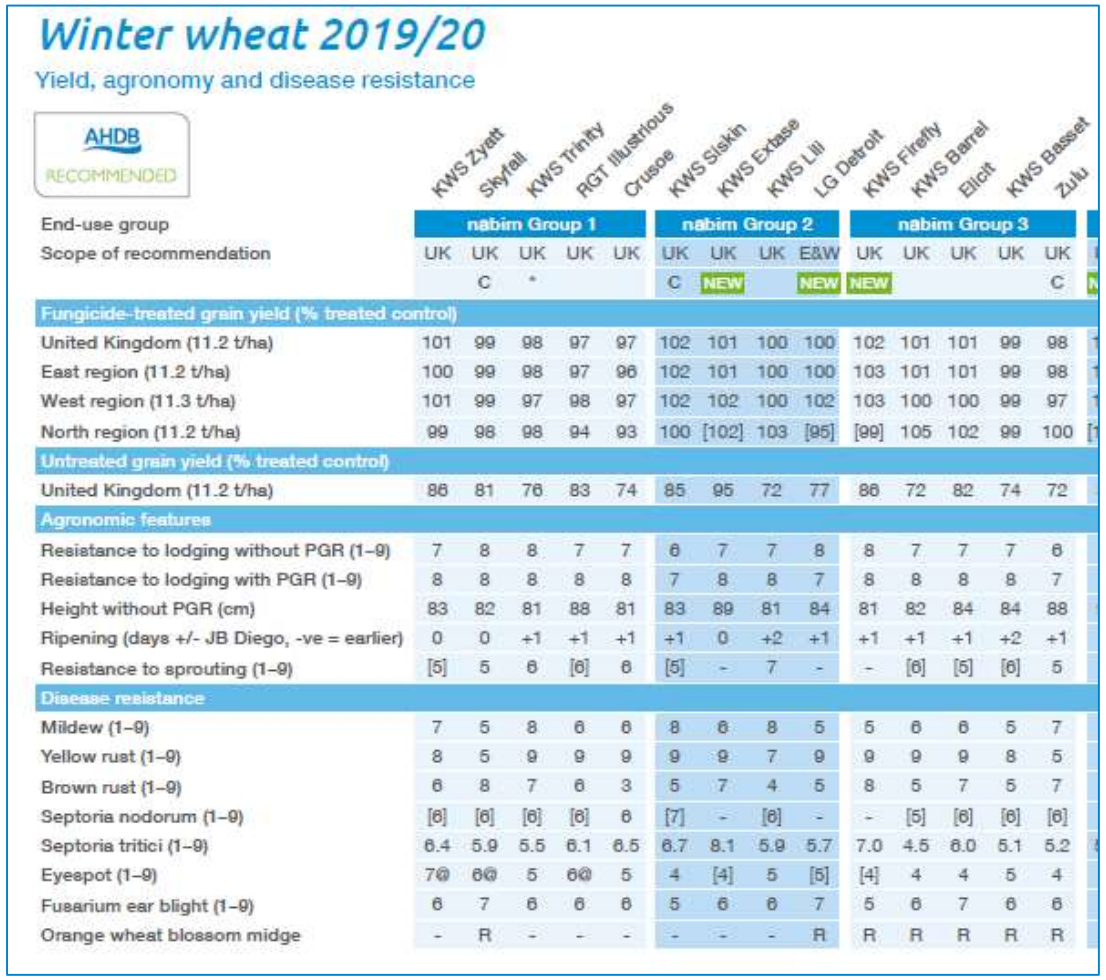
Varietal resistance
- Independent information from the RL

RL Disease ratings

Annual monitoring:

- Untreated trials
- Disease observation plots
- Inoculated trials

Normally 3-5 years of data used in rating calculations



Winter wheat 2019/20

Yield, agronomy and disease resistance

AHDB RECOMMENDED

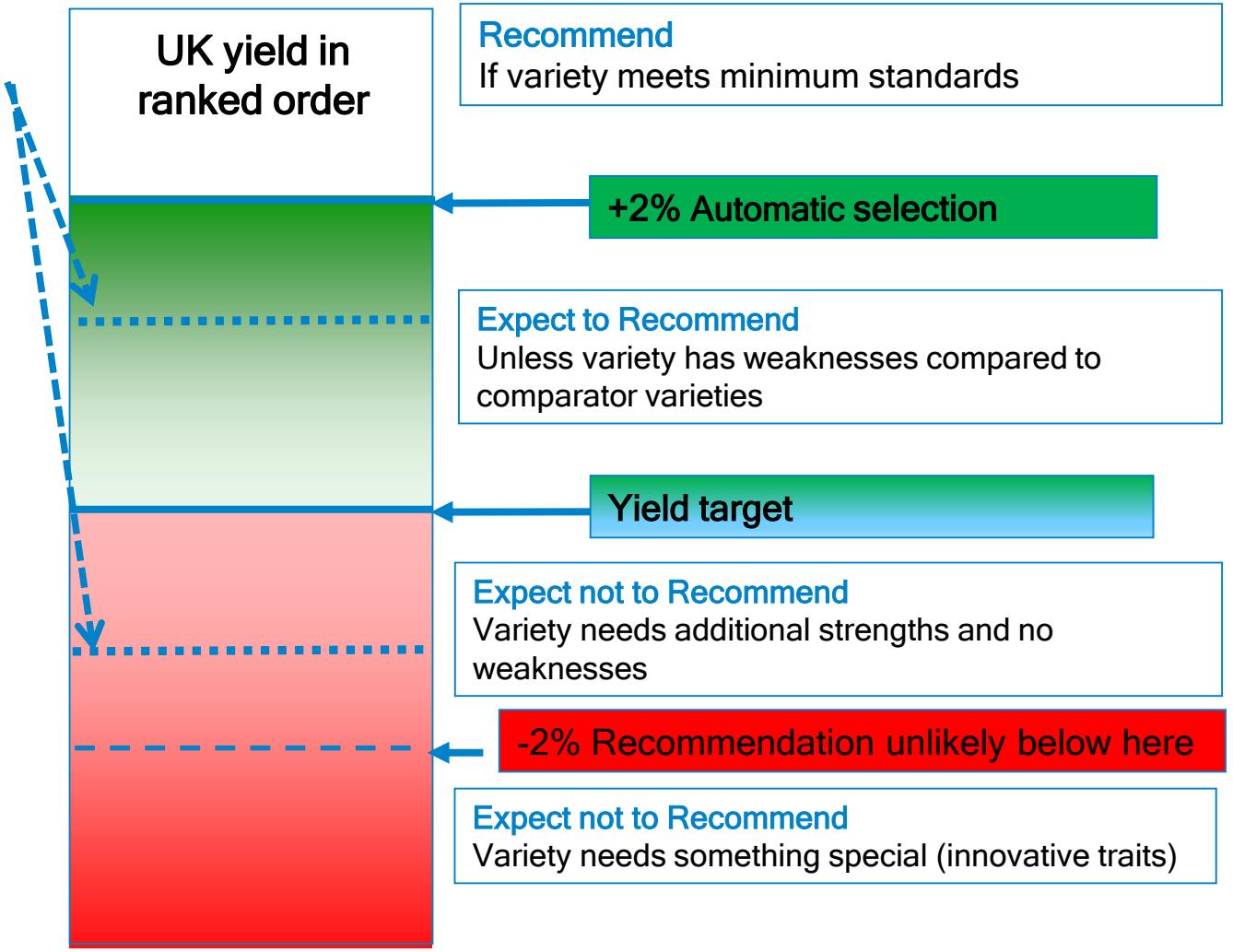
	KWS Zyatt	Skyfall	KWS Trinity	RGT Illustrious	Crusoe	KWS Siskin	KWS Extase	KWS Lili	LG Detroit	KWS Firefly	KWS Barrel	Elicit	KWS Basset	Zulu
End-use group	nabim Group 1					nabim Group 2				nabim Group 3				
Scope of recommendation	UK	UK	UK	UK	UK	UK	UK	UK	E&W	UK	UK	UK	UK	UK
		C	*			C	NEW		NEW	NEW				C
Fungicide-treated grain yield (% treated control)														
United Kingdom (11.2 t/ha)	101	99	98	97	97	102	101	100	100	102	101	101	99	98
East region (11.2 t/ha)	100	99	98	97	96	102	101	100	100	103	101	101	99	98
West region (11.3 t/ha)	101	99	97	98	97	102	102	100	102	103	100	100	99	97
North region (11.2 t/ha)	99	98	98	94	93	100	[102]	103	[95]	[99]	105	102	99	100
Untreated grain yield (% treated control)														
United Kingdom (11.2 t/ha)	86	81	76	83	74	85	95	72	77	86	72	82	74	72
Agronomic features														
Resistance to lodging without PGR (1–9)	7	8	8	7	7	6	7	7	8	8	7	7	7	6
Resistance to lodging with PGR (1–9)	8	8	8	8	8	7	8	8	7	8	8	8	8	7
Height without PGR (cm)	83	82	81	88	81	83	89	81	84	81	82	84	84	88
Ripening (days +/- JB Diego, -ve = earlier)	0	0	+1	+1	+1	+1	0	+2	+1	+1	+1	+1	+2	+1
Resistance to sprouting (1–9)	[5]	5	6	[6]	6	[5]	-	7	-	-	[6]	[5]	[6]	5
Disease resistance														
Mildew (1–9)	7	5	8	6	6	8	6	8	5	5	6	6	5	7
Yellow rust (1–9)	8	5	9	9	9	9	9	7	9	9	9	9	8	5
Brown rust (1–9)	6	8	7	6	3	5	7	4	5	8	5	7	5	7
Septoria nodorum (1–9)	[6]	[6]	[6]	[6]	6	[7]	-	[6]	-	-	[5]	[6]	[6]	[6]
Septoria tritici (1–9)	6.4	5.9	5.5	6.1	6.5	6.7	8.1	5.9	5.7	7.0	4.5	6.0	5.1	5.2
Eyespot (1–9)	7@	6@	5	6@	5	4	[4]	5	[5]	[4]	4	4	5	4
Fusarium ear blight (1–9)	6	7	6	6	6	5	6	6	7	5	6	7	6	6
Orange wheat blossom midge	-	R	-	-	-	-	-	-	R	R	R	R	R	R

Criteria for Recommendation

Does the variety have a balance of features that are sufficiently better than existing varieties & such that it could potentially provide a more economic return in the market?

Comparator varieties

Some characteristics have a greater weighting than yield when recommending varieties



Importance of disease resistance
- For recommendation decisions (reviewed annually)

Comparator characteristics for Group 1 and Group 2 winter wheat varieties (July 2018; subset)

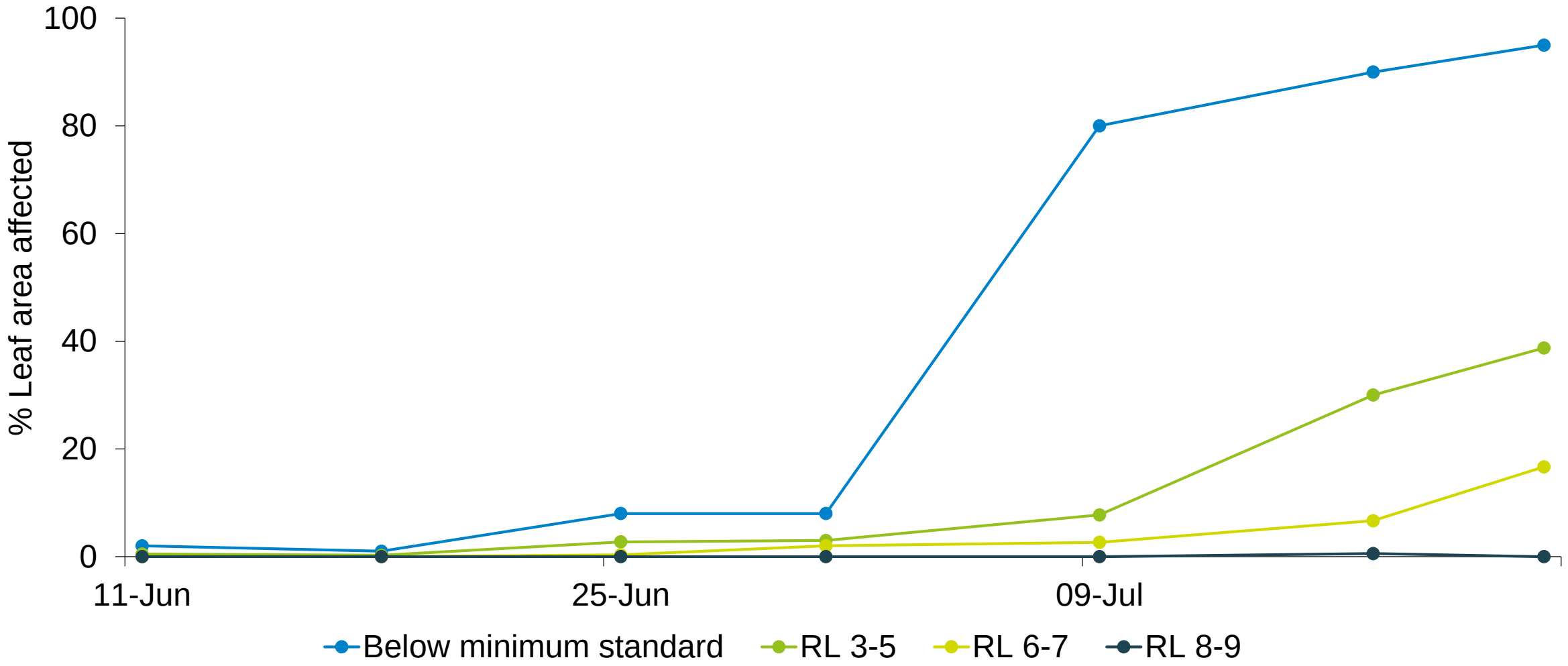
Variate	Importance	Target specification
UK treated yield	High	
UK untreated yield	Med	
Millers assessment	V. high	
Potential for **ukp**	High	
Protein content	Med	
HFN	High	230
Specific weight	High	75
Combination of untreated yield & disease score	High	

Variate	Importance	Minimum standard
Septoria tritici	V. high	4*
Yellow rust	High	3
Brown rust	Medium	3
Eyespot	Medium	3
Fusarium	Medium	3
Mildew	Medium	3
Septoria nodorum	Low	3
OWBM	High**	

* 5.0 for automatic recommendation

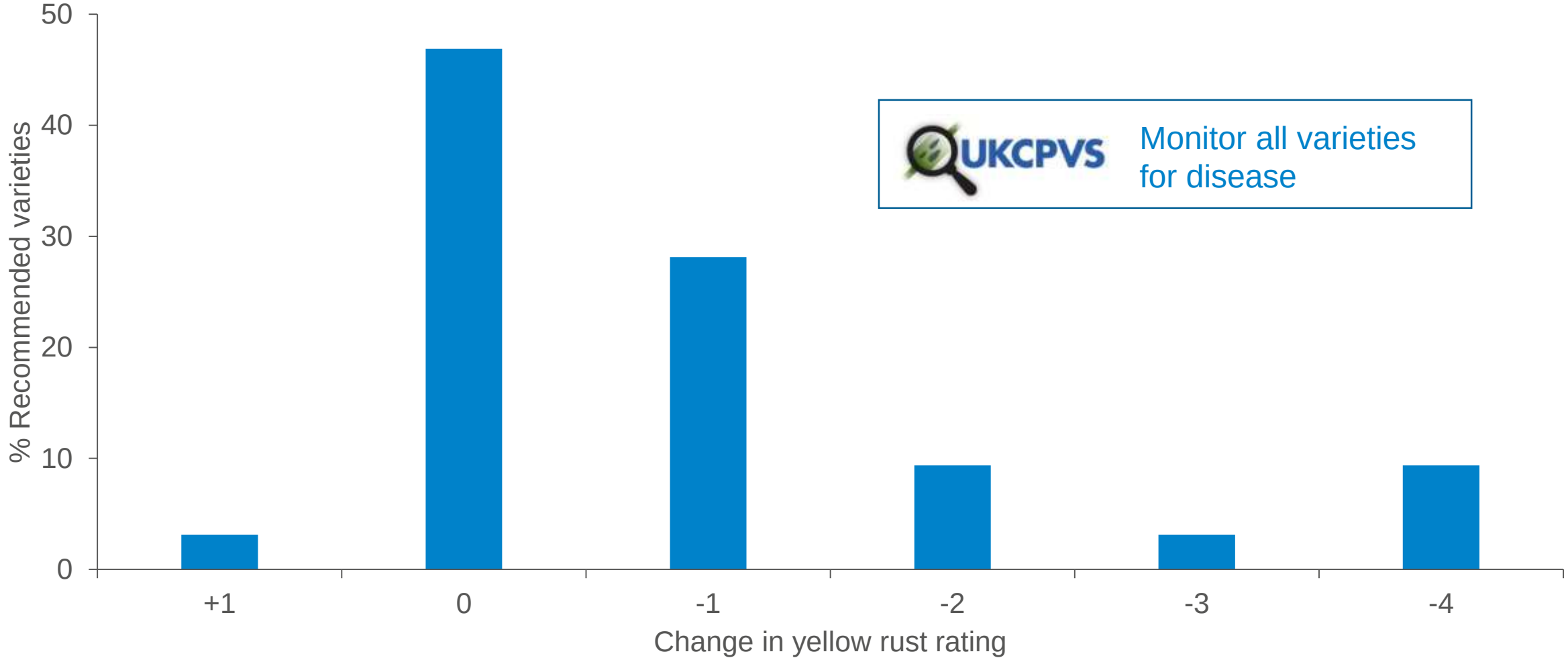
** If reliable data available

Minimum standards
- Yellow rust development

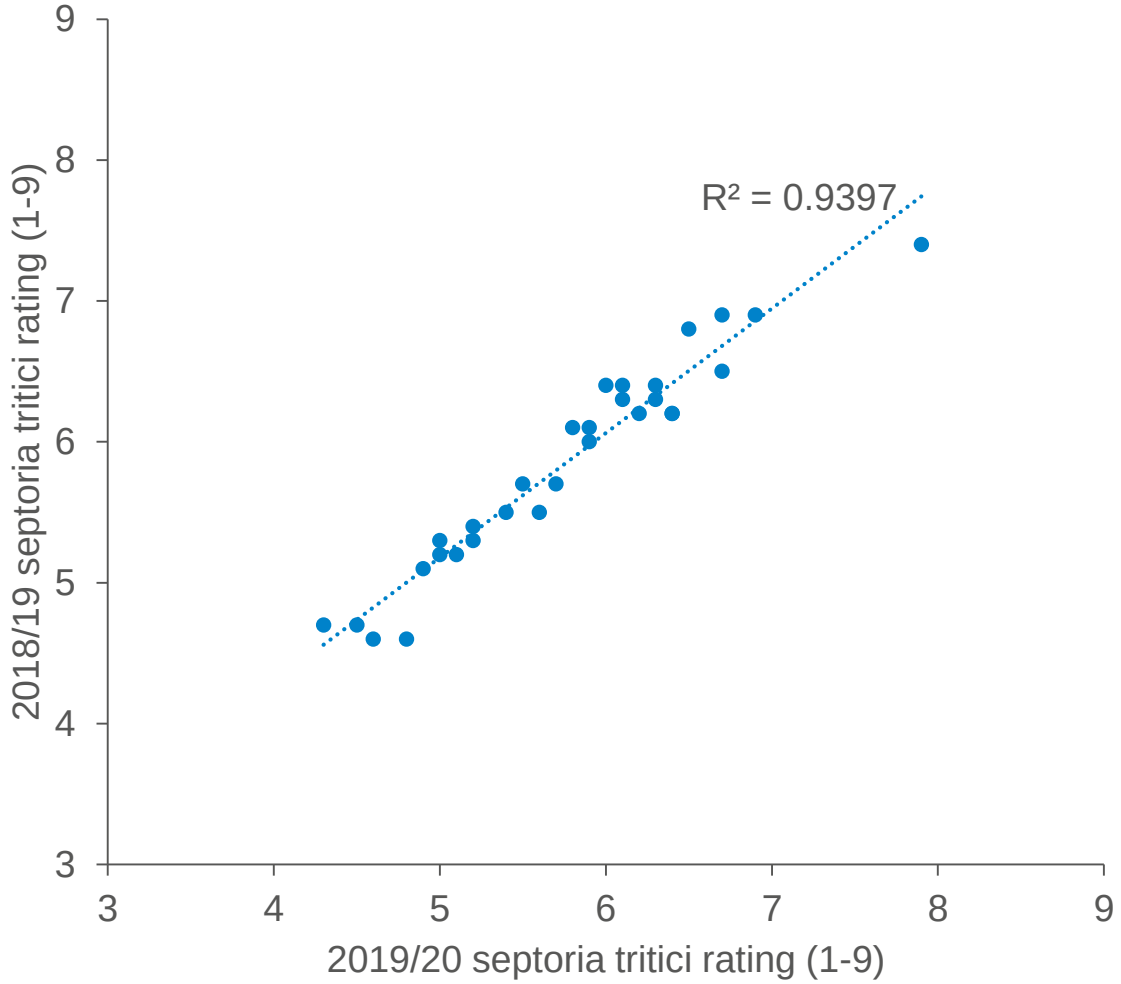


Durability of resistance

- Yellow rust changes in RL ratings between 2015 and 2016



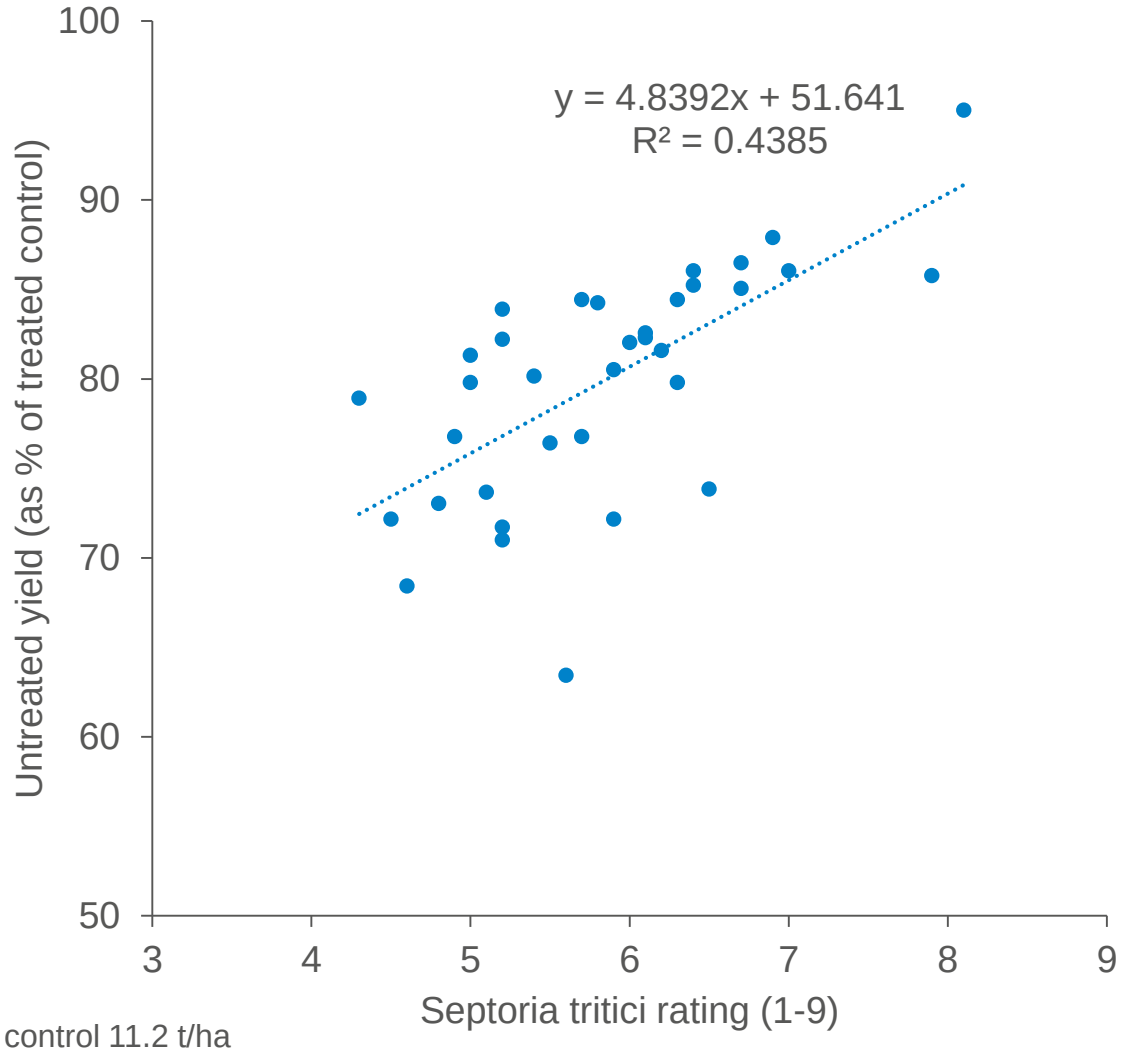
Durability of resistance
- Septoria tritici



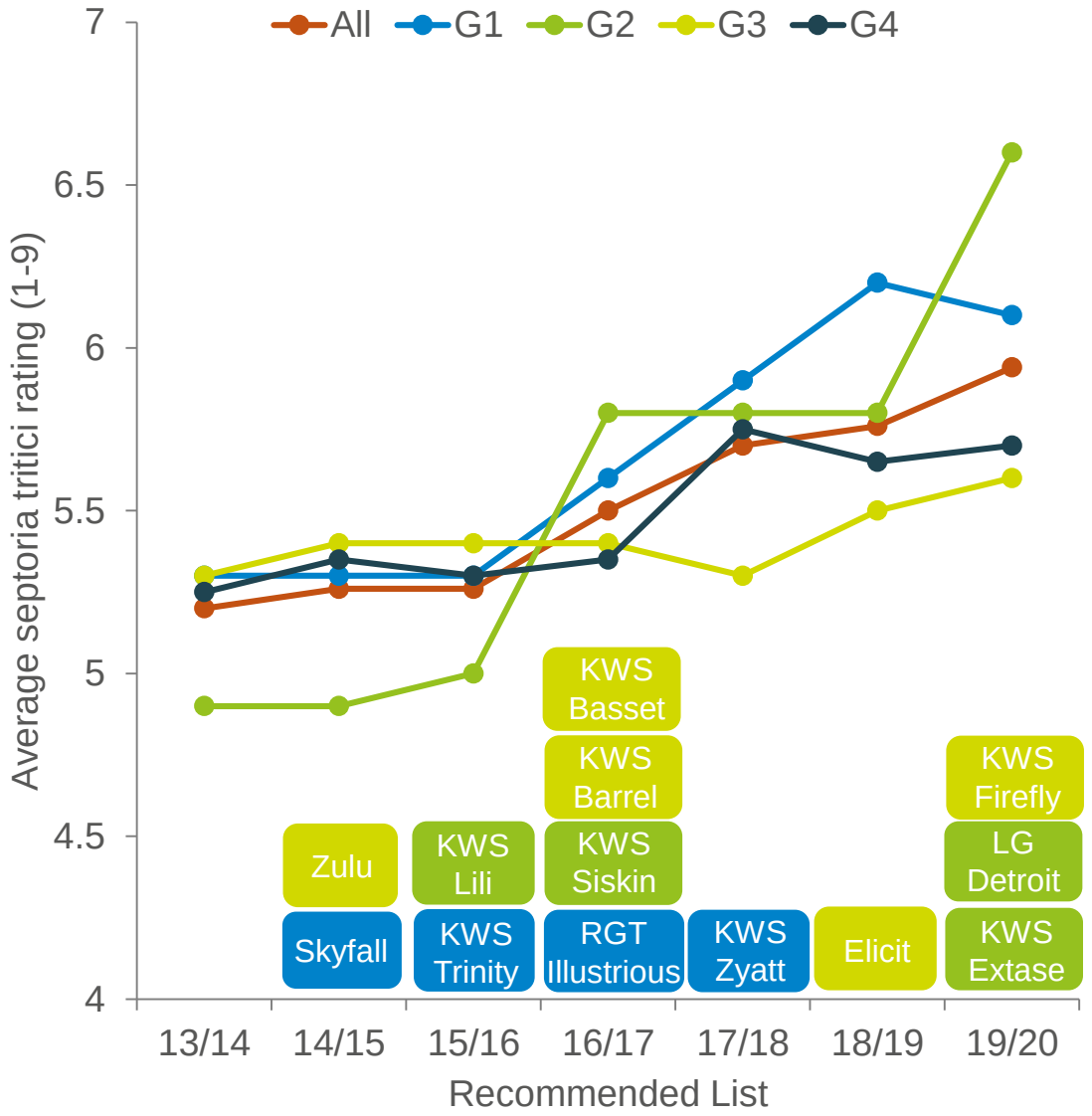
- RL disease ratings are currently stable
- Average change between 2018/19 and 2019/20 RL was -0.01 rating

Does not include 2019/20 P1 varieties

Value of septoria tritici resistance



Yield control 11.2 t/ha



2019/20 Recommended List

CEREALS & OILSEEDS

AHDB Recommended List 2019-20

Crop	New varieties	Varieties removed
Winter wheat	5	11
Spring wheat	2	1
Winter barley	6	2
Spring barley	1	0
Winter oats	0	3
Spring oats	1	2
Winter oilseed rape	9	4
Total	**24**	**23**

New winter wheat
- nabim group 2

	New		
	KWS Extase	**LG Detroit**	**KWS Siskin**
	UK	E&W	UK
UK treated yield	101	100	102
East region yield	101	100	102
West region yield	102	102	102
UK untreated yield	95	77	85
Hagberg	307	280	300
Spec. weight	78.6	77.8	77.5
ukp	[Y]	[Y]	Y
Resistance to lodging + PGR	8	7	7
Yellow rust	9	9	9
Brown rust	7	5	5
Septoria tritici	8.1	5.7	6.7
Fusarium ear blight	6	7	5
OWBM	-	R	-

Yield control: UK 11.2 t/ha, E 11.2 t/ha, W 11.3 t/ha

New winter wheat
- nabim group 3

New

	KWS Firefly	KWS Barrel	Elicit
UK treated yield	102	101	101
UK untreated yield	86	72	82
Hagberg	248	227	222
Spec. weight	75.9	77.3	77.3
uks	[Y]	Y	[Y]
Resistance to lodging + PGR	8	8	8
Ripening	+1	+1	+1
Mildew	5	6	6
Yellow rust	9	9	9
Brown rust	8	5	7
Septoria tritici	7.0	4.5	6.0
Fusarium ear blight	5	6	7
OWBM	R	R	R

Yield control: UK 11.2 t/ha

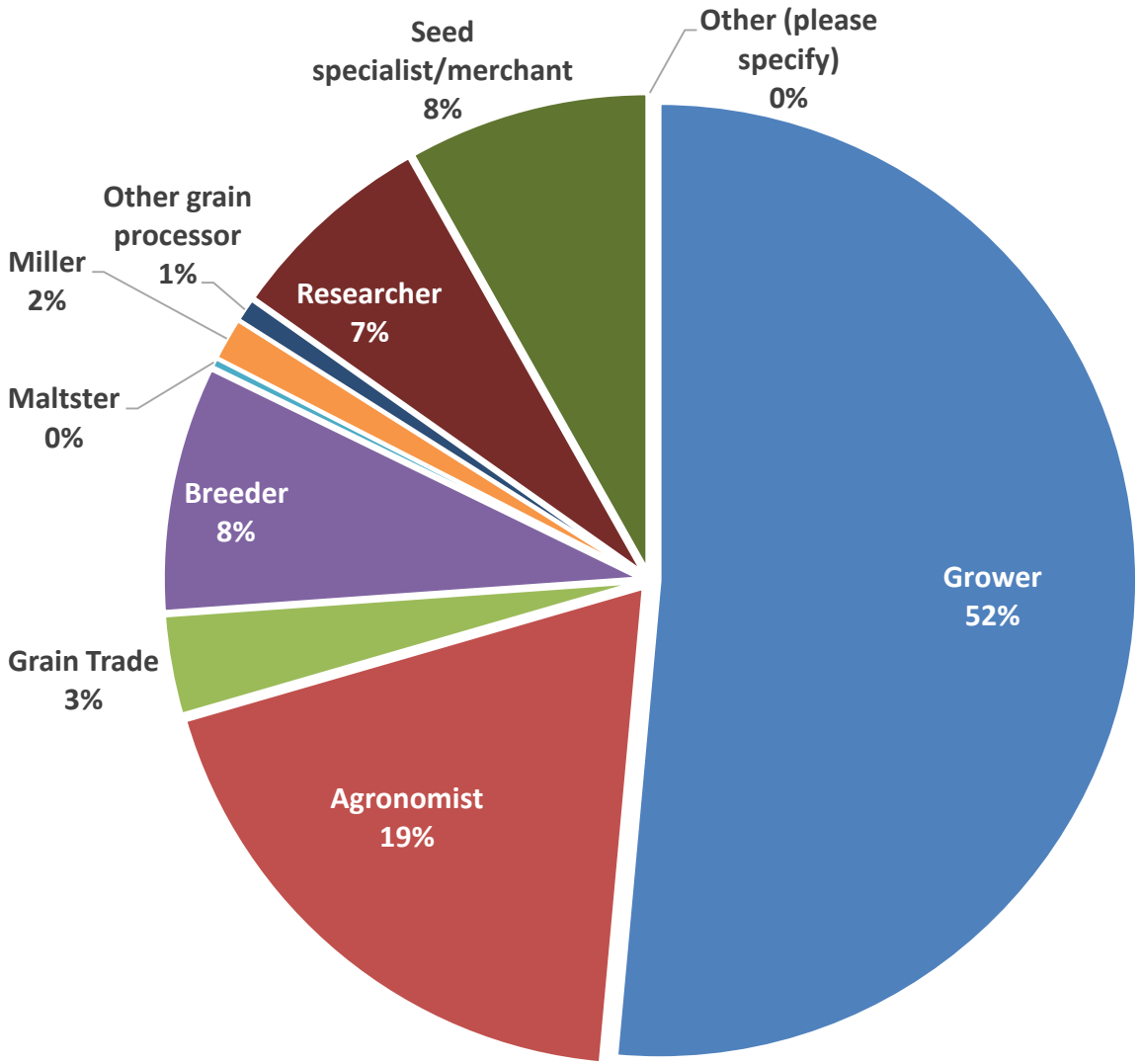
Planning for the future of the RL

What are your priorities?

CEREALS & OILSEEDS

RL Look Ahead activities

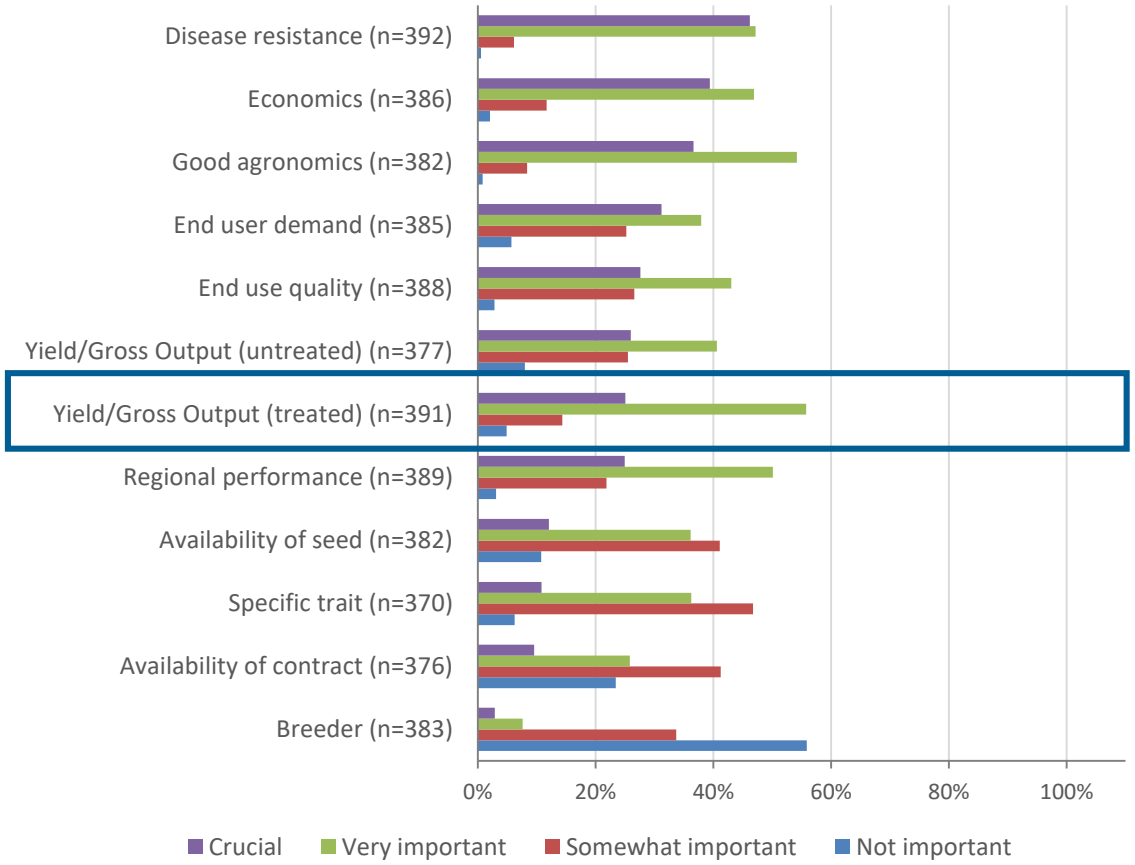
- Survey
- Meetings with growers and agronomists
- Formal Committee and Board meeting
- Discussions at events



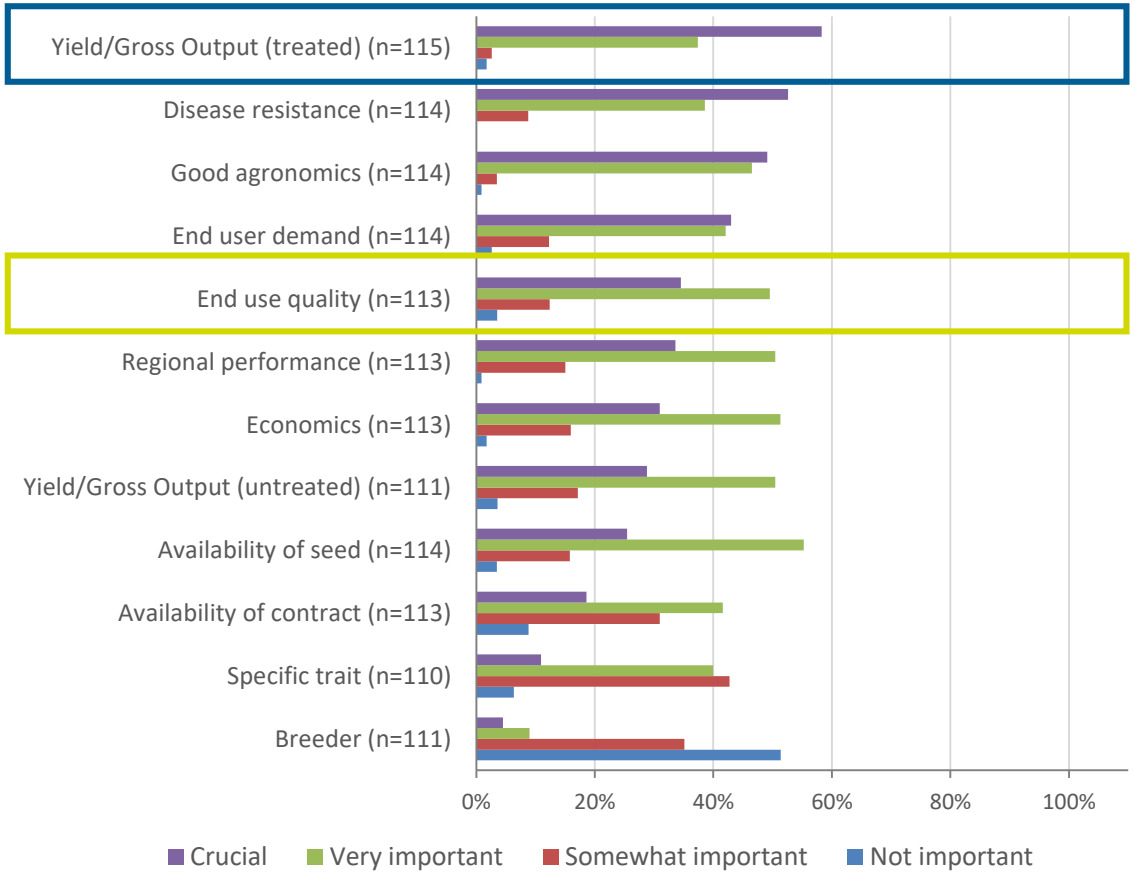
In total 623 responses

What characteristics are important to growers?

Grower & Agronomist response



Other stakeholder response



Most crucial for millers

Summary

- Disease resistant and tolerant varieties are a valuable tool in an integrated disease management programme
- Monitoring activities are important as disease populations can rapidly change
- Disease resistance is an important characteristic for recommendation
- It is possible for a variety with good disease resistance to be recommended if it has not met the yield target
- RL Look Ahead activities have highlighted the importance of disease resistance

Managing wheat crops for quality: finding the farm factor

Sarah Clarke

Crop Physiologist, ADAS

sarah.clarke@adas.co.uk

CEREALS & OILSEEDS

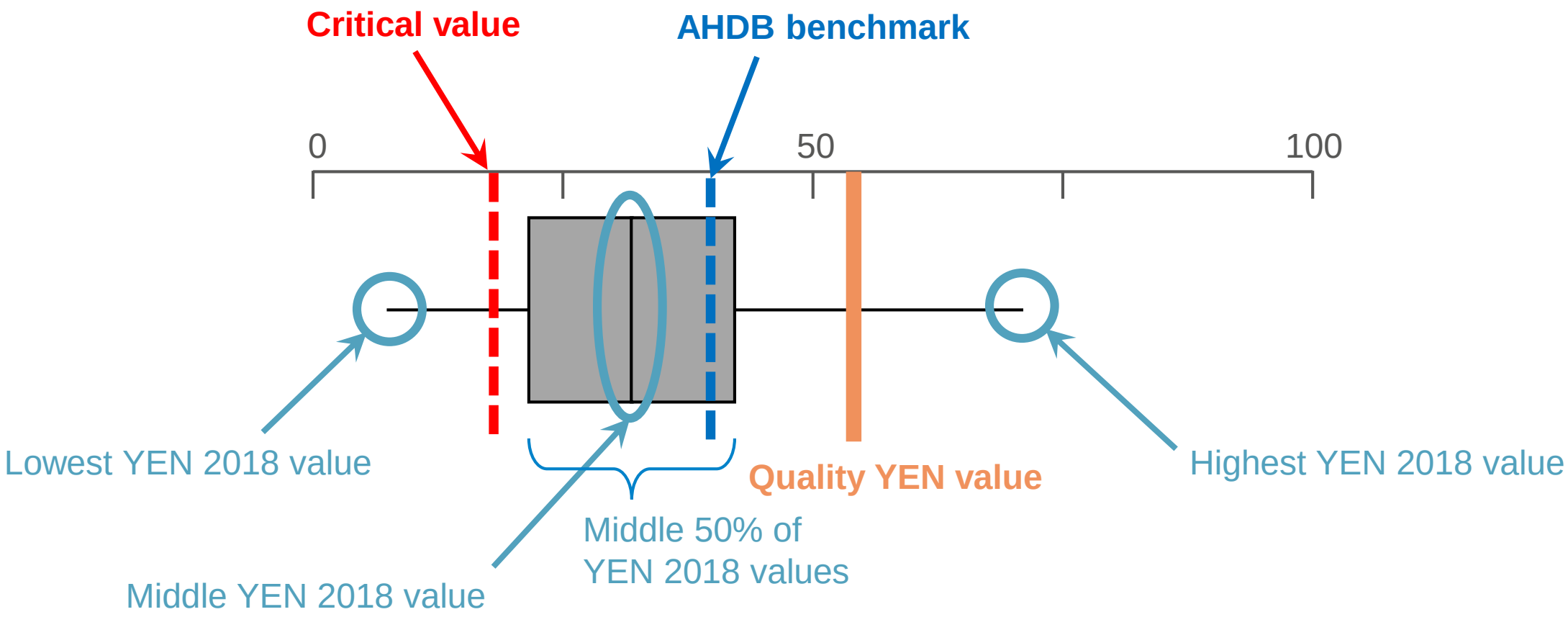
Outline

- YEN 2017 vs 2018 results
- Getting protein right through nutrition:
  - Insights from LearN project
  - Understanding your N requirements with tramline trials
  - New research on milling wheat nutrition
- Conclusions and looking forward to 2019

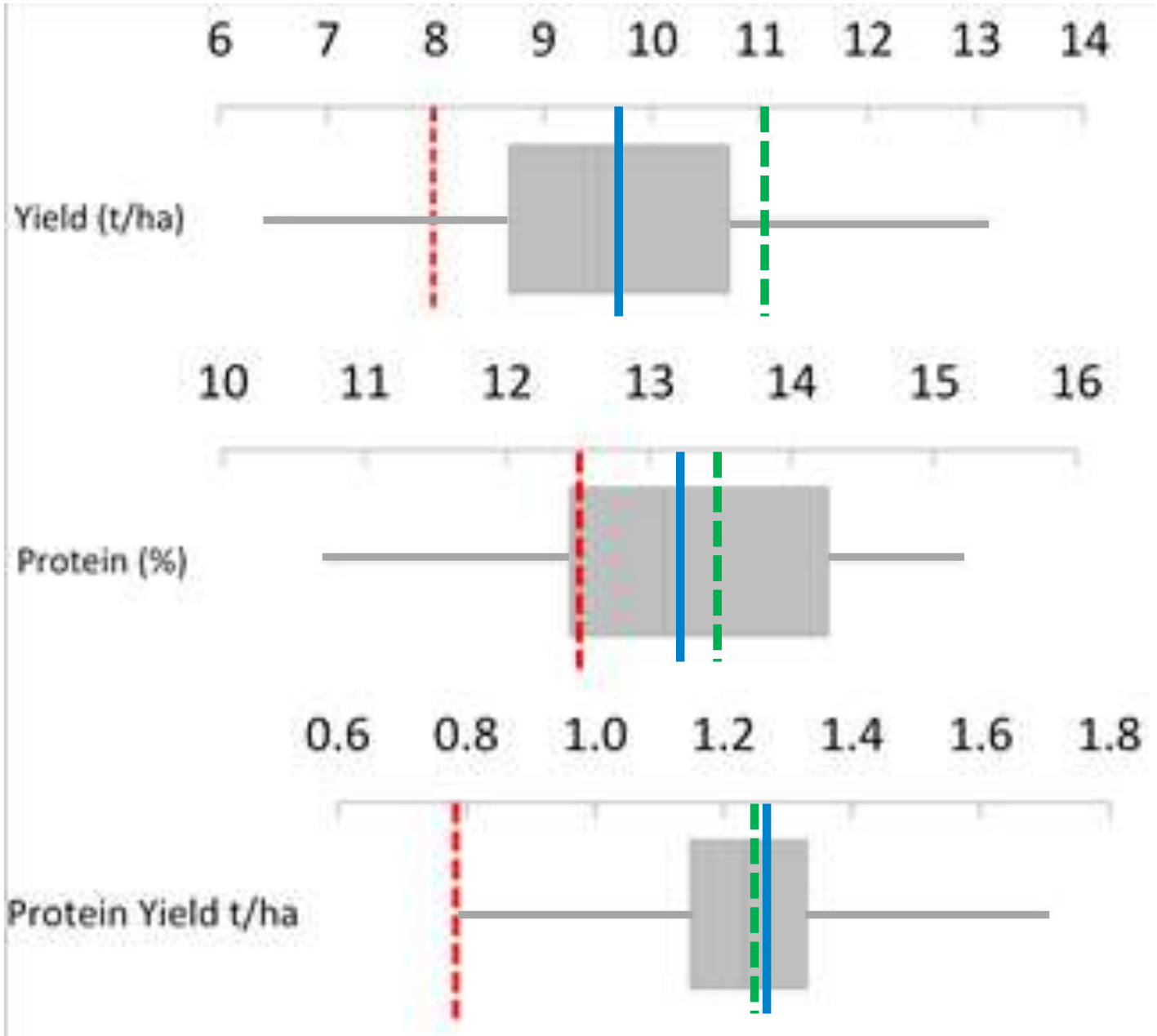
Enhancing Yield AND Quality – YEN data

- Achieving high yields and milling quality ‘Holy Grail’
- Challenge of growing milling wheats acknowledged in milling premiums
- YEN aims to help growers through:
  - Understanding
  - Benchmarking
  - Supporting innovation
- 2017 was first year of Quality YEN
  - 25 Quality YEN entrants
- 2018 saw 32 Quality YEN entrants

YEN Benchmarking



Quality YEN results – 2018 vs. 2017

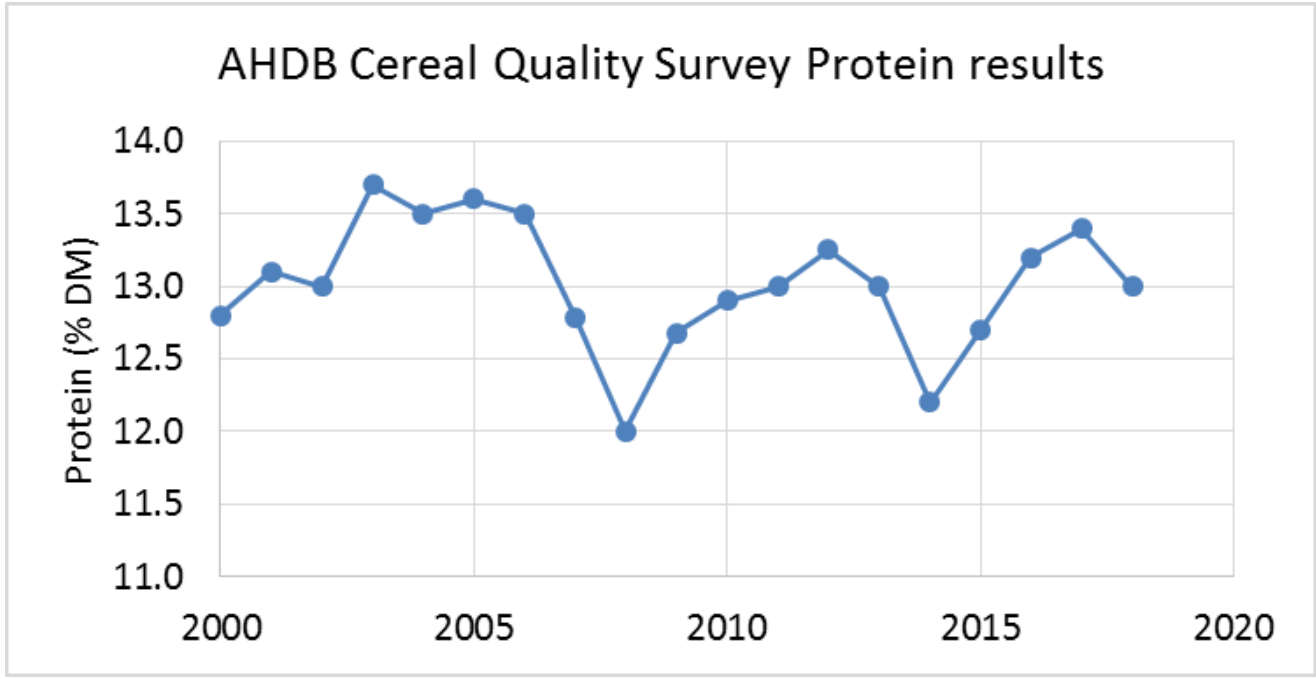


2018

2017

Features of the 2018 growing season

- Water limitation key feature of 2018
  - But where soils held sufficient water very high yields possible
- High temperatures led to early senescence and harvest
- Lower proteins because late uptake hampered?



- Soil and weather only explains a small part of yield variation – ‘Farm Factor’ is dominant

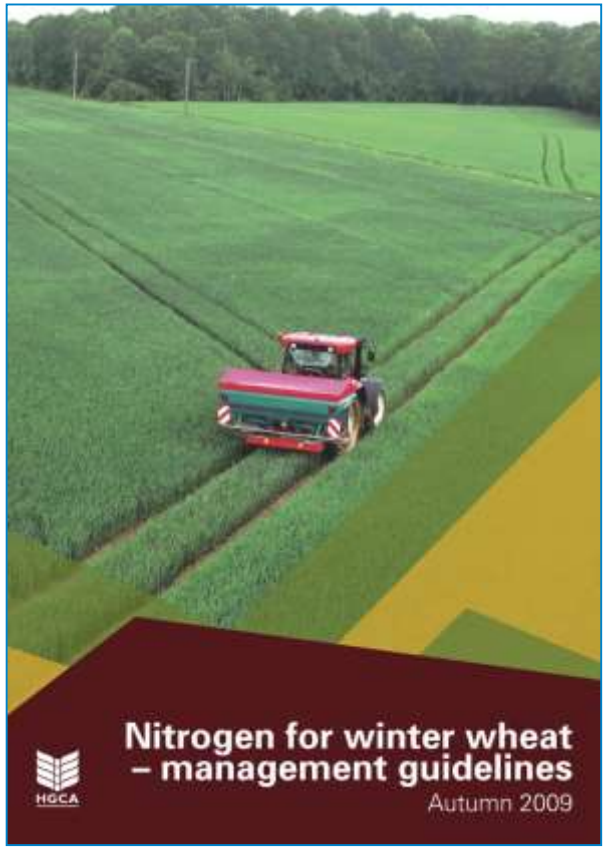
LearN

- To enable individual farms to determine whether, on-average, their N use on wheat is about right …

  … or too much … or too little.

Approach

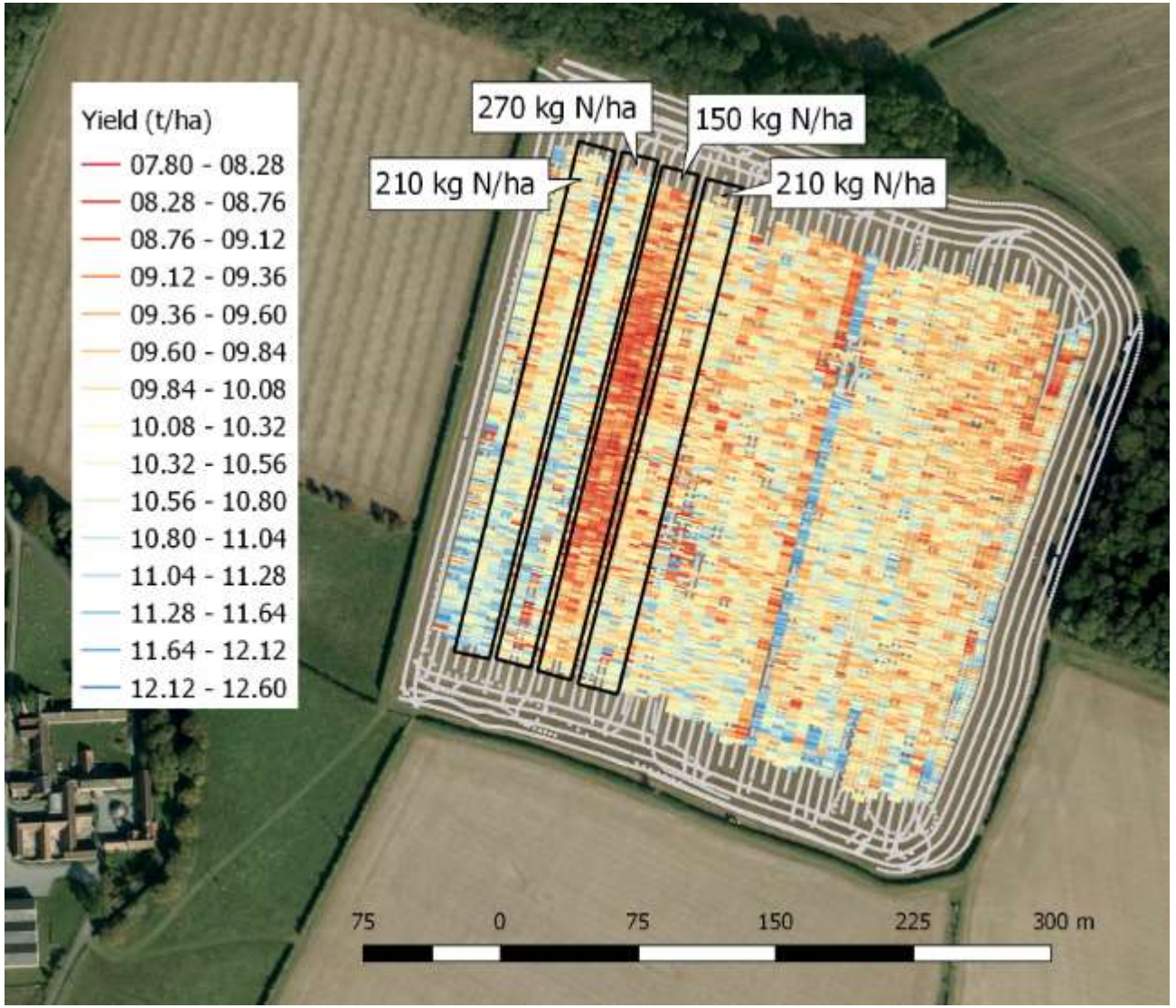
- Full N response experiments alongside strip trials on 6 farms … in East, similar soils & systems
- Strip trials on additional12 farms
- 3 fields per farm for 4 years



Tramline Comparisons

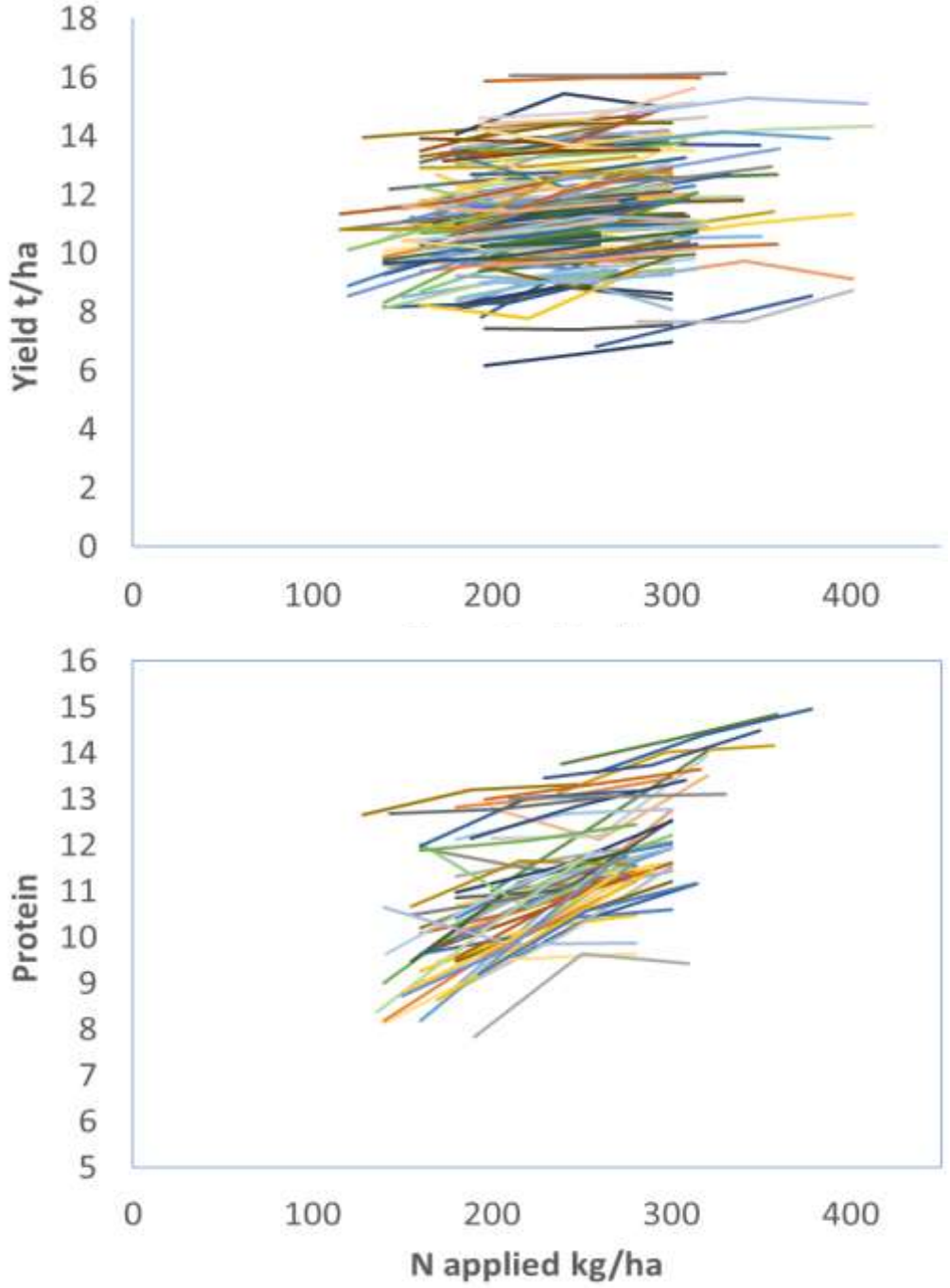
- Farm standard N rate, +60 kg/ha, -60kg/ha
- Yield from mapping data
- Manual grain protein samples
- At current grain & fertiliser prices need 0.3t/ha grain to pay for 60 kg N/ha fertiliser
  - Calculate margins
  - Use standards to judge inherent variation

	N rate kg/ha	Yield t/ha	Margin over N cost £/ha	Protein %DM
Standard	210	9.16	£1135	10.22
High	270	9.43	£1131	11.20
Low	150	8.49	£1084	8.99
Standard	210	8.99	£1112	



LearN findings

- In using ~240 kg N/ha on average, the farms were getting their N rates broadly right
- There is a large ‘farm factor’
- Protein a useful indicator of N responsiveness
  - Slopes were relatively consistent across ~150 trials
- LearN was focusing predominantly on yield



Conclusions

- Tramline trials can be useful … but care must be taken
  - ADAS have developed a guide to on-farm trials
- There is a movement towards ‘Farmer-Centric Research’
  - Farmer Innovation Groups (FIGs) are working to set up co-ordinated on-farm measures and tests
- Opportunity for a milling wheat FIG?
  - Could investigate the economic and quality value of applying urea late N

New AHDB project on milling wheat fertilisation

Aims:

- Update guidance on nitrogen and sulphur fertiliser use for winter milling wheat
- To achieve optimum grain quality and milling specifications for a range of varieties, soil types and growing environments.

Led by NIAB

Duration: July 2018 – March 2022

Trial sites in East Anglia and Scotland to test effects of N and S applications (including foliar) on quality including rheology and baking quality

Summary

- The 2018 season affected the results of the Quality YEN entries, although average proteins were still >13%
- A ‘farm factor’ affects grain protein
- On-farm tramline trials may be a useful tool for milling wheat growers
- New research aims to improve specific milling wheat N and S recommendations
- More entries over more seasons will give us greater understanding of getting the best out of milling wheats

Growing for the market

James Price – Perdiswell Farm

CEREALS & OILSEEDS

The Farm

- 480ha of Cotswold Brash Soils plus 200ha heavy(ish) clay
- Annual Rainfall 580mm
- 1 Full time member of staff plus part time help
- 140ha owned - remainder tenanted & contract farmed

The Farmer

- 40 years old
- Failed to stay at College long enough to get a degree
- Sit on AHDB Cereals and Oilseeds Board & Chair the R & KT Committee
- Chair Arable Technical Working Group for the revision of RB209
- Habit of appearing in the press

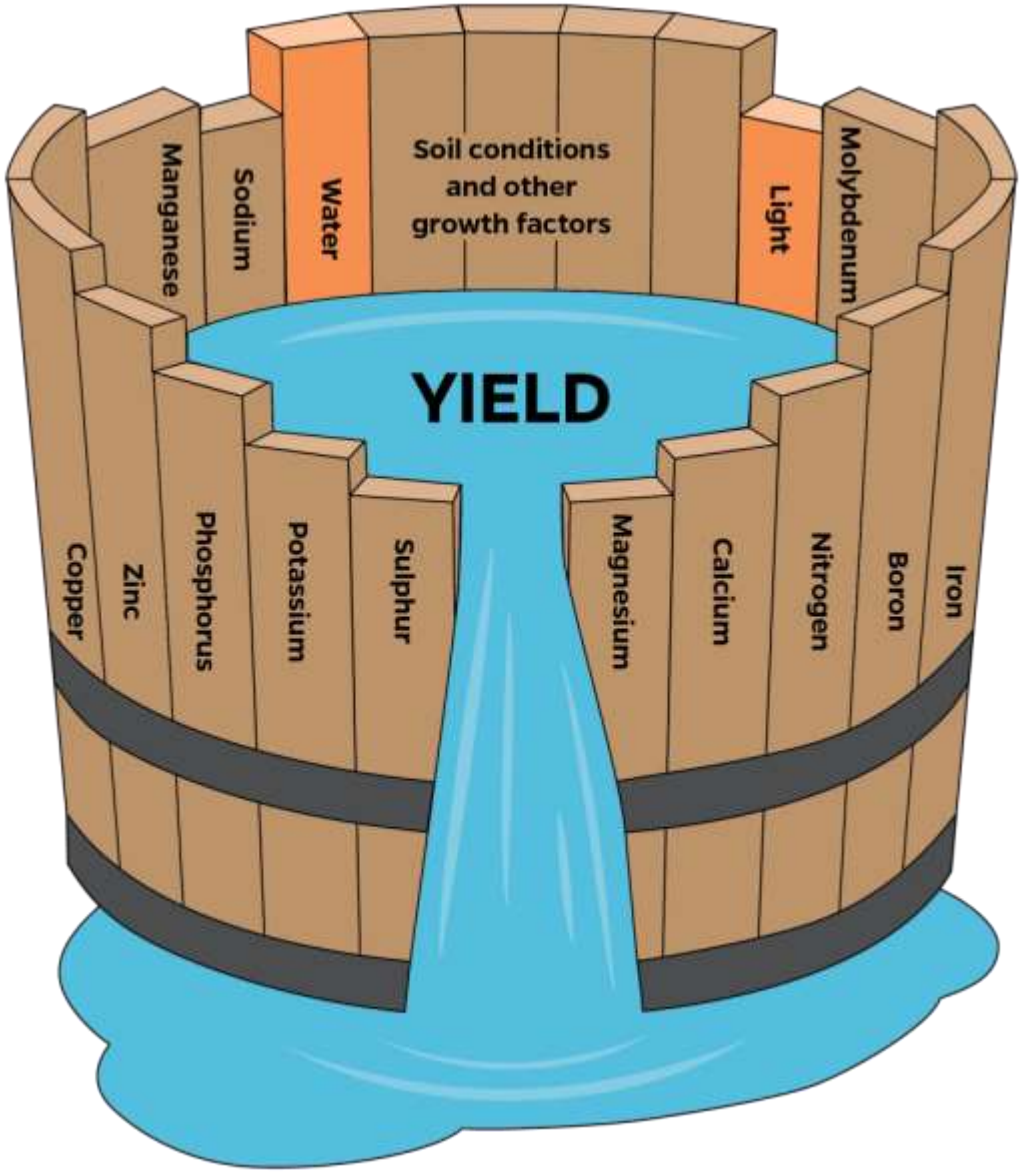
Challenges

- Family farm
- Soils
- Market
- Land ownership
- Weather
- New ideas
- Weed Pressure

AHDB

CEREALS & OILSEEDS

Liebig's Barrel



AHDB

CEREALS & OILSEEDS

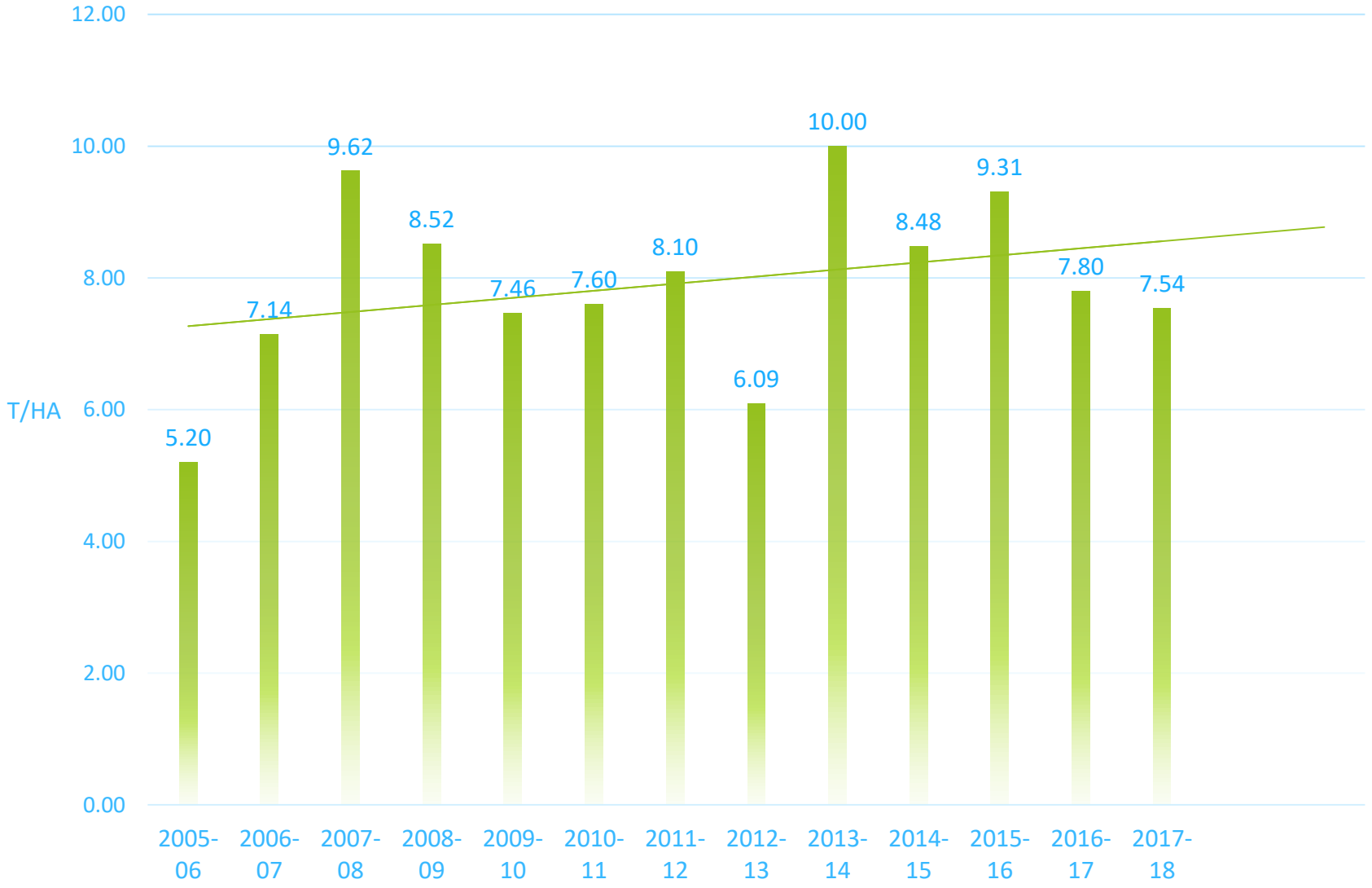
The Solution

- Milling wheat
- Do something completely different!

Varieties

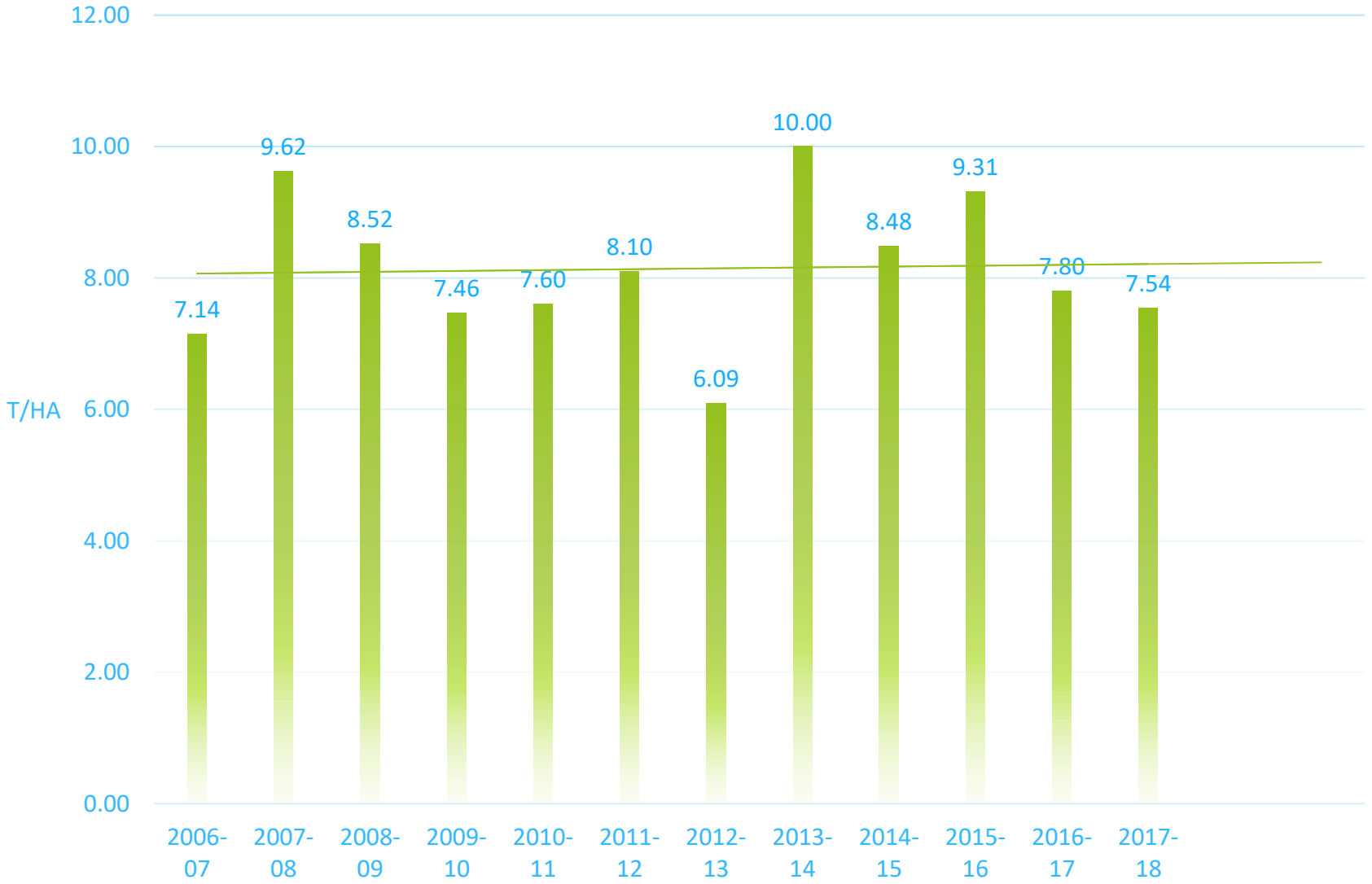
- Started with Hereward
- Tried Solstice
- Quickly went from Crusoe to Skyfall
- Always had a stable Group 2 as a second variety
- Until last year…

Results



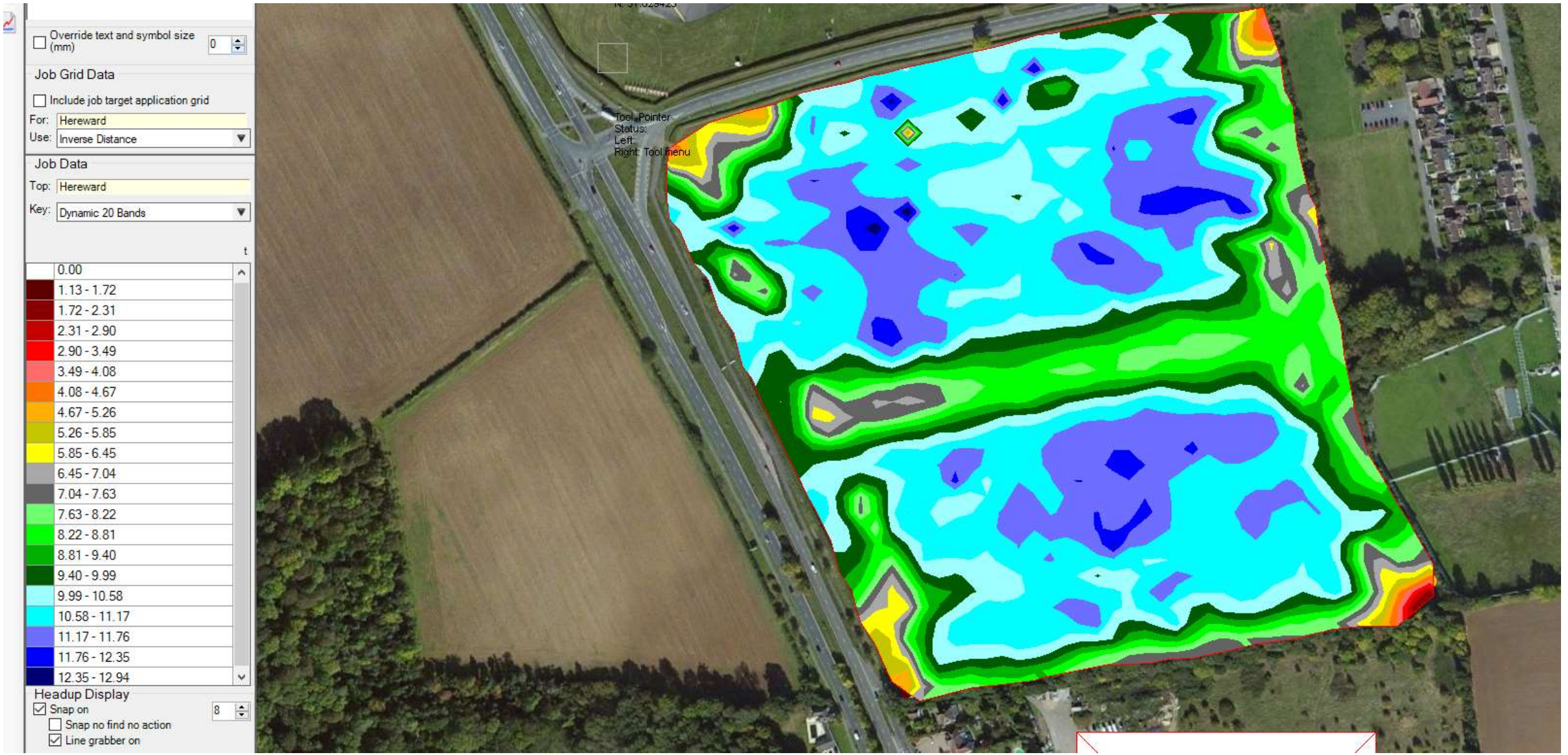
CEREALS & OILSEEDS

Results



CEREALS & OILSEEDS

Results


Override text and symbol size (mm)
0
Job Grid Data
Include job target application grid
For: Hereward
Use: Inverse Distance
Job Data
Top: Hereward
Key: Dynamic 20 Bands
t
0.00
1.13 - 1.72
1.72 - 2.31
2.31 - 2.90
2.90 - 3.49
3.49 - 4.08
4.08 - 4.67
4.67 - 5.26
5.26 - 5.85
5.85 - 6.45
6.45 - 7.04
7.04 - 7.63
7.63 - 8.22
8.22 - 8.81
8.81 - 9.40
9.40 - 9.99
9.99 - 10.58
10.58 - 11.17
11.17 - 11.76
11.76 - 12.35
12.35 - 12.94
Headup Display
Snap on
8
Snap no find no action
Line grabber on
Tool: Pointer
Status:
Left:
Right: Tool menu

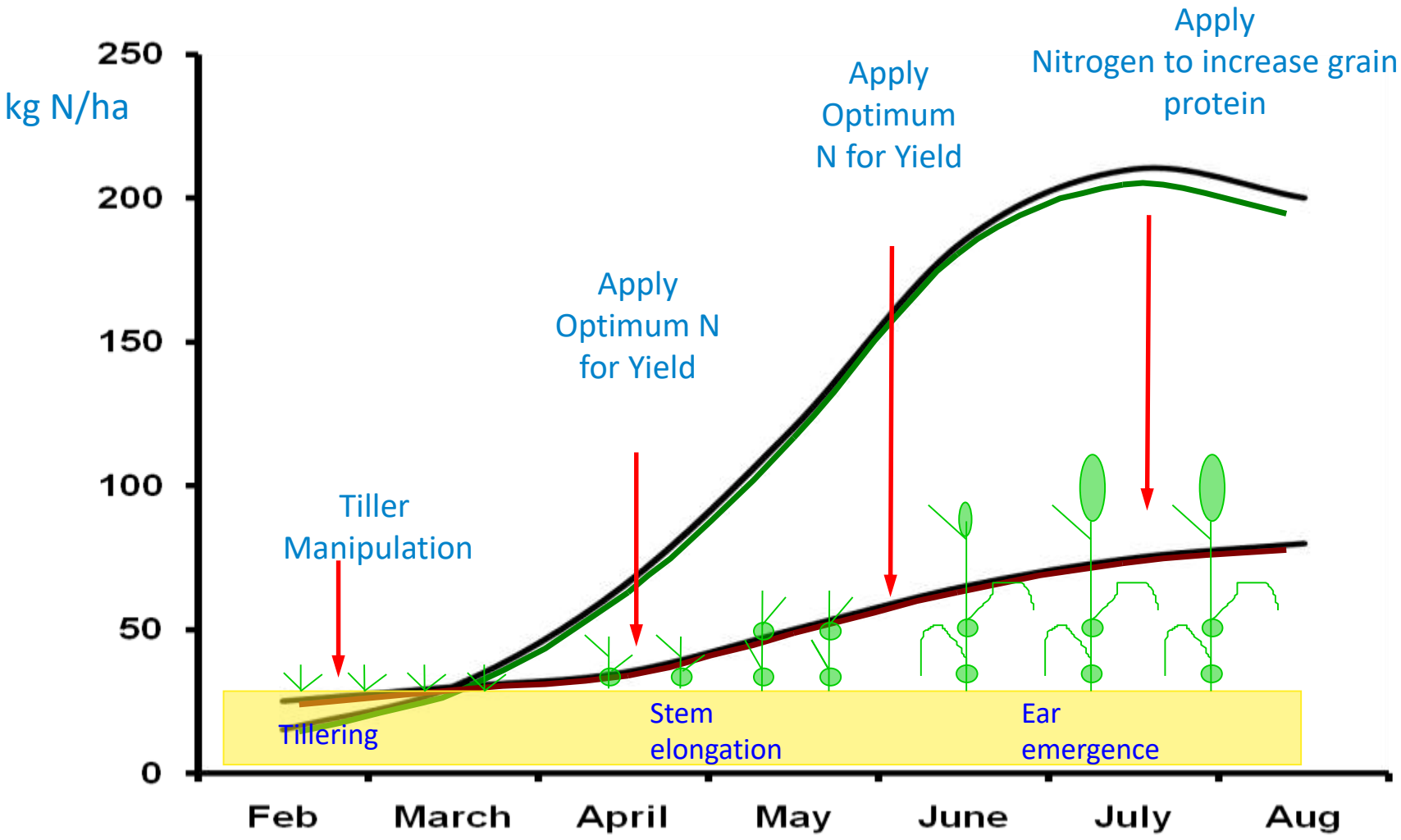
Results

Variety	Date	DON ppb.	Hagberg	Moisture ISO712	Natural Wt. Kg/Hl	Protein	Screenings	ZON ppb.	Acc no	Locality	Qty	Sample ref	Pac
Siskin	26th Jul 2018		0.000	11.820 %	68.900	14.420 %	4.900 %		032923	COOPERS	49.000	HG77000	
Siskin	26th Jul 2018		320.000	11.960 %	74.000	13.120 %	4.400 %		032923	COTMANS	49.000	HG77001	
Siskin	26th Jul 2018		332.000	12.530 %	73.200	13.190 %	3.500 %		032923	HENYARD	49.000	HG77002	
Siskin	26th Jul 2018		280.000	12.820 %	70.700	13.660 %	2.800 %		032923	SLAD	49.000	HG77003	
Siskin	3rd Aug 2018		363.000	11.700 %	71.600	13.480 %	2.900 %		032923	WORKS	49.000	HP217321	
Siskin	3rd Aug 2018		378.000	11.500 %	73.000	12.850 %	3.400 %		032923	CANAL	49.000	HP217322	
Skyfall	26th Jul 2018		358.000	12.450 %	79.900	13.260 %	1.800 %		032923	MUTOX E	49.000	HG76999	
Warburtons Skyfall	3rd Aug 2018		376.000	11.100 %	78.400	13.360 %	1.900 %		032923	PRARLE	49.000	HP217316	

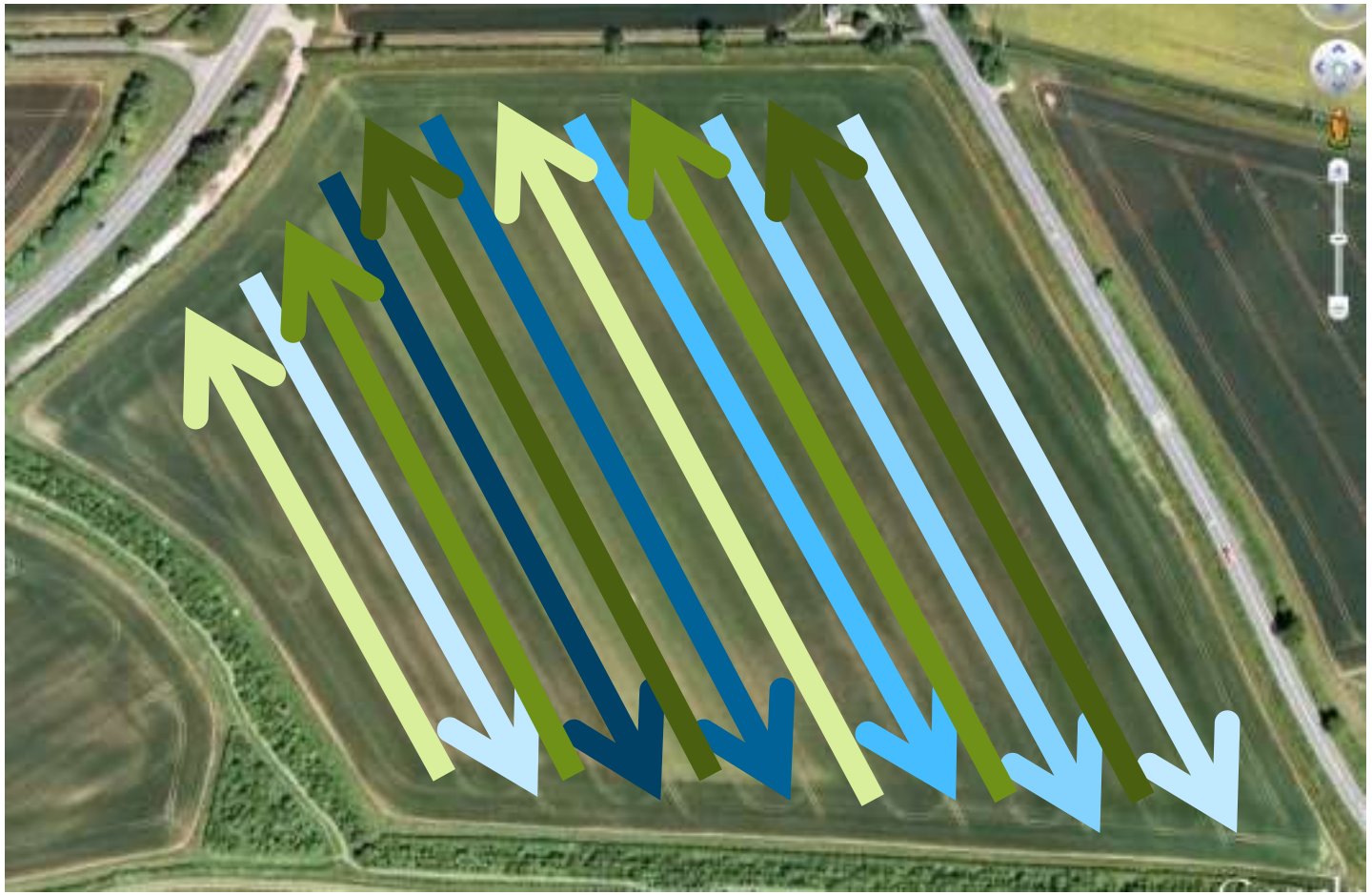
Nutrition

- Aim for total of 240kg N
- No bagged P and K for over 10 years
- 4 Splits – Liquid N+S then solid AN
- Challenge of no Nufol for Warburtons
- N-Sensor used throughout

Nutrition

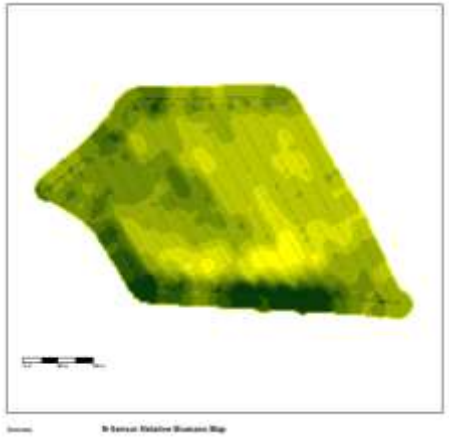

kg N/ha
250
200
150
100
50
0
Feb
March
April
May
June
July
Aug
Tiller Manipulation
Apply Optimum N for Yield
Apply Optimum N for Yield
Apply Nitrogen to increase grain protein
Tillering
Stem elongation
Ear emergence

Nutrition

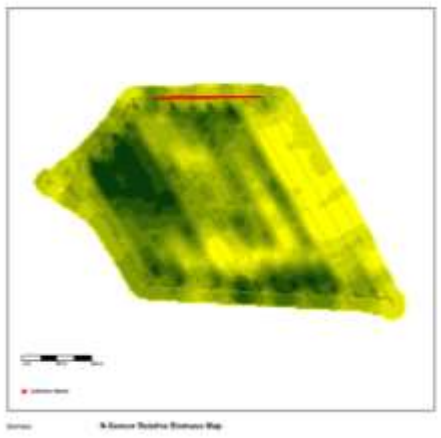


- Blues – Variable Rate
- Greens – Flat Rate

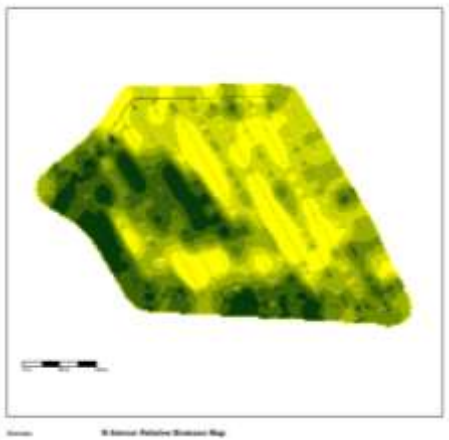
Nutrition



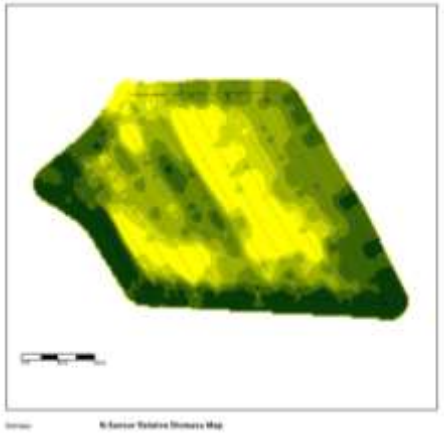
1st Application



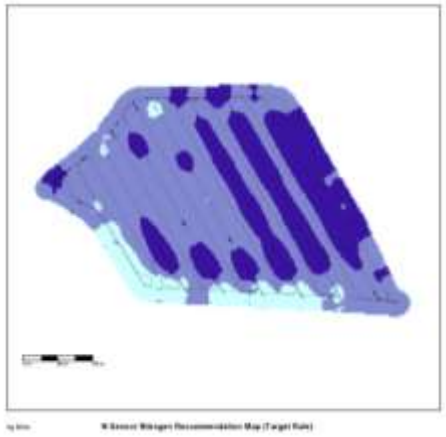
2nd Application

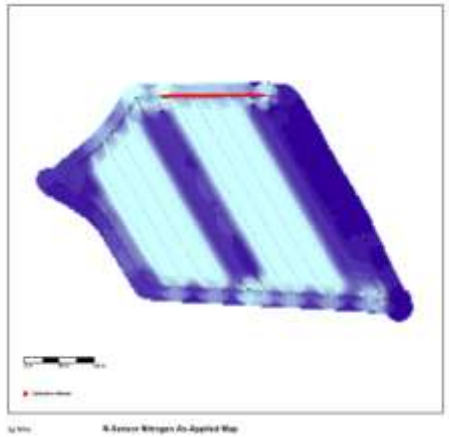


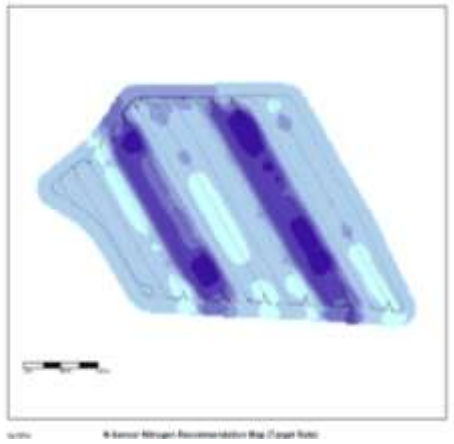
3rd Application

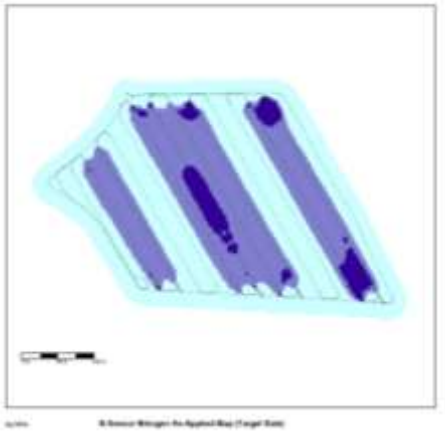


4th Application

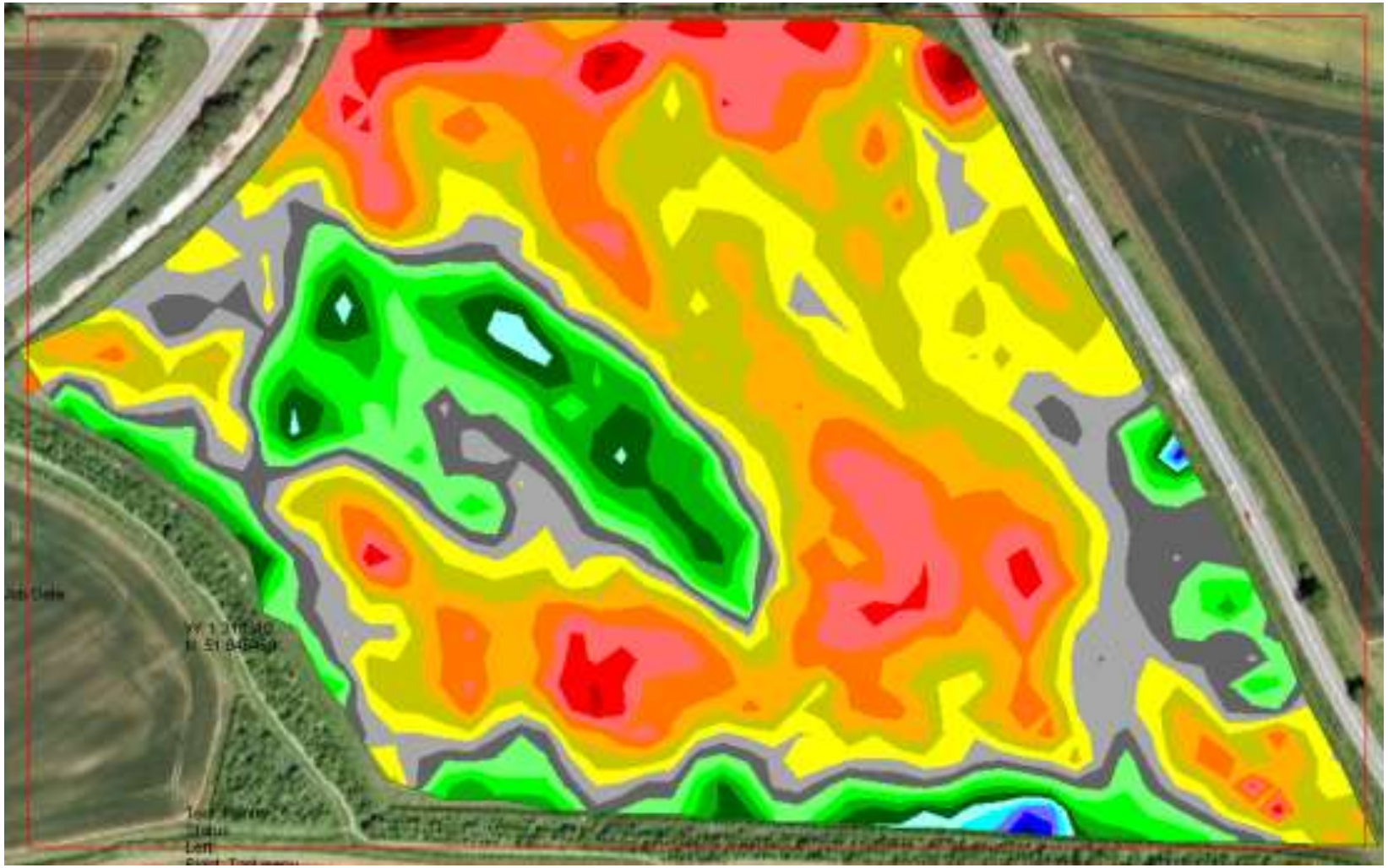








Nutrition



AHDB

CEREALS & OILSEEDS

Nutrition

- Fresh P and K
- What is my limiting factor?

Fungicide Strategy

- Do I have a choice?
- T0 if necessary, not for past 2 years
- T1 – SDHI plus CTL
- T2 – SDHI plus azole/CTL
- T3 – Azole, cheap/expensive depending on season

Harvest Management

- Combining
- Drying
- Storage

PRICE BAKER

Marketing

- Group Cereals – Centaur – Openfield
- Warburtons
- Price+ Contracts where possible
- 50:50 Group 1 and 2
- Mix of pools, forward sales and spot price
- August 18 - £205/t

Am I doing anything differently?

- Organic Manures
- Precision Farming
- Net Margin Maps
- Cover Crops with Livestock

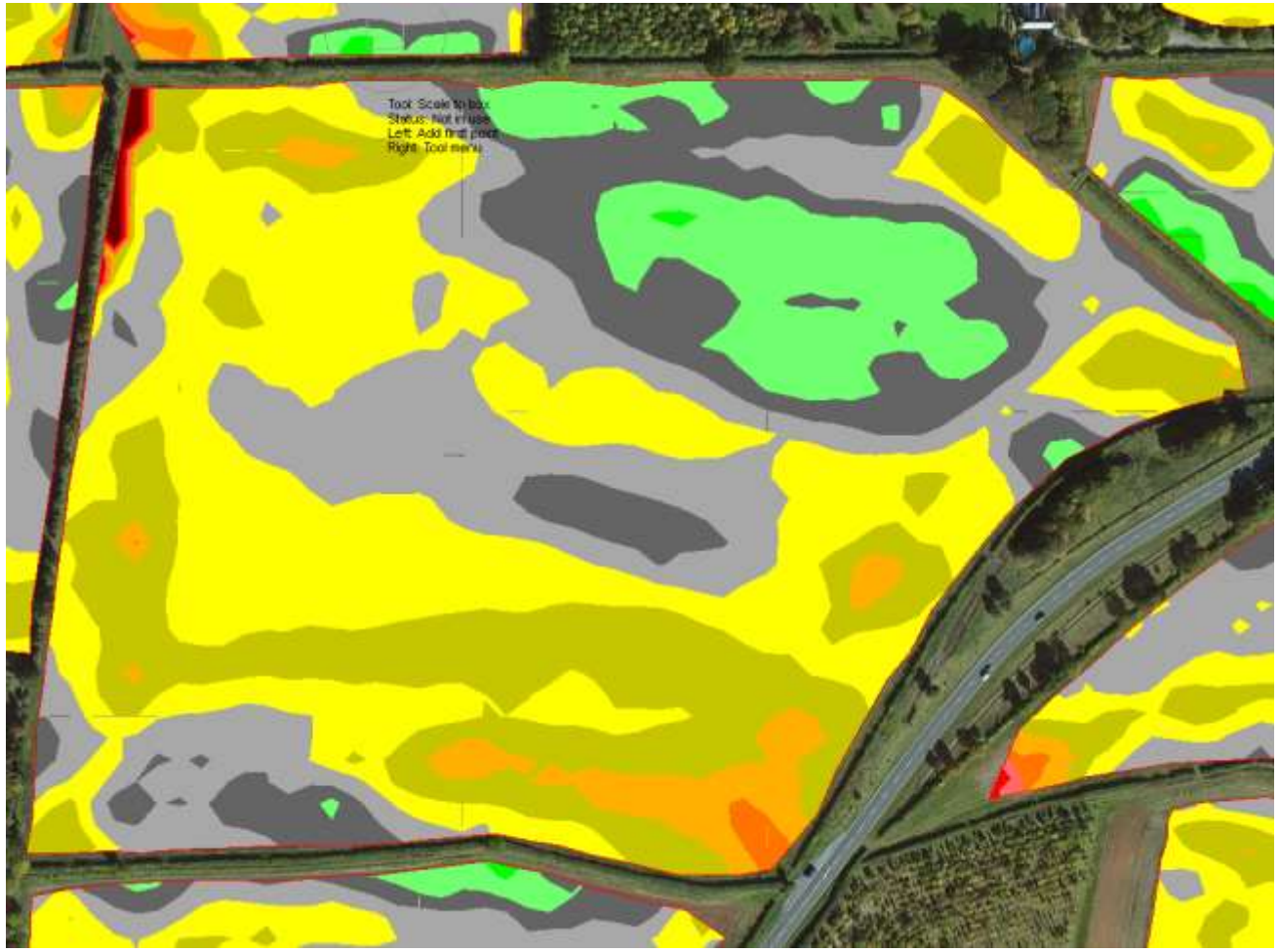
Organic Manures

Precision Farming

- N-Sensor
- Database of soil analysis alongside OM tests
- Autosteer
- Telematics
- Wireless Data Transfer

Normalised Yield Variation Maps

< 10%
10% - 20%
20% - 30%
30% - 40%
40% - 50%
50% - 60%
60% - 70%
70% - 80%
80% - 90%
90% - 100%
100% - 110%
110% - 120%
120% - 130%
130% - 140%
140% - 150%
150% - 160%
160% - 170%
170% - 180%
180% - 190%
> 190%



CEREALS & OILSEEDS

Cover Crops

AHDB

CEREALS & OILSEEDS

The Future

- Varieties
- Loss of actives
- Contracts
- New Land
- Marginal Land removal
- Should I just be aiming to grow a 7t crop?

Capturing and maintaining quality – storage and drying

Philip Darke – Camgrain Stores Ltd

CEREALS & OILSEEDS

Farm and Customer Requirements

- Variety Selection
- When do I intend to combine the crop?
  - at the start of harvest
  - at the end of harvest
- Combine and drying capacity
- What is the target market for the crop?
  - premium – milling wheat / malting bar
  - feed
  - a mix of the above
- How robust is hagberg / quality retention?

Premium crops

- Combine promptly
  - within 7 days of optimum
  - depending on weather
    - ambient temperature
    - moisture
    - crop maturity

How robust is my system for crop storage?

- Great in a dry year
- Wet harvest
  - I sit on the side of the field and wait for good weather
  - Yield and quality sliding
  - Premium for quality going up
- Store cleaning down programme
  - use of pre harvest chemicals
  - use of post harvest chemicals
- Laboratory and sampling procedures
  - moisture, germination, mycotoxins, ergot
- Segregation
- Moisture measurement crucial
  - calibration of moisture meters / laboratory equipment
  - does the moisture go up in store?

Drying options

- High temperature drying

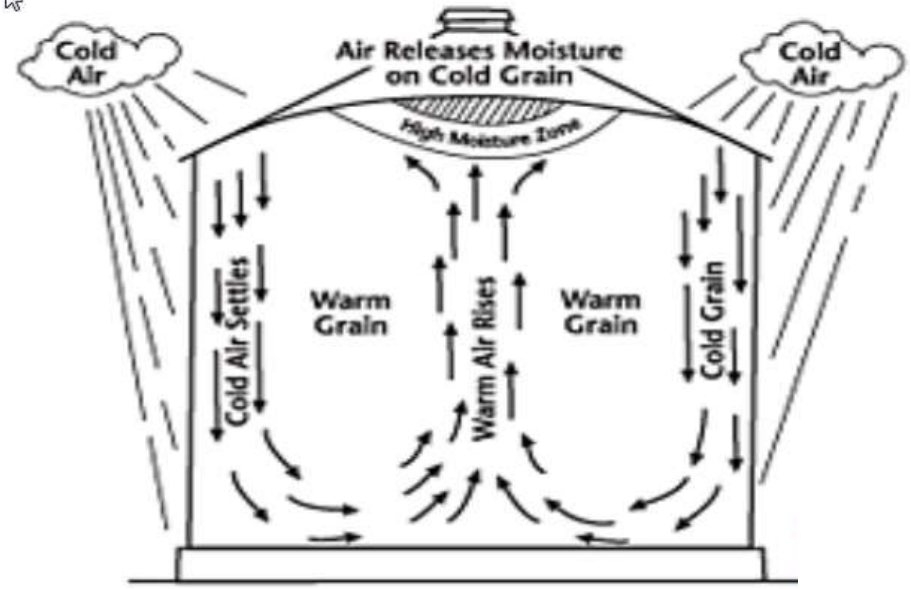
- Bulk drying

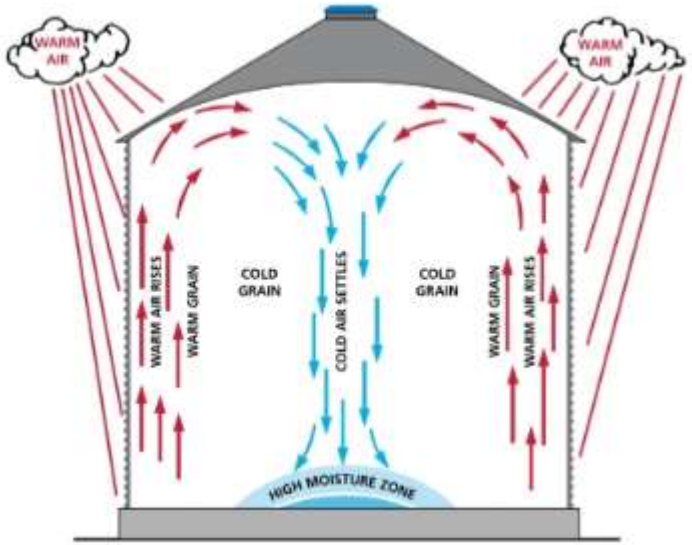
High temperature grain drier

- Holding capacity
  - with aeration / without aeration
- Dry capacity
- Read the drier manual!
- Servicing and preparation – crucial
  - clean out drier
    - first fire opportunity
    - grain hung up from last year
    - Insect infestation opportunity for new crop
- Operation and calibration of burners
- Temperature gauges
  - air on – do not exceed!
  - grain temperature – do not exceed!
- Can you dry in one pass?
  - don't run drier too slow!
  - fire hazard
  - blend and aerate carefully to drier where possible – steady speed
  - for fuel efficiency avoid running drier taking small % moisture out

Post drier action

- Cool
  - careful use of power
  - temperature differential? high / low
  - reduce from 30ºC plus asap
- Eliminate temperature gradients
- Avoid sweating of silo and flat store
- Storage term – 1 month, 11 months, overyearing?
- Target temperature 5ºC, 10ºC, 15ºC?
- Start fan as soon as possible after harvesting and average outside air temperatures are at least 5ºC cooler than the grain in the bin
- Important if large moisture and / or temperature variations
- Ideal grain temperature is 5-10ºC during the entire storage period

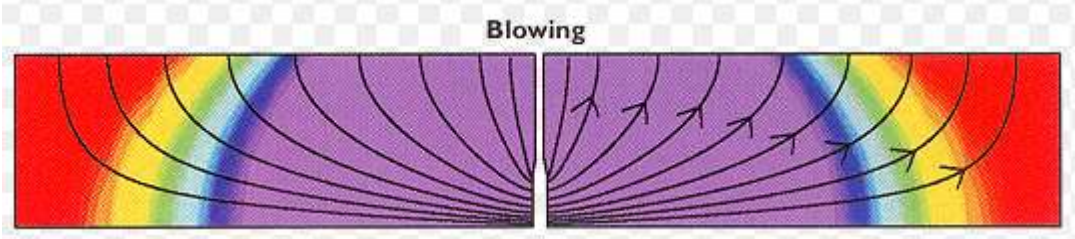




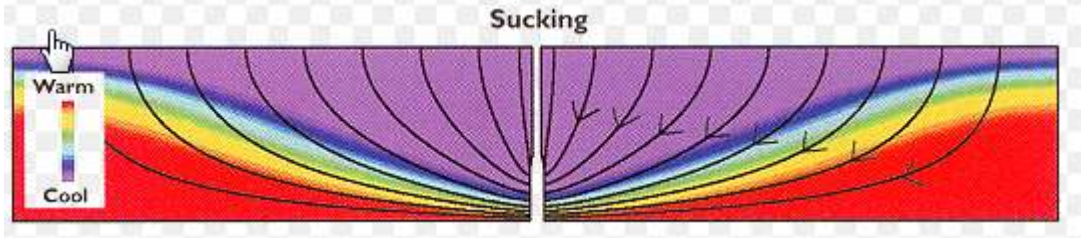
No ventilation

Which air flow direction should be used?

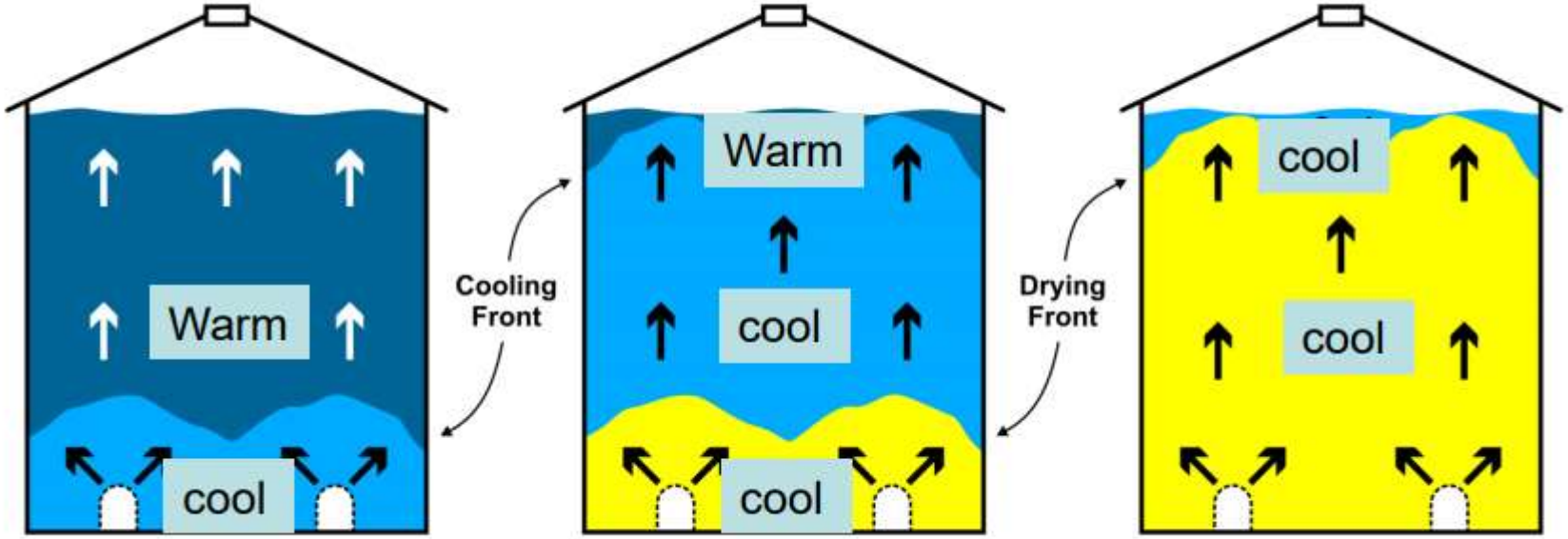
- Upward flow
  - Fan blows air into the duct (traditional method)



- Downward flow
  - Fan sucks the air (used under special conditions)



How aeration systems work?



Importance of cooling front

Bulk Drying

- Bulk Drying
  - How long to dry?
  - Accurate moisture measurement
- Monitoring
  - Regular in bulks / how regular?
- Insects
  - gestation period
  - temperature
  - more insects everywhere
  - how good was cleaning program, will find out end of October ish!
- Temperature monitoring
  - automate if possible
  - calibration of systems

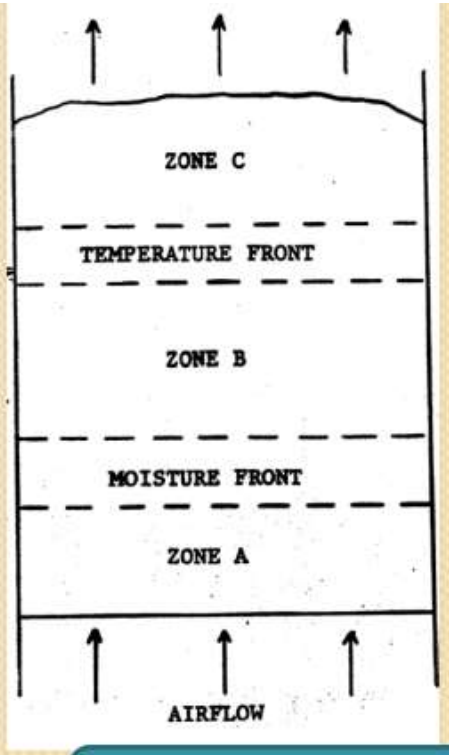
Principles of Aeration and Drying

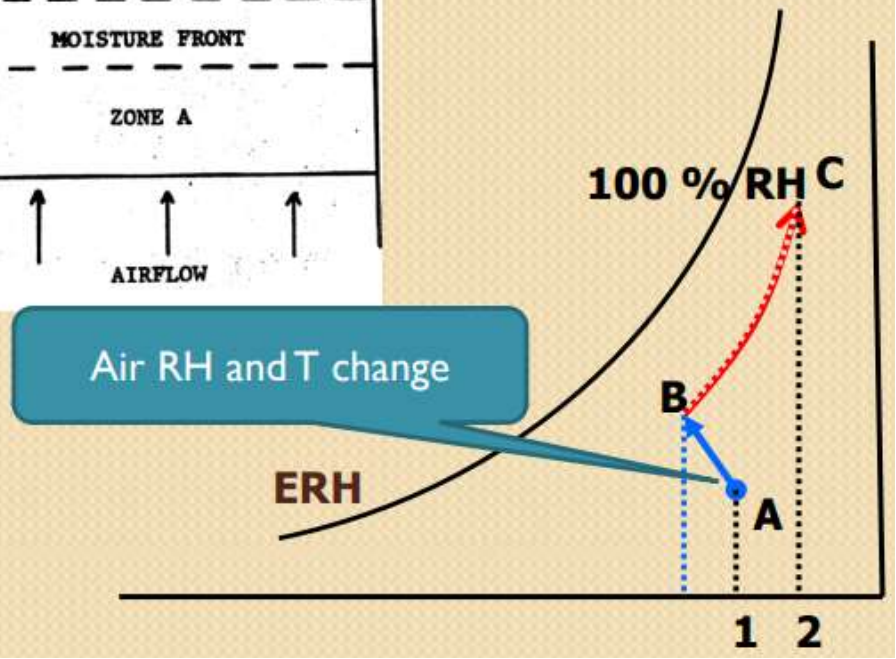
I: Cold and dry ambient air

1: A: Air condition
2: C: Grain condition

Drying of grain occurs in both the temp. and moisture fronts

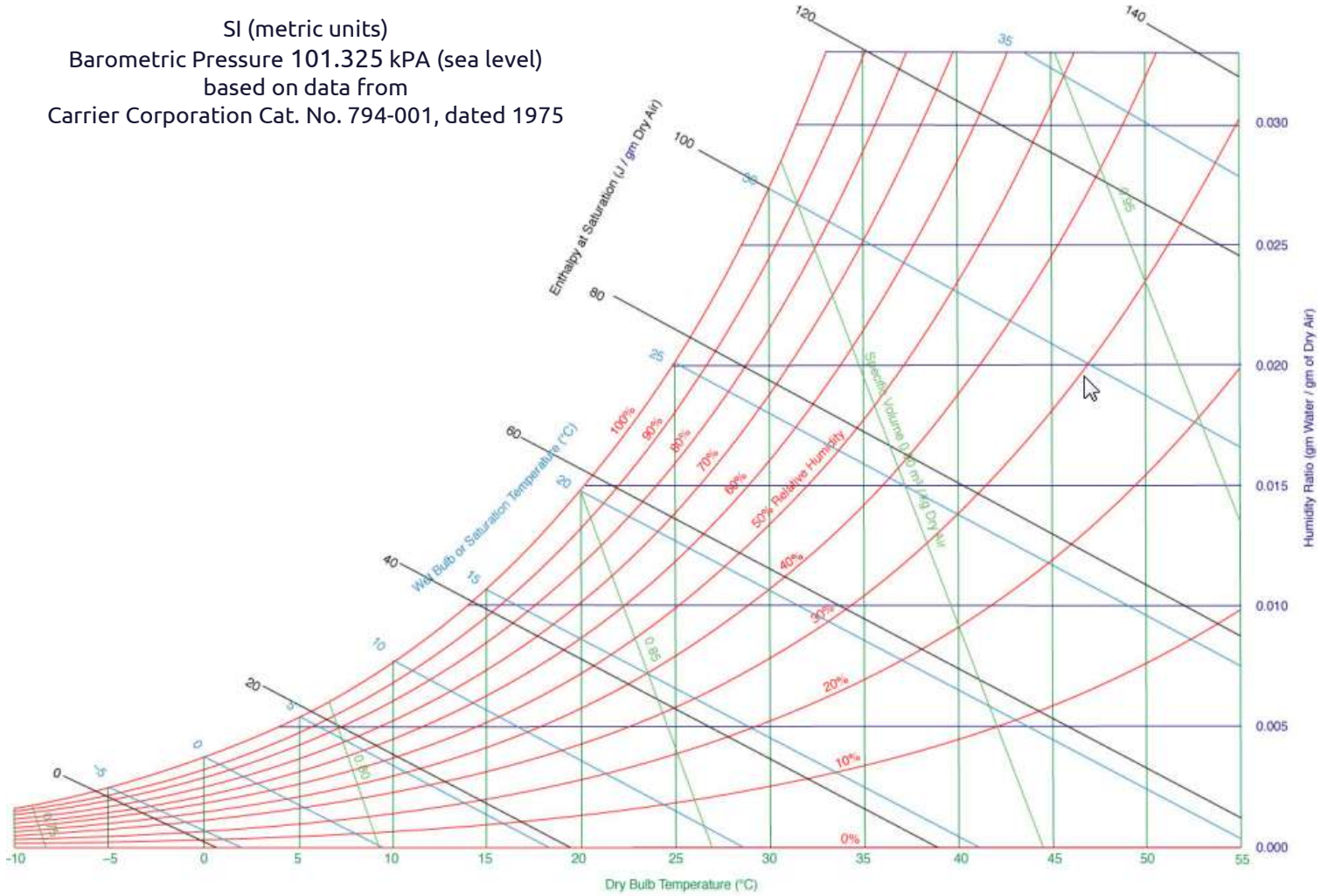
A: Zone A
B: Zone B
A-B: Moisture/drying front
C: Zone C
B-C: Temperature front



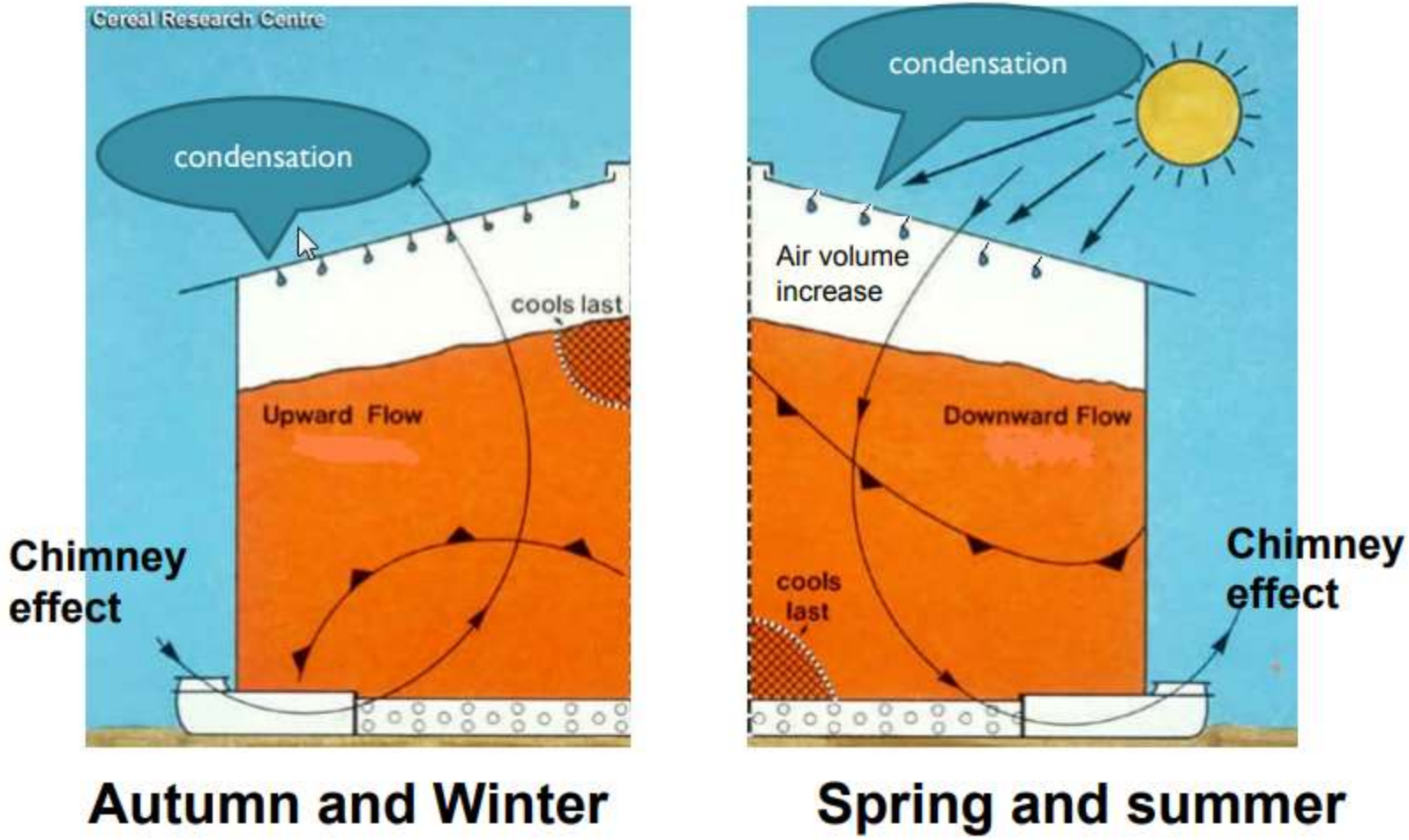


Psychrometric Chart

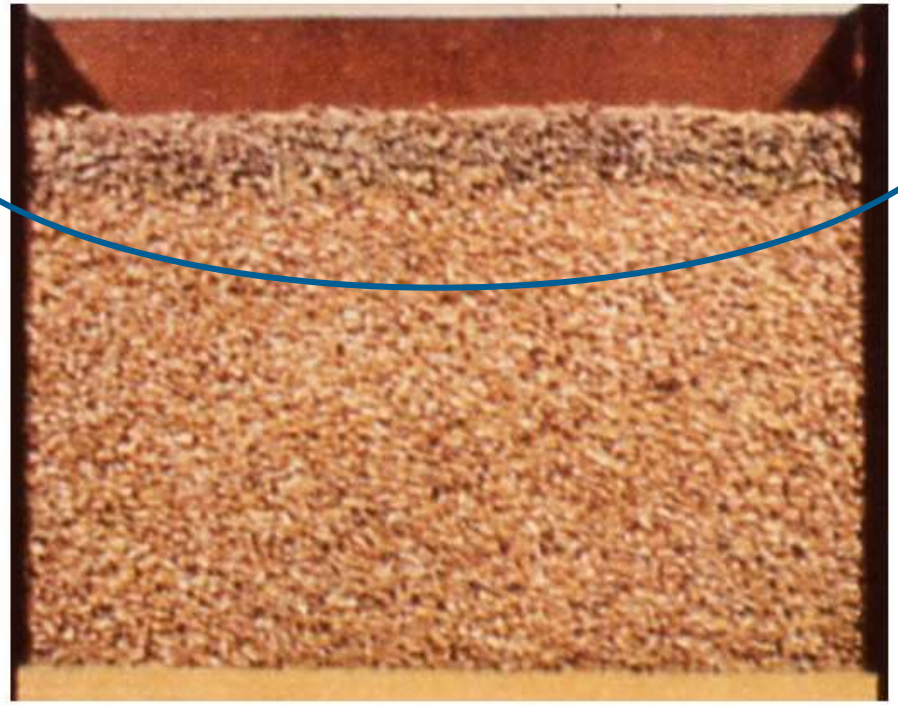
SI (metric units)
Barometric Pressure 101.325 kPA (sea level)
based on data from
Carrier Corporation Cat. No. 794-001, dated 1975



Why should the fan be sealed when not being used?



Bulk capping / mould formation



- Temperature front didn’t make it.
- Moulding started before aeration was completed.
- All points of the temperature front must get all the way through the grain

Managing bulks

- Condition can be corrected by keeping the grain levelled or coring the grain.
- Lower than 15ºC air has limited air holding capacity. Therefore, night air will not dry grain, but can cool grain.
- The best drying condition of the ambient air is decided by the combination of both air temperature and relative humidity. Not only the air temperature.

Important points

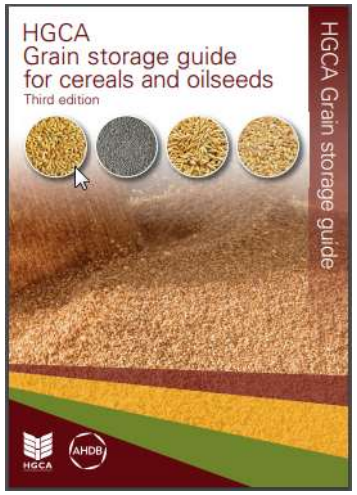
- Always act promptly
- Risk Assess - how large is bulk
- Attention to detail
- Good hygiene practices - effective pest control, clean up spills

Golden Rules

- Aeration - Most crops can be held with good ventilation
- Segregation – Avoid contamination e.g Ergot, mycotoxins, fusarium, other crops
- Water tight - - a water leak, roof or silo. Difficult to spot, can be catastrophic.

References

- HGCA / AHDB Grain storage guide for cereals and oilseeds



Miller Panel Discussion

CEREALS & OILSEEDS

HEYGATES
FLOUR & ANIMAL FEED MILLERS
www.heygates.co.uk

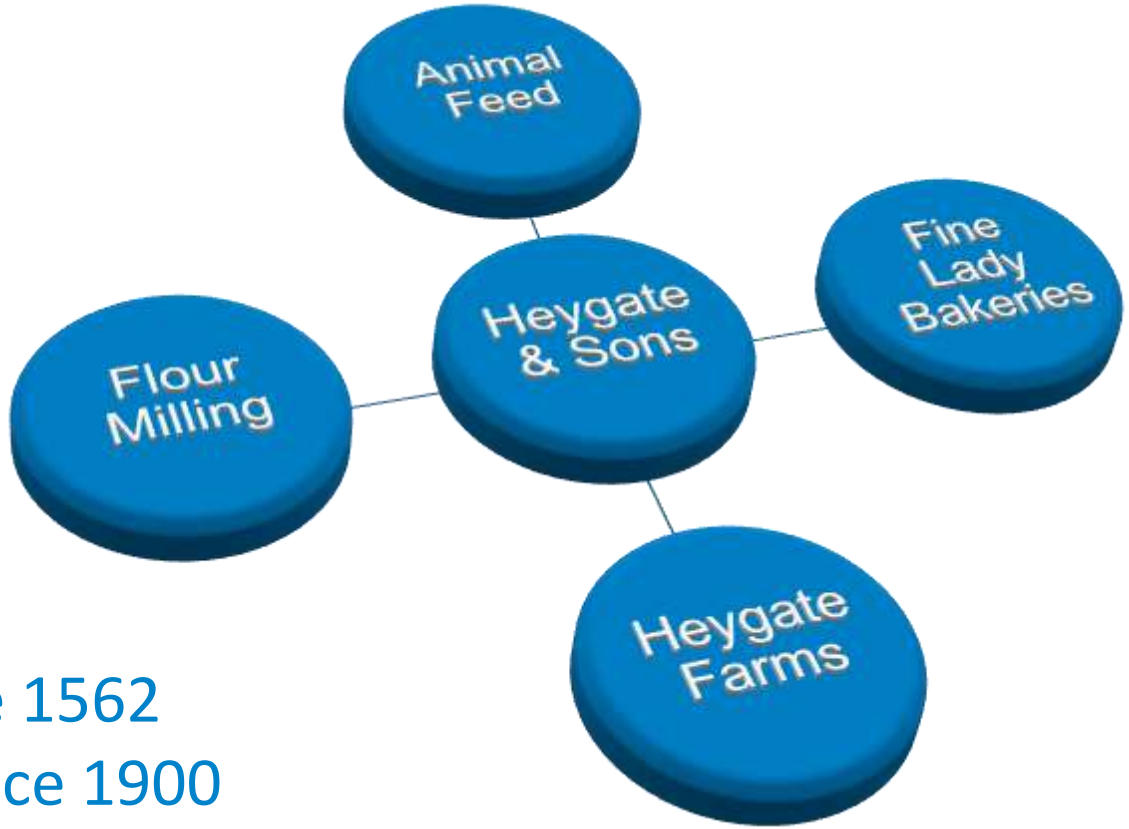
AHDB

Heygates – the UK milling Industry

George Mason

CEREALS & OILSEEDS

Heygate Group



Farming since 1562

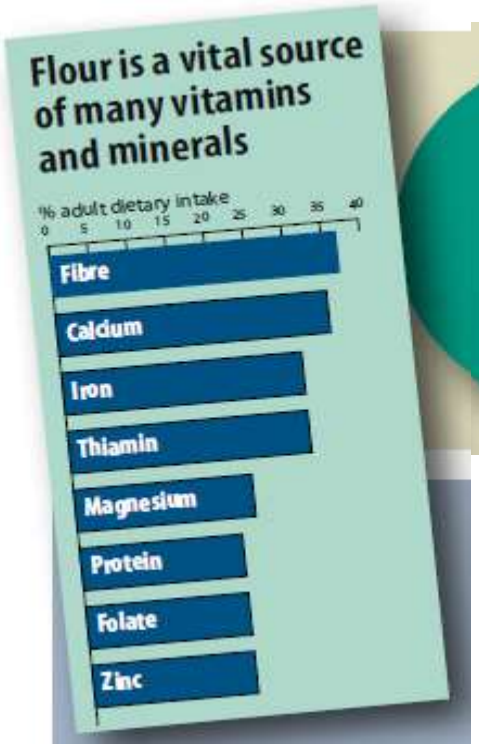
Milling since 1900

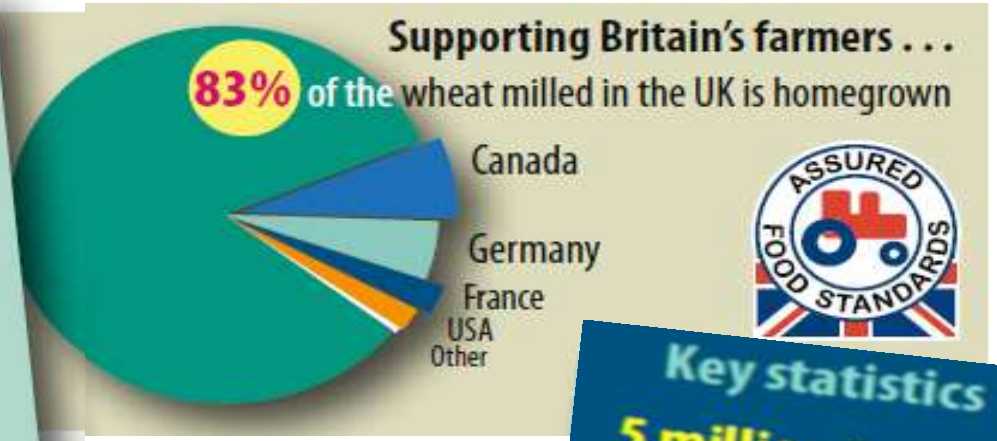
Baking since 1965

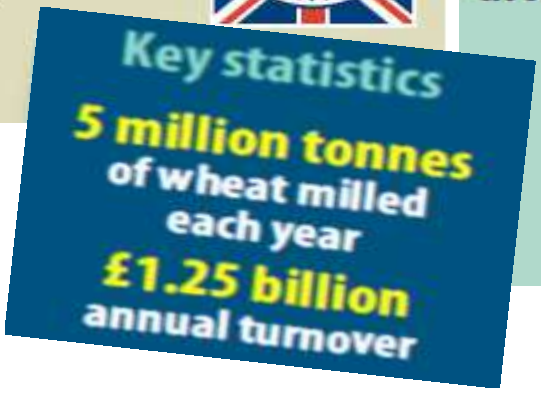
Milling wheat sector

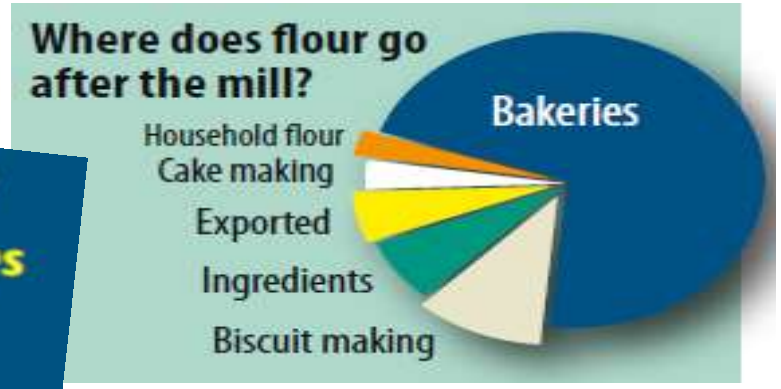
- One of the oldest & traditional UK Industries
- Although consolidating it is a reliable, solid market:
  - 29 companies operating 48 mills
  - 5 million tonnes / year worth over £1.25 billion in annual turnover

Flour demand









BREAD MOST POPULAR
ITEM BOUGHT IN BRITAIN

99.8% HOUSEHOLDS BUY BREAD

MORE PEOPLE IN BRITAIN BUY BREAD THAN TOILET PAPER

STRENGTHENING
BRITAIN'S ECONOMY

5 million tonnes of wheat milled each year

£1.25bn annual turnover

130 million SLICES OF BREAD

5 million PACKETS OF BISCUIT

4.5 million CAKES & BUNS

2 million PIZZAS

MADE FROM BRITISH FLOUR
ARE PURCHASED IN THE UK EVERYDAY

All Grades & Varieties required

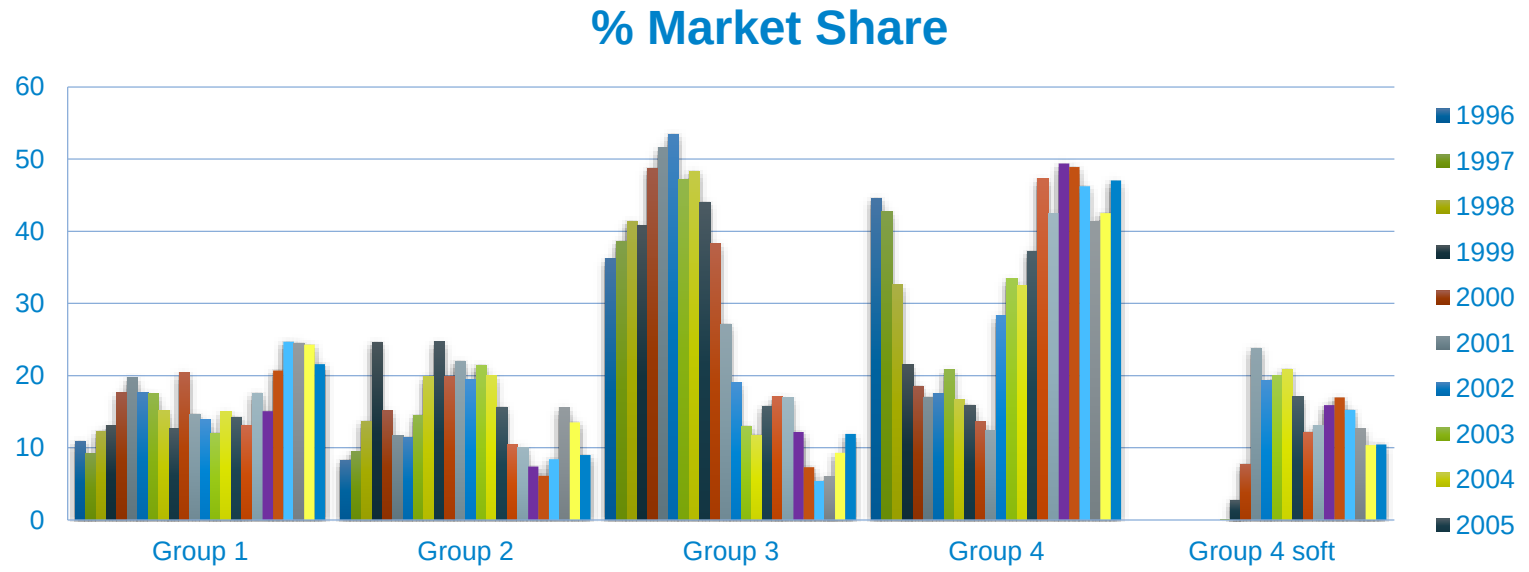
Group 1

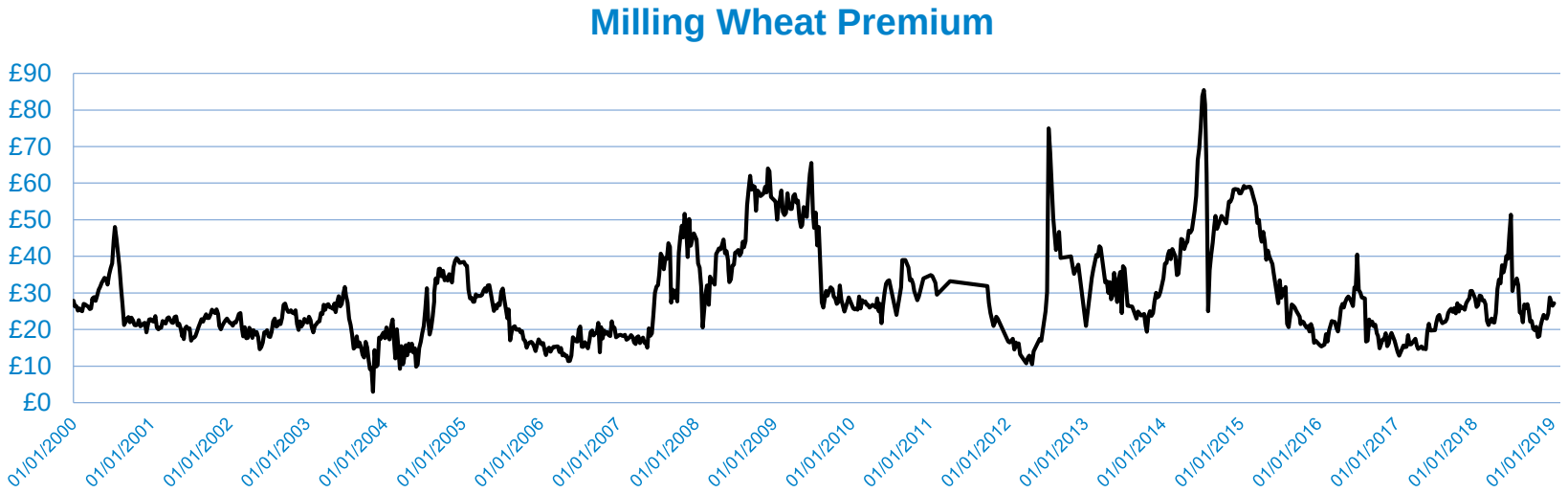
Group 2

Group 3

Group 4 Hard

Group 4 Soft





Political Freedom

Freedom for farmers to flourish to their full potential,
Freedom to trade unhindered & without restriction

Tariffs

Wheat €95.00 per tonne, Flour €172.00

CARR'S

• GETTING THE BEST OUT OF WHEAT •

AHDB

Carr's Flour Mills – getting the best out of wheat

Julius Deane

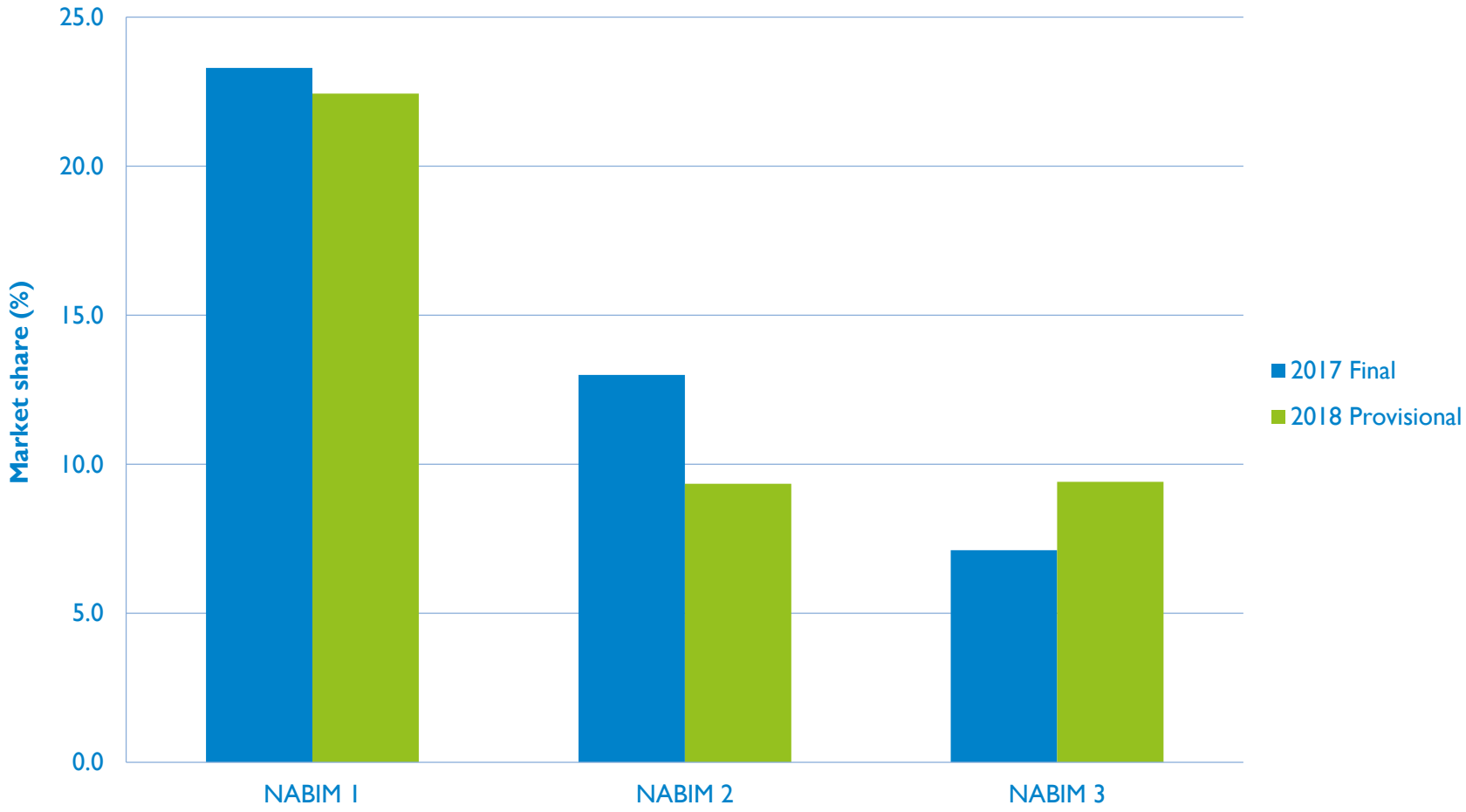
CEREALS & OILSEEDS

Carr's Flour Mills

CEREALS & OILSEEDS

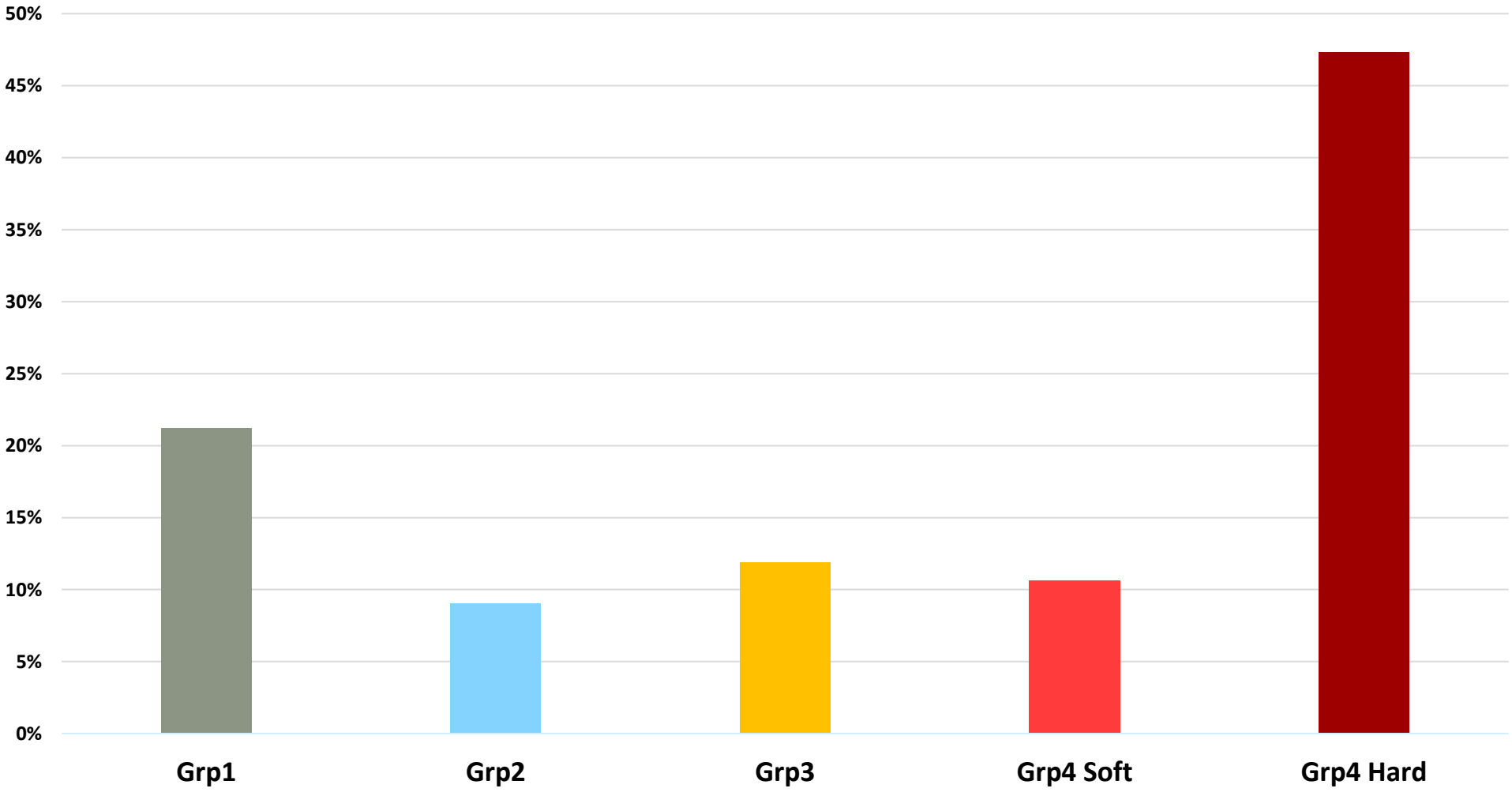
Soft wheat – UK supply

Certified Seed harvested 2018 – England & Wales



Soft wheat – UK supply

Estimated plantings for Harvest 2019 - UK



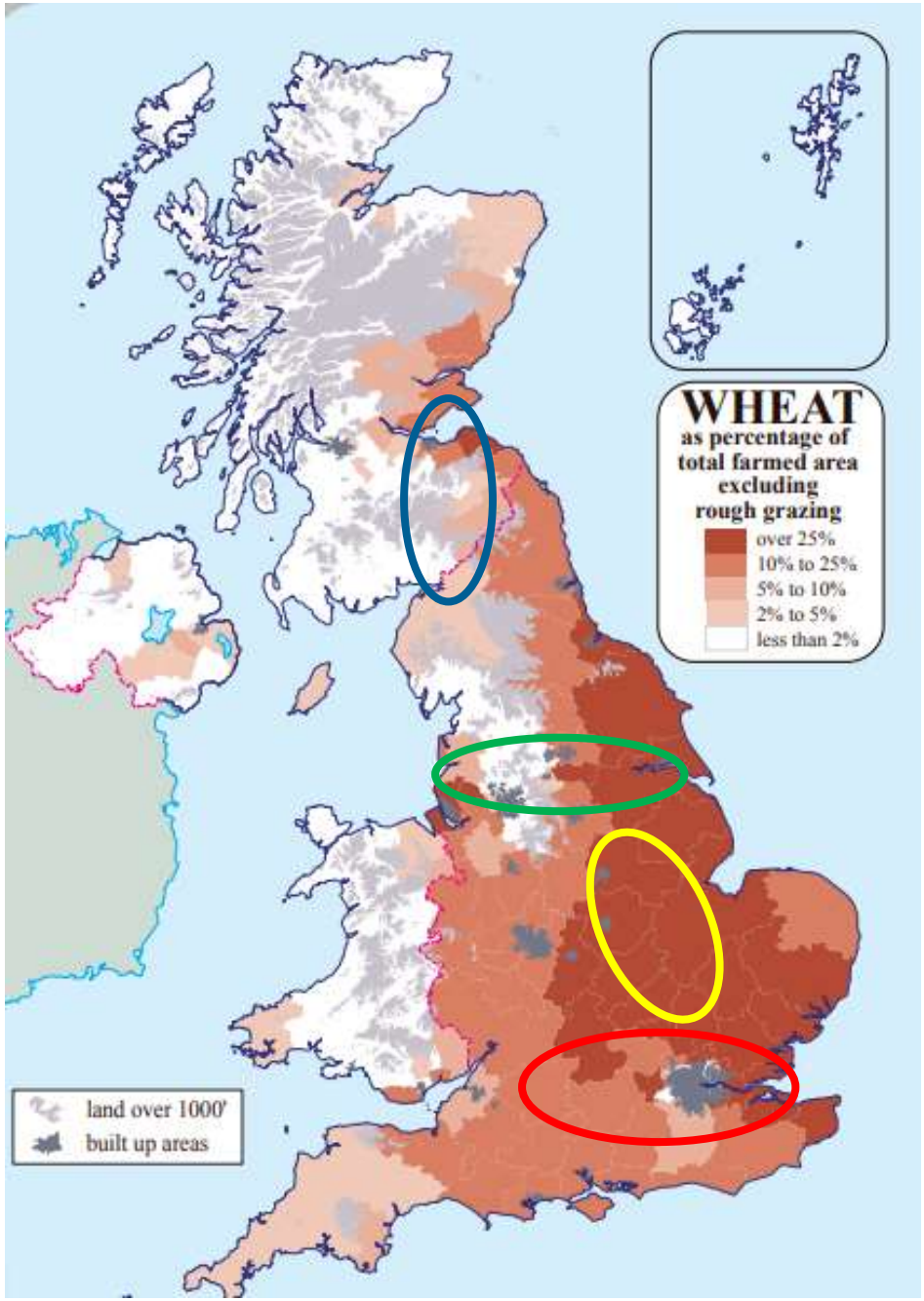
Soft wheat – UK demand

- 6 million Ginger Nuts and 6.5 million Custard Creams made every day!
- UK Flour millers require 800,000-1,000,000 tonnes soft wheat each year
- Starch/Alcohol/Ethanol millers require 2-3 million tonnes – preferably soft wheat
- Ongoing export requirement for uks

- Flour milling demand for soft wheat is there and regular – and there are few alternatives…

UK Milling Wheat Geographical demand

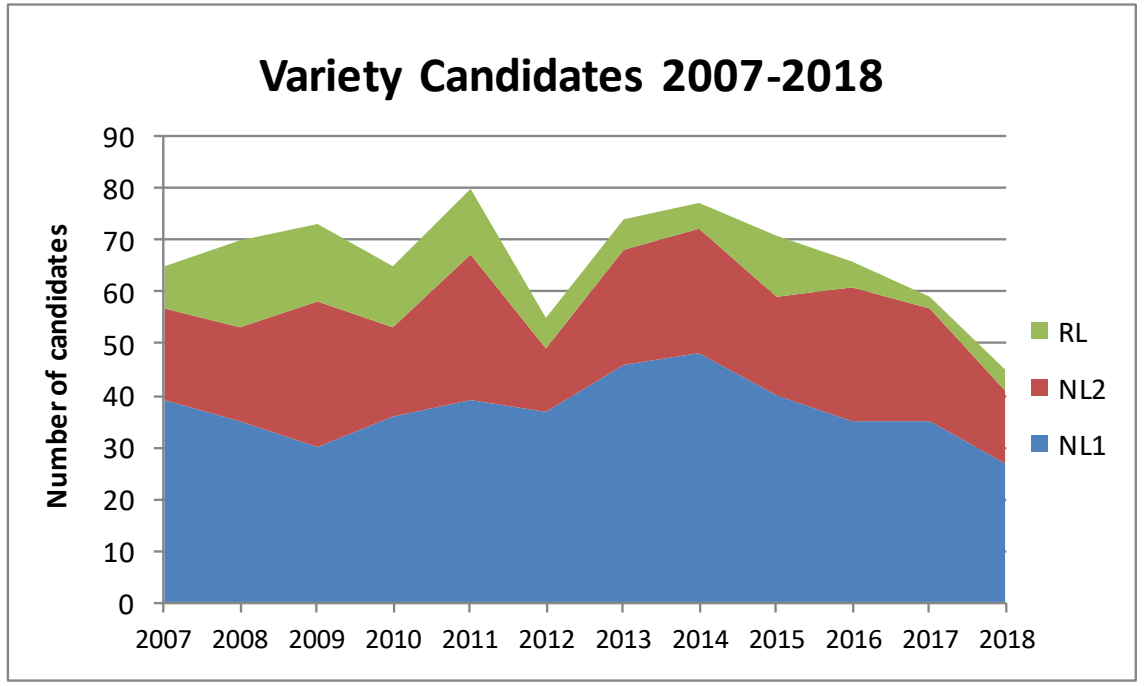
- Scotland & Cumbria – 3 mills
- M62 – 10 mills
- Midlands – 9 mills
- South – 10 mills



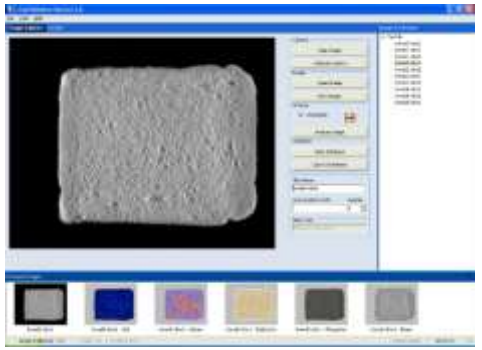
nabim Varieties Working Group

Wheat testing

Flour/dough testing



Baking tests using various baking systems



nabim Varieties Working Group

- Cross-Industry group that agrees the "***nabim*** Groups"
- See new variety samples from 5 years before large scale wheat supply
- Final commercial milling on Bread wheat before full Grp1 status given
- Gives certainty to grower and miller

EB Bradshaw & Sons - Traceability in Flour Milling

Stuart E. Bradshaw

Bell Mills, Driffield

Picturesque home of E B Bradshaw & Sons Limited

BRADSHAW

Original Bell Mills was completely destroyed by fire in 1949.

The mill was rebuilt between 1950-52, the first All Metal Mill in the world.

A segregated wheat store was built in 1955, giving the site a total of 98 wheat bins, 6,500T total capacity. Also two flat stores

All wheat bins have a cruciform on the hopper, allowing FIFO emptying.

Wheat can be tracked in time and space.

Once blended (a grist) this too can be tracked and traced.

For most flour, it is all about the wheat. Varieties are like different sized stones being placed into a dry stone wall.

Get it right, the wall stands for 100’s of years. Get it wrong and it falls down.

This is the importance of keeping varieties separate.

Knowing what varieties work well on your farm - both agronomically and economically.

Keeping accurate records.

Growing for markets.

Reliable and Resilient Haulage Sector

The whole of the Grain Chain needs :

Efficiently schedule and complete grain collections.

Supply accurate records.

Driver demographic is ageing.

ADM Feeds Your Food Business

ADM Milling UK – Technical challenges and opportunities

Simon Penson

CEREALS & OILSEEDS

ADM Agriculture Ltd.

ROLLE, January 17, 2019.

Archer Daniels Midland Company (NYSE: ADM) today announced it has signed an agreement to purchase the remaining 50 percent stake of Gleadell Agriculture Ltd., currently jointly owned by ADM and InVivo, including Gleadell's wholly owned subsidiary Dunns (Long Sutton) Ltd. ADM will merge Gleadell and Dunns with ADM Arkady, ADM's UK destination marketing business, and ADM Direct UK, ADM's specialist combinable crop origination business to create ADM Agriculture Ltd, thus strengthening ADM's presence across the UK.

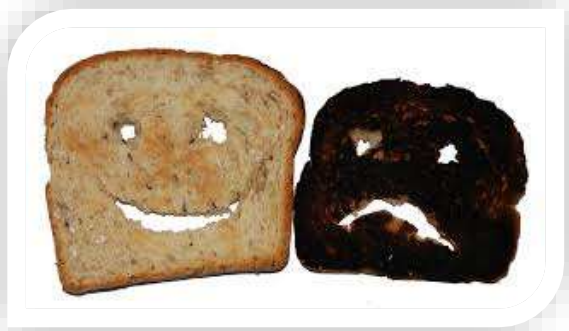
The transaction will increase ADM's origination, storage and destination marketing capabilities in the UK, allowing it to serve as the trading partner of choice for even more farmers and customers.

Technical challenges in the milling sector

- **Availability of Milling Quality Wheat**
- **Food Safety**
- **Product Quality and Product Development**
- **Legal and Regulatory Compliance**

Food Safety Challenges: wheat

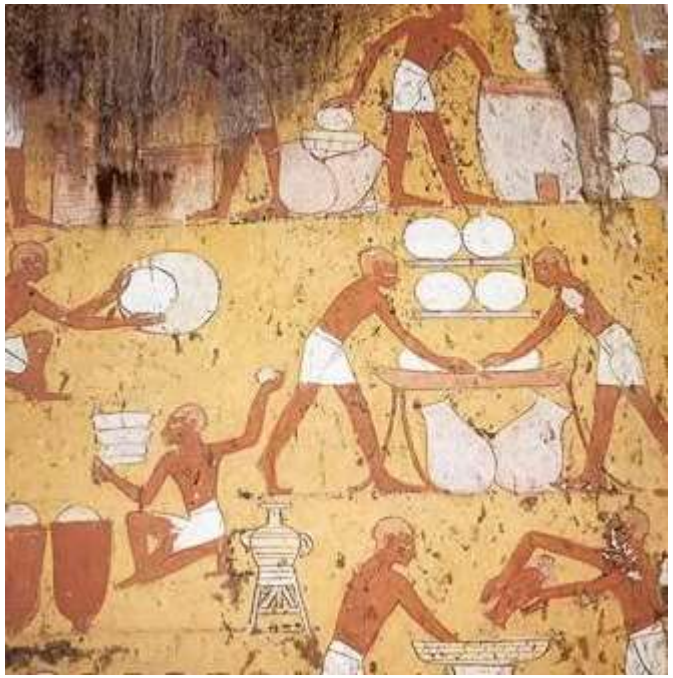
- **Contaminants**
  - **Physical**
  - **Chemical**
- **Mycotoxins**
- **(Acrylamide)**



Consumer Trends: Diversification and New Benefits

A bakers perspective on milling wheat and consumer expectations from the loaf

Eva Wheeler – Head of Technical – Allied Bakeries



Wheat made into bread since Ancient Egyptian times

…. So we should be experts by now!

Challenges

100% UK every year
Harvest transition
High output Bakeries
Loaf quality changes

Shelf – life
Consistency
Salt reduction

Consistency is key in a continuous batch process making 10,000 loaves per hour

Ingredients

5 x 70t Silo's

Mix for 180s

Cut into Dough Pieces @10000 loaves per hour

Weigh each dough piece

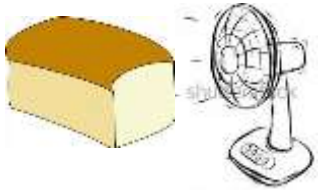
0 to 1.5 min

1.5 min to 10 min

Mould each dough piece

Prove for 55 minutes

Bake @ 230c for 21 minutes



Cool loaves for 2 hours

65 min to 206 min

10 min to 65 min

Slice Loaves @55 packs per Minute

Put each loaf in a bag and weigh for 800g

Deliver to our Customers

206 min to 215 min

215 min ready to dispatch

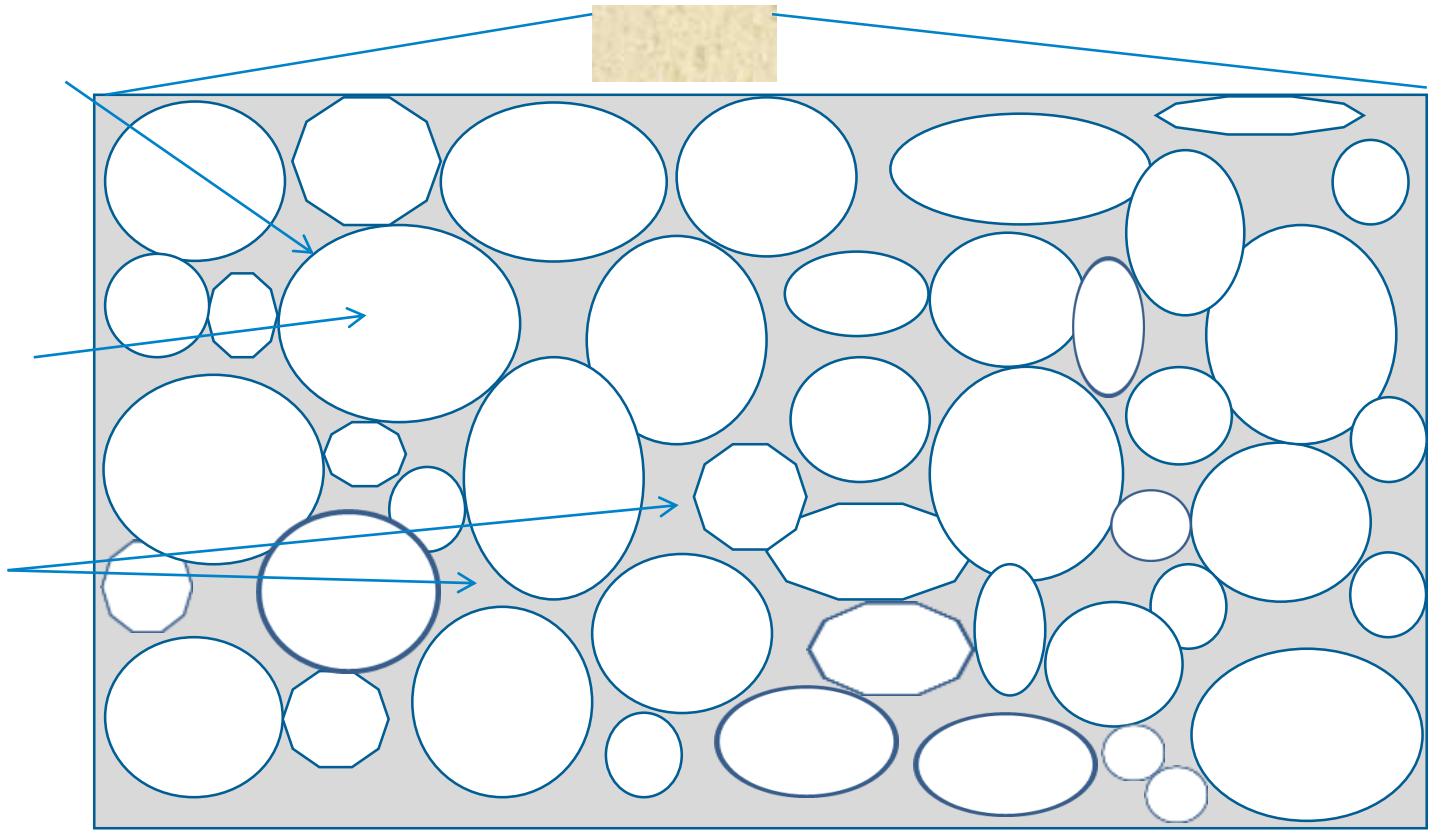
What's important for Bread Quality?

- ✓ Flour water absorption – Helps shelf life & yield
- ✓ Gluten quality – Helps dough development, crumb strength, oven spring, texture & whiteness
- ✓ Flour extraction process – Too much bran = collapse
- ✓ Natural flour enzymes – Can help or hinder
- ✓ Good dough rheology –Allows the bread to rise uniformly and helps moulding for good texture
- ✓ High Hagberg falling number – Stops sticky slices, gumming and high waste
- ✓ UK Group 1 Wheat varieties usually the best but blends of lower groups can add benefits and reduce costs
- ✓ At Harvest - Positive release through baking and quality checks is key & Consistency, Consistency, Consistency!!!!

A thin film of protein from flour (gluten)
forms a bubble

Yeast fills
The bubbles
with CO2

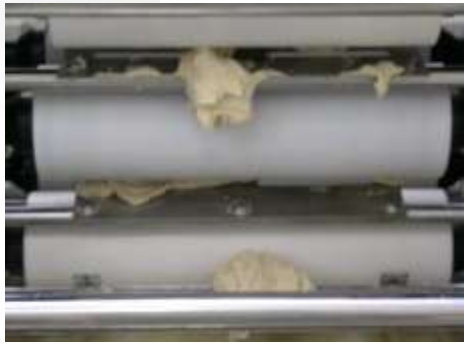
Starch fills
the spaces
and provides
Stability



Salt strengthens gluten & stabilizes the dough

1. Create bubble structure (Mixing)
2. Increase the size of the bubbles, raise the dough (Proofing)
3. Set the structure (Baking)
4. Cool, slice & wrap …. At speed

Effect of Salt, Sugar & Sat Fat Reductions



HIGH

Strengthens gluten & stabilises the dough = better, stronger crumb structure and butterability.
Aids shelf life and Impacts Taste!

Too little and we lose control of the dough (sticky), big bread, stales faster, bland

Levels have reduced > 25% over 15 yrs driven by Dept of Health Targets & more to come!

MEDIUM

Most bakery products contain very little added sugar. Declared comes from fermentation

Pancakes sugar reduction interesting!
Texture, calorie myths & substitutes

LOW

Most of our bakery products are low in saturated fat so not an issue for us

Focus on Green Palm the bigger issue

Consumer expectations

1) Loaf Softness = freshness perception – The 3 second loaf squeeze test in store

2) Slice softness – loaf lasts @ 1 week

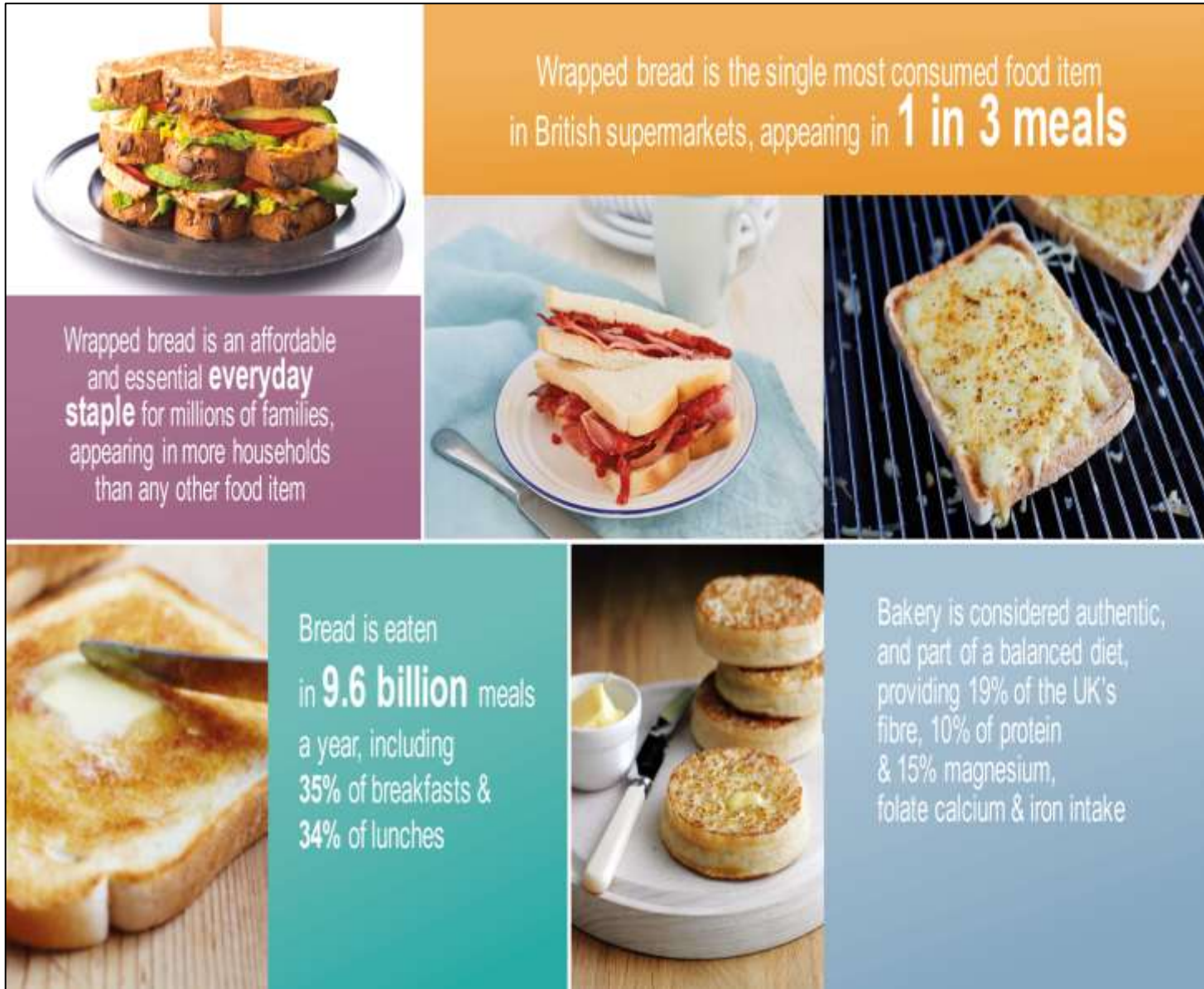
3) Butterability – Crumb Strength

4) Crumb resilience - good texture & Toast!

5) Even texture & colour – Too open and it will stale more quickly

6) Consistency – Bread is bought frequently so small differences are noticed

7) …. And yes … Tastes good!



In Summary – Remember the 3 C's

Consumer

- Freshness = softness
- Shelf life
- Health trends
  - Fact vs. fiction
- Small differences noticed

Challenges

- Made & delivered everyday
- Small differences noticed
- Health targets make it more difficult
- Baking needed before you know the true Quality

Consistency

- Highly automated plant Bakeries
- Harvest transition
- Consistency of product and flour key

Introduction to the
Yield Enhancement Network

Roger Sylvester-Bradley

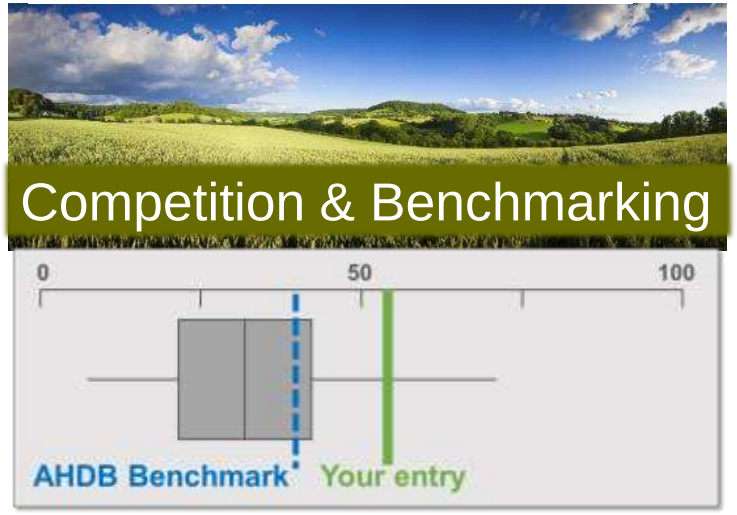
Head of Crop Performance, ADAS

CEREALS & OILSEEDS

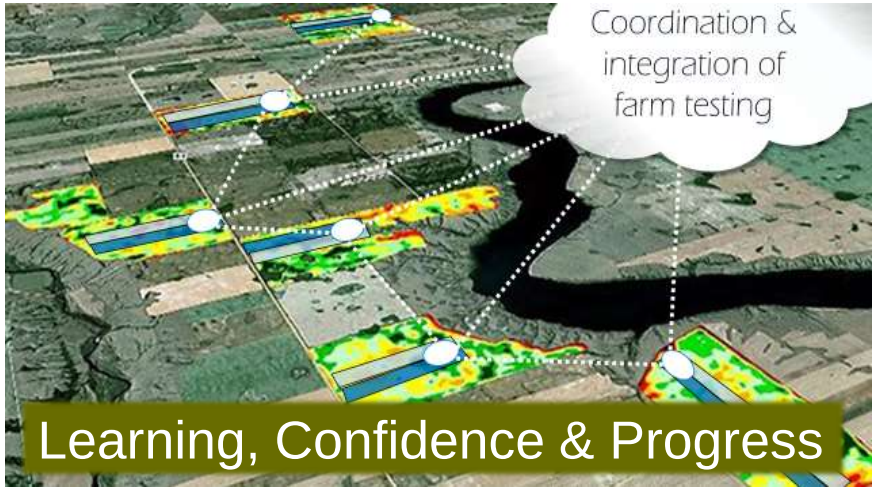
… to develop the confidence to do <u>better than 'best practice'</u>

Sharing

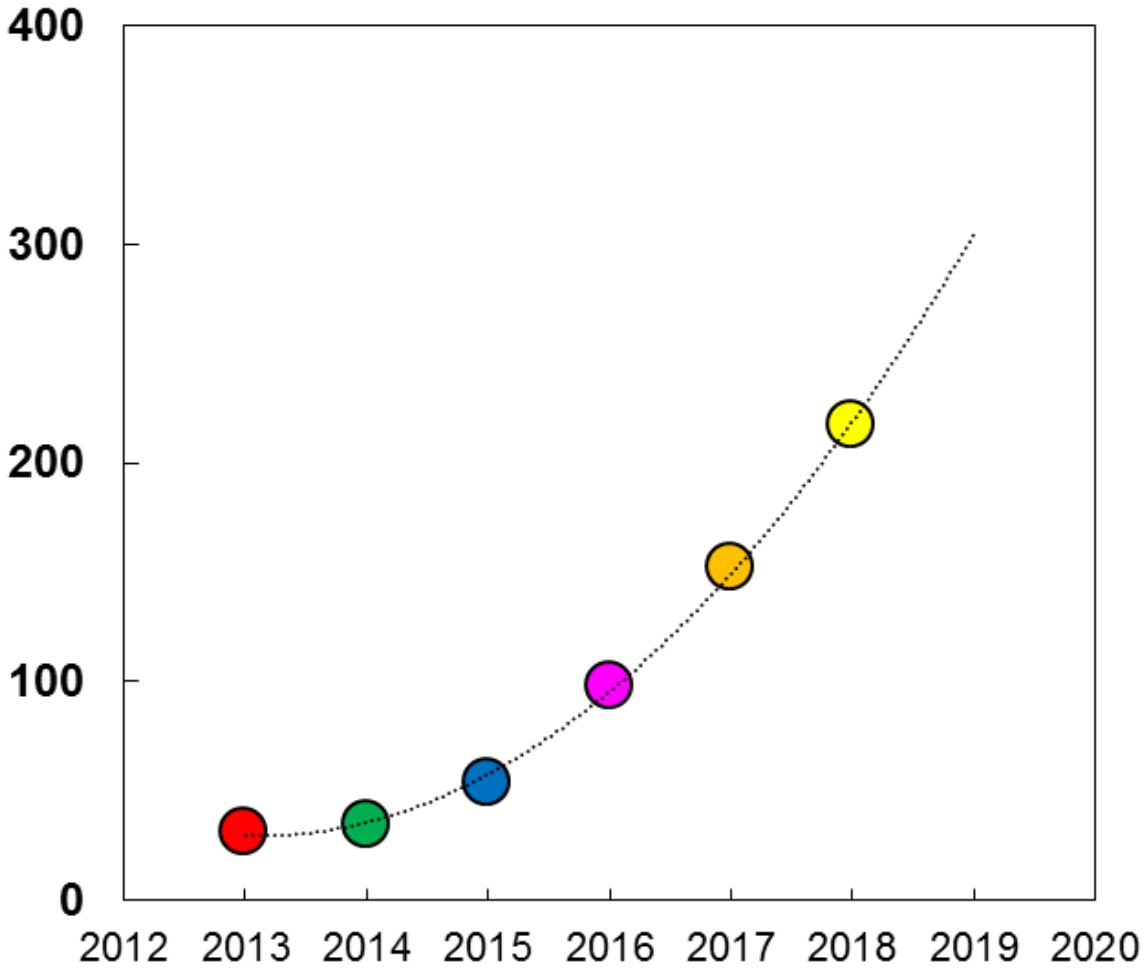
Measuring



Testing



YEN entries: 2013, 2014, 2015, 2016, 2017, & 2018



YEN Reports

Entrant's Report

Harvest 2018

Name	
YEN User ID:	YEN Field ID:
Region: Scotland	Supporter:
Crop: Winter wheat	Variety: Revelation
Primary contact email:	
Sponsor/Supporter email:	
Additional supporter email:	

The 2018 YEN competition saw completed entries from 204 fields and 10 trial plots.

- The average grain yield for the Cereal YEN 2018 competition was 10.1 t/ha for absolute field yield.
- The average yield potential was 17.7 t/ha and the average % of potential yield achieved was 57%.
- Your entry yield of 9.5 t/ha ranked 123 for absolute field yield within all YEN field entries.
- This represents 52% of an estimated yield potential of 18.4 t/ha at your site in 2018, which ranked 132 for achieving the highest percent of potential yield within all YEN field entries.

	Rank	Grain yield (t/ha)	Rank	Grain yield (% potential)
	1	16.2	1	103%
	2	15.4	2	98%
	3	14.1	3	96%
Your entry	123	9.5	132	52%

CONTENTS

Our detailed analysis of your yield result is provided in the following pages, including comparisons with other YEN entries and with benchmarks taken from the AHDB Growth Guide and the AHDB Nutrient Management Guide (RB209). We hope that this helps you to identify aspects of your husbandry and growing conditions that offer possible routes to further yield enhancement on your land.

Our approach in this report is to consider yield potentials and growing conditions for crops in the 2017-18 season, then (new this year) the agronomy of your crop, its development, the basic resources (light energy & water) available to it, its success in capturing these and in converting them to grain. Lastly we use grain analysis to provide a post-mortem on your crop's nutrition. If you were involved in tramline trials, we have also tabulated all results so you can compare your treatments easily.

CONTENTS 2
POTENTIAL GRAIN YIELDS 3
Potential yields 3
GROWING CONDITIONS 4
The season's weather 4
Overall crop progress 4
Site overview 5
Soil analysis 6
AGRONOMY 7
CROP DEVELOPMENT 9
RESOURCES & THEIR CAPTURE 10
Water capture 10
Energy capture 11
Image of this entry 12
YIELD ANALYSIS 13
Yield formation 13
Grain Yield 14
Grain formation & size 14
CROP NUTRITION POST MORTEM 16
TREATMENT COMPARISONS 18
SUMMARY 19
THE YIELD ENHANCEMENT NETWORK 20
CONTACTS 20
YEN SPONSORS 21

POTENTIAL GRAIN YIELDS

"The YEN exists to help you to enhance your yields."

The key to high yields amongst YEN entries has been accelerating crop growth. So our approach to enhancing yields is to work out what is limiting growth – light energy or water – and then develop ideas to target better green canopies or better rooting accordingly.

To estimate potential yields we assume a theoretically 'perfect' variety grown with 'inspired' husbandry on your land with its 2017-18 weather, achieving either:

(i) **60% capture of light energy** through this season (including some in August), and its conversion to 1.4 tonnes of biomass per hectare, or
(ii) **Capture of all the available water** held in the soil to 1.5 m depth (or to rock if less) plus all rainfall from April to July, and conversion of each 20 mm into a tonne of biomass per hectare.

Taking the lesser of these two biomass amounts, we assume that a maximum of 60% can be used to form grain (this is the 'harvest index').

The maps below show potential grain yields for retentive and light soils in 2018[1]. Potentials in arable areas would have commonly been water limited, even on medium soils. They ranged from 13 t/ha upwards so, on deep soils, high yields were theoretically possible everywhere.

Potential yields

2018
Retentive soils (with 260 mm AWC)

2018
Light soils (with 160 mm AWC)

[1] We are using weather data from Defra in 2018 and assumed deep soils with no irrigation. Note we have not yet processed long term met. data from Defra so cannot show a map of long-term average yield potentials.

YEN Reports

Entrant's Report

Milling Wheat Quality Award

Harvest 2018

A. Farmer	Field / Site: CFXXXXX
YEN User ID: FXXXXX	YEN Field ID: Dummy
Region: South East	Sponsors/Supporter: ADAS
Crop: Winter wheat	Variety: Group 1
Primary contact email:	YEN@adas.co.uk
Sponsor/Supporter email:	
Additional supporter email:	

The 2018 YEN Wheat Quality competition saw completed entries from 32 fields.

Thank you for submitting sufficient grain to be assessed for this award.

- Average grain yield for all Group 1 varieties entered in the YEN 2018 was 9.8 t/ha and average grain protein yield was 1.3 t/ha
- Your entry yielded 9.8 t/ha grain and 1.3 t/ha of grain protein, which ranked 15 for protein yield within all YEN Group 1 entries.
- Your entry was included amongst the 12 finalists selected by the milling industry for rheology and baking tests this year.

This report provides results for your entry, summarises the procedures used to determine the YEN Wheat Quality Awards, and shows results for all the finalists.

nabim
REPRESENTING UK FLOUR MILLERS

The YEN Wheat Quality Award is sponsored and organised by nabim.

With thanks to the milling industry for the analysis of entries.

1 ©ADAS2019

SHORT-LISTING & QUALITY TESTING METHODOLOGY

All YEN entries that were UK-grown nabim Group 1 varieties were eligible to enter the YEN Wheat Quality competition. The growers of these entries were sent a large sample container to fill with the required amount (5kg) for rheology and baking tests. As with all YEN entries, yields were determined and certified, and grain was tested for specific weight and protein concentration. In addition, samples of YEN Wheat Quality entries were sent for Hagberg Falling Number (HFN) determination and assessments were made of grain appearance and presence of impurities. Grain protein yield was calculated. In total there were 32 entrants. Eight of these did not have verifiable yields, lacked grain analytical data or did not provide enough sample, and were not included.

The remaining 24 entrants were initially sifted according to the grain analytical quality criteria of 12.5% protein, 76.0 kg/hl specific weight and 250s HFN. Typically, a 13.0% protein level would be used to sift entrants, but as this was a lower protein season a lower requirement was applied. 12 entrants did not meet these criteria and did not proceed to the second stage of the competition. Additionally, three entrants were significantly under the 5kg sample requirement and were excluded. All entrants scored well in terms of grain appearance and the presence of impurities so this was not a factor in sifting.

The remaining 12 entries were cleaned and reanalysed in a cereals laboratory prior to small-scale milling. Samples of the milled flour were tested for dough quality and test-baked using the Chorleywood Breadmaking Process (CBP) and both the '800g open top recipe' and the 'Spiral 800g open top recipe'. These are two common breadmaking recipes used to assess Group 1 wheat and millers look for consistent performance across both bake types. Where less than 5kg of sample was submitted by entrants, there was not enough grain to carry out dough quality testing as well as test bakes.

The finalists were assessed by considering the yield, protein yield and the quality of flour, dough and baked bread. The results for all finalists can be seen in Table 1. Images of the baked loaves can be seen in Table 2.

WINNING ENTRIES

First place – This entry had the highest yield of 12.16 t/ha grain, the highest protein yield of 1.35 t/ha and demonstrated excellent grain analytical quality. Dough quality was good, although gluten was slightly too resistant, this was a feature of the 2018 wheat crop generally. Loaves from both baking systems were excellent, with white breadcrumb colour and good structure and texture. So, in conjunction with the high grain yield, this entry was judged to be the best overall.

Second place – This entry had the second-highest yield and protein yield of 11.83 t/ha and 1.32 t/ha respectively. Whilst there was insufficient sample to carry out dough analysis, and there was some slight coarseness was seen in the crumb texture, the quality of the baked loaves was excellent.

Third place – This entry had the third-highest grain and protein yield of 10.06 t/ha and 1.30 t/ha respectively. Whilst the grain protein was higher than is usually optimal for UK breadmaking varieties, the baking quality was excellent with good loaf size, quality and structure. There was insufficient sample to carry out dough analysis.

Other finalists – A number of the other nine entries had good breadmaking quality, however, yields and protein yields were significantly lower than the top three entrants. From the results of the dough analysis, three entries (CF01008FS, CF00866 and CF01015) showed a gluten strength that was too tough and this was reflected in poor quality baked loaves. These entries had high grain protein, demonstrating that protein quality as well as quantity is critical to flour performance.

2 ©ADAS2019

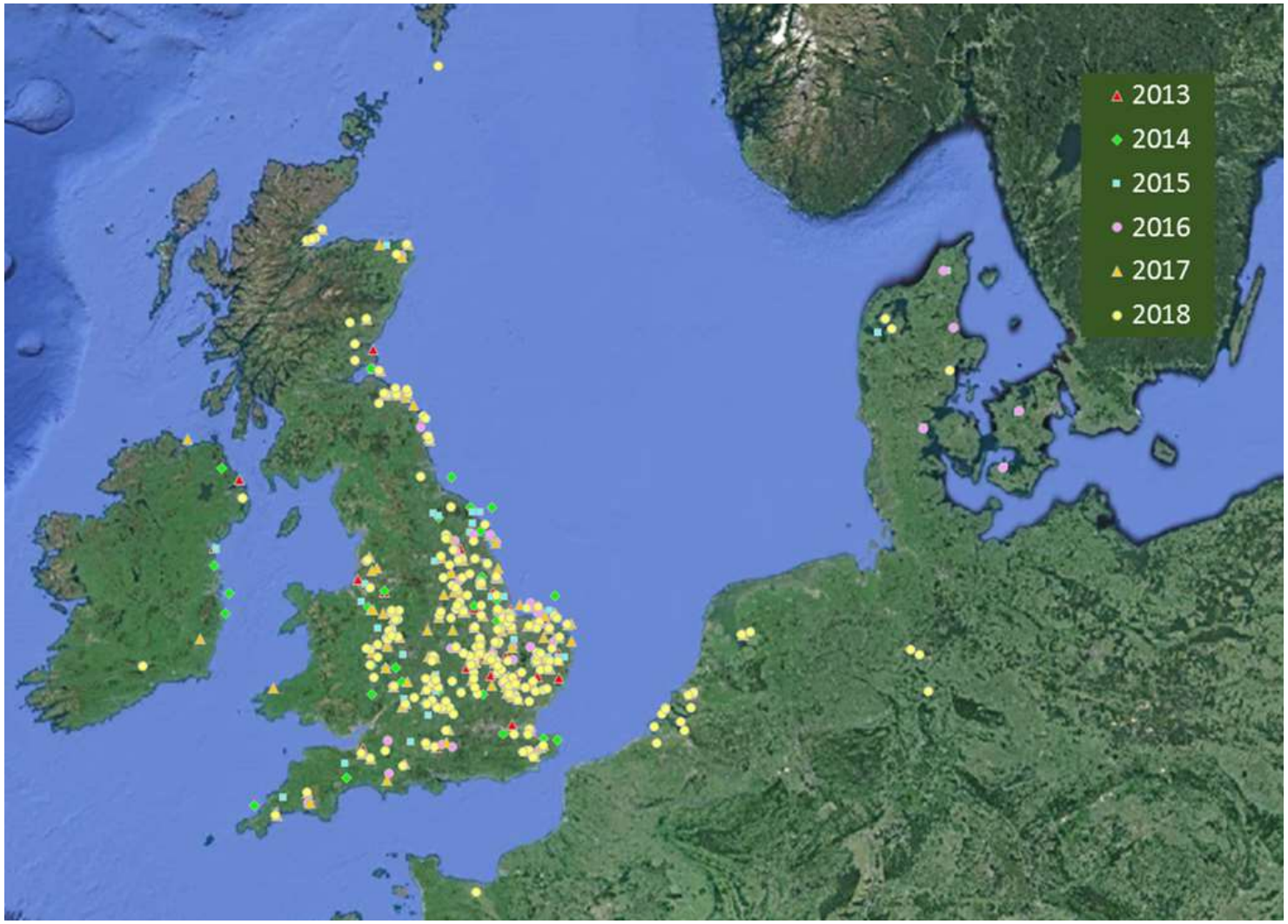
MILLING QUALITY RESULTS

The results for your entry and all other entries in the YEN Wheat Quality Competition 2018 are summarised below in box and whisker charts. The charts include critical or threshold values, if appropriate. The key to the charts is as follows:

The 'whiskers' show the range of values from all YEN Wheat Quality Award entries in 2018 and the box shows the middle half of these values, with a line for the mid-value. The orange line shows the value for this entry and the red dashed line is a limit beyond which milling quality is reduced.

3 ©ADAS2019

YEN database: 2013, 2014, 2015, 2016, 2017, & 2018



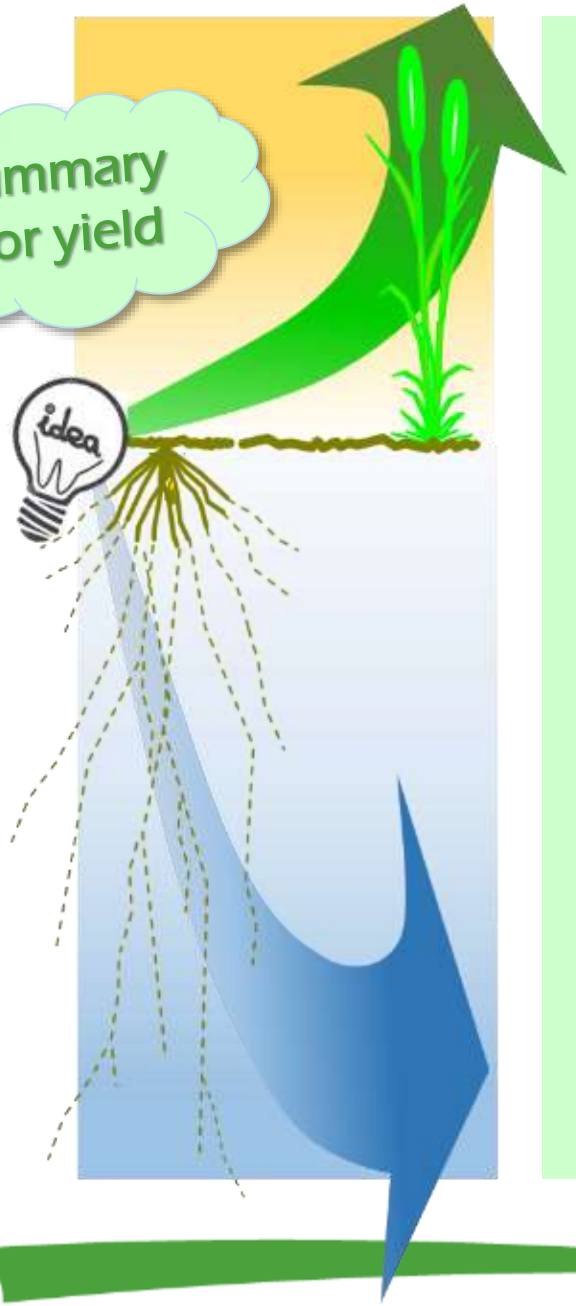
- ~570 yields
  - Average = 10.8 t/ha
  - Range: 5.0 to 16.5 t/ha
- ~540 proteins
  - Average: 11.9% dry matter
  - Range: 8.3 – 15.4%
- Multi-variate data analysis

  … giving *Associations*

  … not causes

"Associations prioritise research questions"

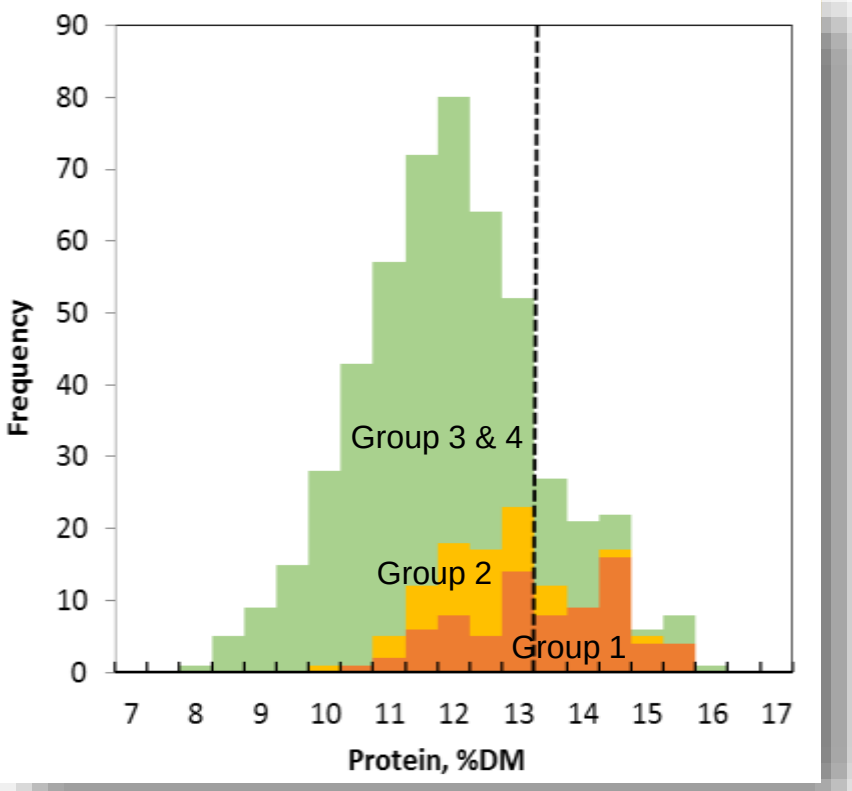
Summary for yield



- **15 t/ha is possible ... almost anywhere**
- It's less about what you spend, more about …

  'Attention to Detail'
- **Large yields come from large crops**
  - With more ears than average
    … and tending to be taller, with greater straw N%
  - So important associations include good nutrition, and control of disease & lodging risks
  - Husbandry factors associated with high yields include:
    … following a break crop
    … narrow row widths
    … applying slurry
    … adequate N use … but liquid N (straight) was questionable
    … and several PGR applications.

Summary for Protein



Individual protein associations

Protein changes (%DM) in relation to …

- **nabim group: Group 1 ~12.5%**
  - Group 2: -0.7% Group 3: -1.0% Group 4: -1.2%
- **Fertiliser N** … +0.5% per 100 kg/ha N
- **Region:** Scotland -0.6% or South West 0.6%
- **Soil:** Organic +1.4%, Shallow soils over chalk -0.8%
- **Soil depth:** -0.6% per metre
- **Soil P :** +~0.4% per index
- No associations (yet) with fertiliser P, K or S, N fertiliser type, micronutrients, biostimulants, fungicides, PGRs, cultivation type, or grass history.

YEN would not exist without its sponsors

YEN

ADAS · BASF We create chemistry · AG Space · BAYER · ADAMA · TFF The Farming Forum

agrimetrics · iteris · NIAB TAG · AHDB Cereals & Oilseeds · nrm laboratories · nabim · HUTCHINSONS Crop Production Specialists

Limagrain United Kingdom · NFU · Rothamsted Research · De Sangosse · syngenta · YARA

nabim short-list

Based on Protein Yield (t/ha) with checks for low protein, HFN, Sp.Wt., etc.

YEN Yield Enhancement Network · YEN Yield Enhancement Network

YEN Wheat Quality Competition

Explanation of Award Testing

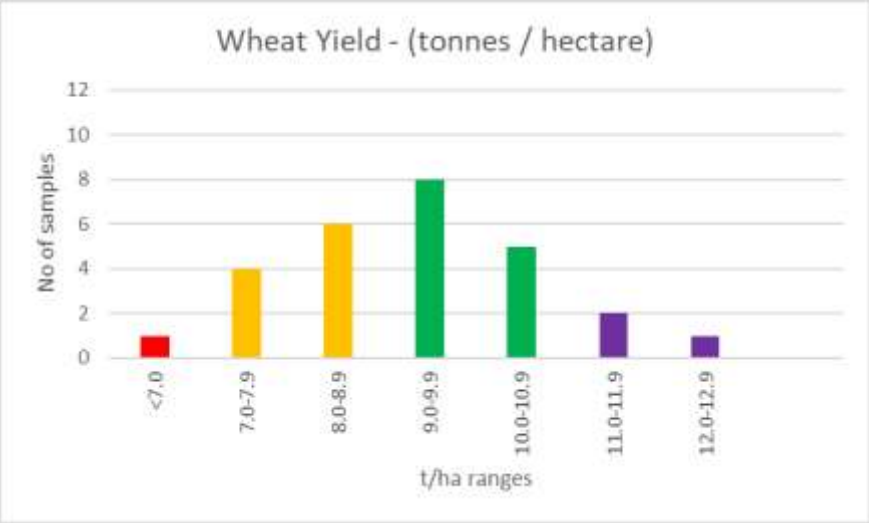
Mark Charlton, **nabim Variety Working Group**

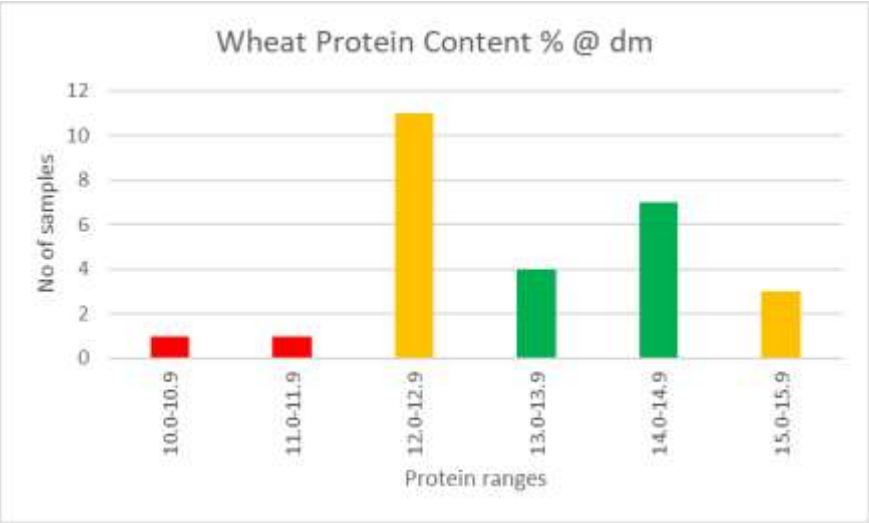
Starting point – 32 entries

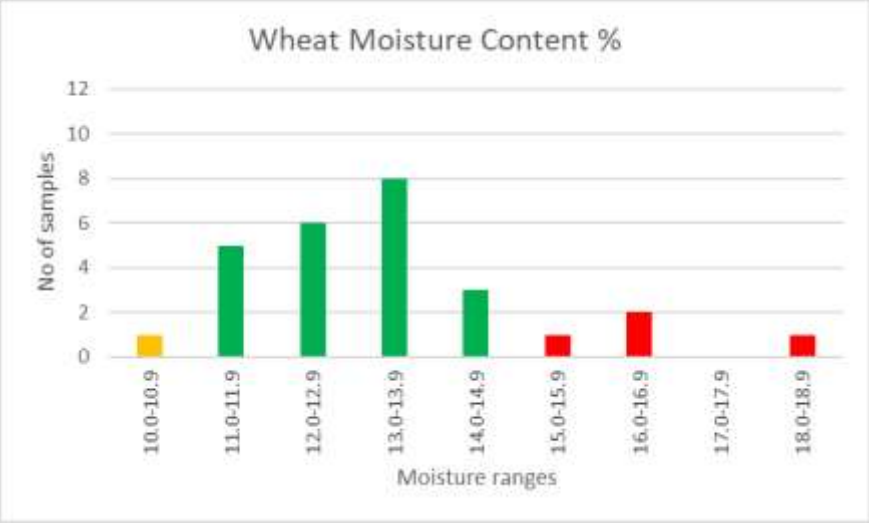
Five were excluded due to either no yield data or incomplete wheat test results .

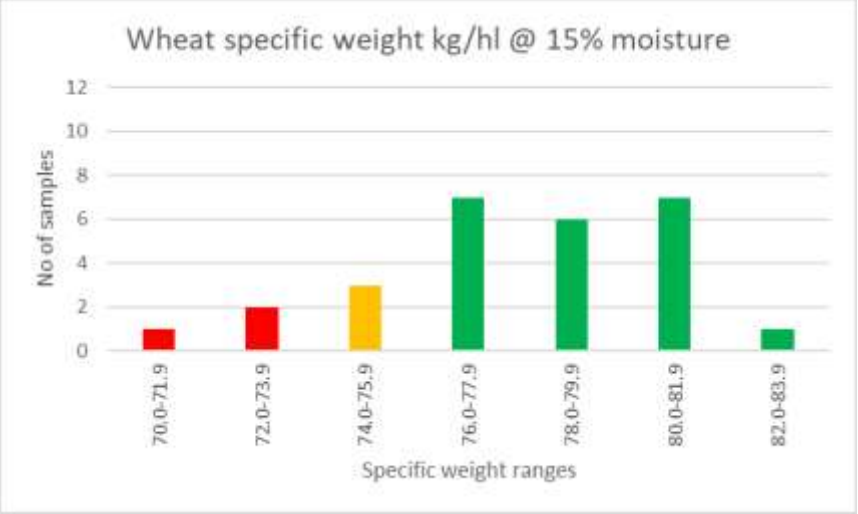
	Original number of entries	Sifted entries for milling and baking
Crusoe	10	4
KWS Zyatt	7	1
KWS Trinity	1	0
RGT Illustrious	4	1
Skyfall	10	6

Wheat Yield & Grain Intake Tests to select 12 from the 27 entries left









Wheat data of the 27 entries

YEN Field ID	Variety	Yield (t/ha) @ 15% moisture	Combine Grain Moisture (%)	Protein % @ dm	Protein per hectare (t/ha) 100% DM basis	Specific weight	Hagberg Falling number
CF01025	Crusoe	12.2	13.2	13.0	1.35	81.7	405
CF00985	Crusoe	10.1	13.1	15.2	1.30	80.8	414
CF00814A	KWS Zyatt	11.8	12.5	12.8	1.28	80.6	363
CF00841	KWS Zyatt	10.4	11.6	14.3	1.27	78.2	425
CF01010	Skyfall	9.3	11.1	14.4	1.14	79.8	457
CF00872	RGT Illustrious	9.7	11.4	13.7	1.13	77.0	441
CF00900	Skyfall	9.5	11.8	13.6	1.10	81.7	423
CF00972	Crusoe	9.0	12.6	13.6	1.04	79.1	420
CF00866	Skyfall	8.4	12.0	14.4	1.03	78.3	451
CF01015	Skyfall	7.9	12.2	15.0	1.01	76.8	462
CF00920FS	Crusoe	7.7	14.0	14.3	0.94	76.3	383
CF00924	Skyfall	7.8	16.1	14.0	0.93	76.7	441
CF00853	Skyfall	11.9	14.6	11.4	1.15	79.4	407
CF00817	KWS Zyatt	10.4	13.2	10.8	0.95	74.2	399
CF00806	KWS Zyatt	10.2	11.3	12.0	1.04	80.4	359
CF00973	RGT Illustrious	10.2	15.8	12.4	1.07	76.7	410
CF00869	Crusoe	9.9	14.1	12.1	1.03	76.6	363
CF00819T	Skyfall	9.9	13.0	12.3	1.03	81.6	391
CF00840	Skyfall	9.2	16.0	12.5	0.98	75.5	410
CF01008FS	Skyfall	9.1	12.5	12.8	0.99	79.6	439
CF00978	Crusoe	8.9	13.1	14.5	1.10	73.1	425
CF00843	Crusoe	8.9	12.0	12.8	0.97	82.5	424
CF00971	KWS Zyatt	8.8	18.4	12.6	0.94	71.2	404
CF00940FS	RGT Illustrious	8.8	13.6	12.2	0.91	76.2	425
CF00979	Crusoe	8.4	13.7	15.0	1.07	73.3	413
CF00898	KWS Zyatt	7.8	10.8	14.3	0.95	75.4	421
CF00830	Skyfall.	6.4	13.3	12.7	0.69	80.2	418

Sifting

12 through to next stage of analysis

8 with protein <12.5% - sifted out

3 excluded due to insufficient sample

5 with specific weight <76.0kg/hl – sifted out

5 excluded due to missing yield or wheat data

Miller's Testing Regime

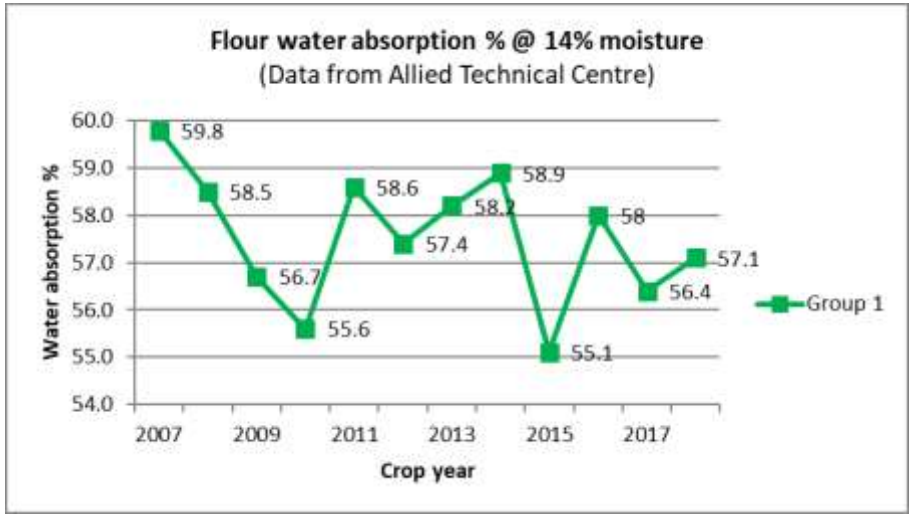
1. Repeat of grain analysis
2. Pilot milled into white flour
3. Test for flour water absorption and dough strength
4. Test baking using CBP and Spiral methods

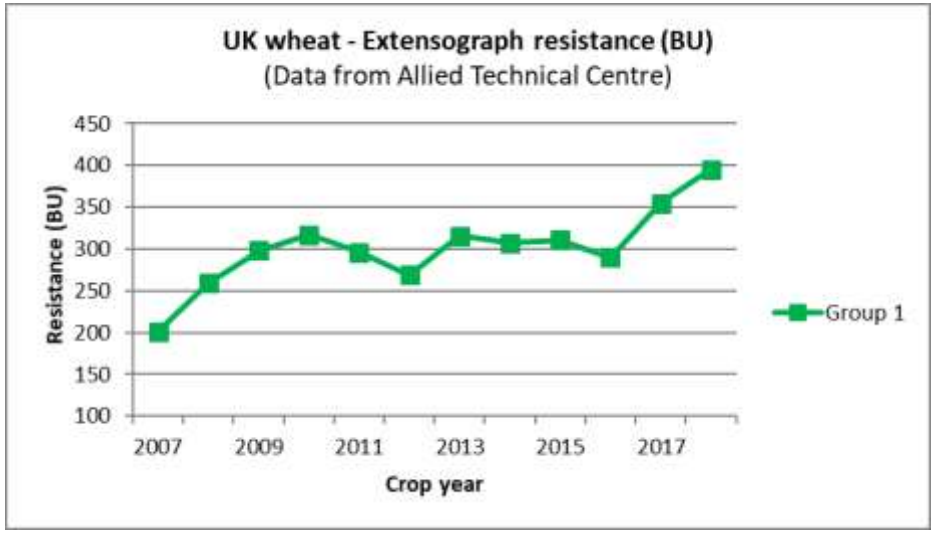
The above analysis was carried out by two **nabim** milling companies involved with the Varieties Working Group

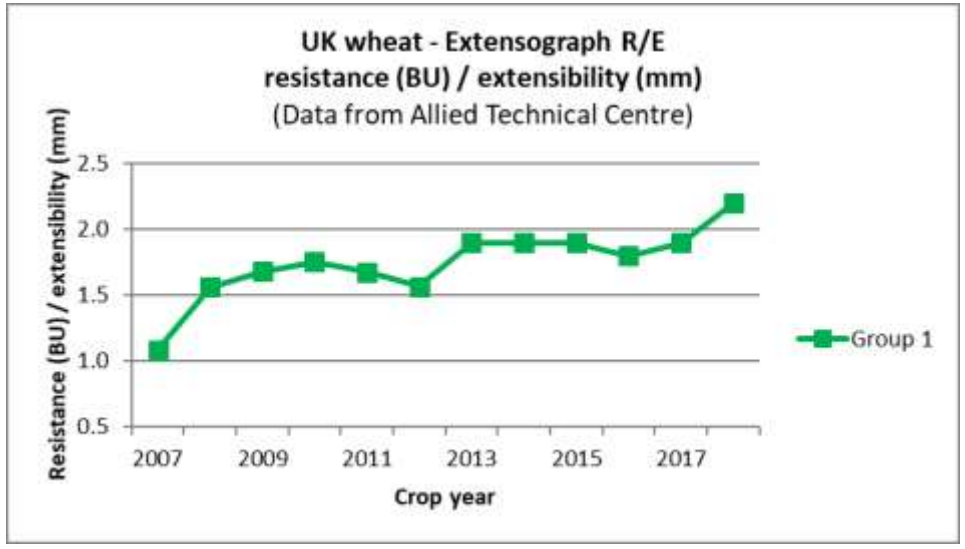
Visual Inspection of the final 12

CF1025 – Crusoe	CF00985 – Crusoe	CF00814A – KWS Zyatt	CF01010 – Skyfall	CF00872 – Illustrious	CF00900 – Skyfall
CF00866 – Skyfall	CF01015 – Skyfall	CF01008FS – Skyfall	CF00843 – Crusoe	CF00920FS – Crusoe	CF00924 – Skyfall

Key quality attributes of the UK 2018 crop



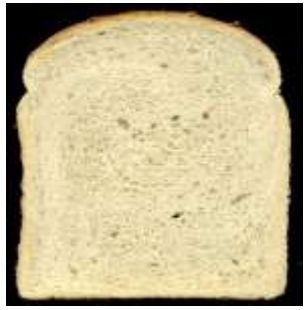
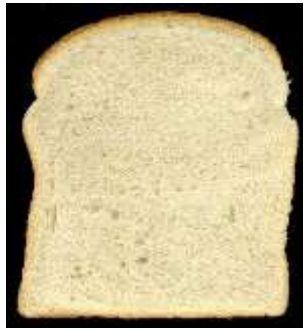




Miller's Test Results

				Mill laboratory cleaned wheat analysis				Dough analysis Extensograph			Baking analysis Baking 800g CBP (Open top)				Baking analysis Baking 600g Spiral (Open top)			
YEN Field Entry ID	Variety	Yield (t/ha)	Protein yield (t/ha)	Protein % (dm)	Specifi weight kg/hl	Hagberg Falling No.	Extract-ion rate %	Resistance (B.U.)	Extensibility cm	R/E (B.U./mm)	Loaf volume cm^3	Crumb colour	Crumb Texture	Crumb structure	Baked height cm	Crumb colour	Crumb Texture	Crumb structure
CF01025	Crusoe	12.16	1.35	13.1	82.5	399	81.8	410	17.2	2.4	3840	White	Fine	Resilient	14.2	White	Fine	Resilient
CF00814A	KWS Zyatt	11.83	1.32	13.1	81.7	389	80.0	Not enough sample			3870	White	Fine	Resilient	15.0	White	Slightly coarse	Resilient
CF00985	Crusoe	10.06	1.30	15.2	81.4	414	80.3	Not enough sample			3980	White	Fine	Resilient	15.5	White	Fine	Resilient
CF01010	Skyfall	9.31	1.16	14.6	80.3	460	77.8	410	19.8	2.1	3950	Creamy	Slightly coarse	Slightly weak	16.0	White	Fine	Resilient
CF00872	Illustrious	9.70	1.12	13.6	78.4	452	79.2	430	19.2	2.2	3870	Creamy	Fine	Resilient	Not enough sample			
CF00900	Skyfall	9.51	1.09	13.5	82.5	431	78.3	Not enough sample			4010	White	Fine	Resilient	16.1	White	Fine	Resilient
CF01008FS	Skyfall	9.07	1.03	13.3	79.5	458	77.2	530	18.5	2.9	3680	Yellow	Very open	Firm	14.5	Yellow	Slightly coarse	Slightly weak
CF00866	Skyfall	8.41	1.02	14.3	78.8	506	78.0	570	18.9	3.0	3510	White	Very open	Firm	14.9	Yellow	Slightly coarse	Slightly weak
CF01015	Skyfall	7.90	1.00	14.9	77.9	494	78.4	510	20.2	2.5	4030	Creamy	Coarse	Weak	16.3	White	Fine	Resilient
CF00843	Crusoe	8.88	0.96	12.7	83.2	428	80.9	390	16.8	2.3	3820	White	Fine	Resilient	15.7	White	Fine	Resilient
CF00920FS	Crusoe	7.74	0.95	14.5	77.4	442	79.4	410	22.9	1.8	4098	White	Fine	Slightly weak	16.0	White	Slightly coarse	Resilient
CF00924	Skyfall	7.83	0.93	14.0	78.0	443	78.6	Not enough sample			3730	Creamy	Coarse	Firm	14.5	Yellow	Slightly coarse	Slightly weak

Poorer Bakes

				Mill laboratory cleaned wheat analysis				Dough analysis			Baking analysis				Baking analysis			
								Extensograph			Baking 800g CBP (Open top)				Baking 600g Spiral (Open top)			
YEN Field Entry ID	Variety	Yield (t/ha)	Protein yield (t/ha)	Protein % (dm)	Specifci weight kg/hl	Hagberg Falling No.	Extract-ion rate %	Resistance (B.U.)	Extensibility cm	R/E (B.U./mm)	Loaf volume cm^3	Crumb colour	Crumb Texture	Crumb structure	Baked height cm	Crumb colour	Crumb Texture	Crumb structure
CF00866	Skyfall	8.41	1.02	14.3	78.8	506	78.0	570	18.9	3.0	3510	White	Very open	Firm	14.9	Yellow	Slightly coarse	Slightly weak
																		
CF01015	Skyfall	7.90	1.00	14.9	77.9	494	78.4	510	20.2	2.5	4030	Creamy	Coarse	Weak	16.3	White	Fine	Resilient
																		

The Winner's Bakes

				Mill laboratory cleaned wheat analysis				Dough analysis Extensograph			Baking analysis Baking 800g CBP (Open top)				Baking analysis Baking 600g Spiral (Open top)				
YEN Field Entry ID	Variety	Yield (t/ha)	Protein yield (t/ha)	Protein % (dm)	Specifci weight kg/hl	Hagberg Falling No.	Extract-ion rate %	Resistance (B.U.)	Extensibility cm	R/E (B.U./mm)	Loaf volume cm ^{3}	Crumb colour	Crumb Texture	Crumb structure	Baked height cm	Crumb colour	Crumb Texture	Crumb structure	Ranking
CF01025	Crusoe	12.16	1.35	13.1	82.5	399	81.8	410	17.2	2.4	3840	White	Fine	Resilient	14.2	White	Fine	Resilient	First Place
CF00814A	KWS Zyatt	11.83	1.32	13.1	81.7	389	80.0	Not enough sample			3870	White	Fine	Resilient	15.0	White	Slightly coarse	Resilient	Second Place
CF00985	Crusoe	10.06	1.30	15.2	81.4	414	80.3	Not enough sample			3980	White	Fine	Resilient	15.5	White	Fine	Resilient	Third Place

	First Place	Second Place	Third Place
CBP			
Spiral			

Thank you

YEN Wheat Quality Award Winners

1st Alex Wilcox

2nd Sam Markillie

3rd Richard Carr

				Mill laboratory cleaned wheat analysis				Dough analysis Extensograph			Baking analysis Baking 800g CBP (Open top)				Baking analysis Baking 600g Spiral (Open top)				
YEN Field Entry ID	Variety	Yield (t/ha)	Protein yield (t/ha)	Protein % (dm)	Specifci weight kg/hl	Hagberg Falling No.	Extract-ion rate %	Resistance (B.U.)	Extensibility cm	R/E (B.U./mm)	Loaf volume cm^3	Crumb colour	Crumb Texture	Crumb structure	Baked height cm	Crumb colour	Crumb Texture	Crumb structure	**Ranking**
CF01025	Crusoe	12.16	1.35	13.1	82.5	399	81.8	410	17.2	2.4	3840	White	Fine	Resilient	14.2	White	Fine	Resilient	**First Place**
CF00814A	KWS Zyatt	11.83	1.32	13.1	81.7	389	80.0	Not enough sample			3870	White	Fine	Resilient	15.0	White	Slightly coarse	Resilient	**Second Place**
CF00985	Crusoe	10.06	1.30	15.2	81.4	414	80.3	Not enough sample			3980	White	Fine	Resilient	15.5	White	Fine	Resilient	**Third Place**

© Agriculture and Horticulture Development Board 2017 | All Rights Reserved