PRIFYSGOL ABERYSTWYTH UNIVERSITY

(www.quoats.org)

# Variation in fatty acid composition within breeding lines of novel oat varieties as potential ruminant feeds

Alexander A Cowan, Jon M Moorby and Athole H Marshall

BBSRC bioscience for the future

defra Department for Environment Food and Rural Affairs

LINK collaborative research

The Scottish Government

Llywodraeth Cymru Welsh Government

ERDF Llywodraeth Cymru Welsh Assembly Government
Ewrop & Chymru: Buddsoddi yn eich Dyfodol
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Sefydliad y Gwyddorau Biolegol, Amgylcheddol a Gwledig
IBERS ABERYSTWYTH
Institute of Biological, Environmental and Rural Sciences



- Introduction
- Breeding targets
- Results
- Conclusions



# Background

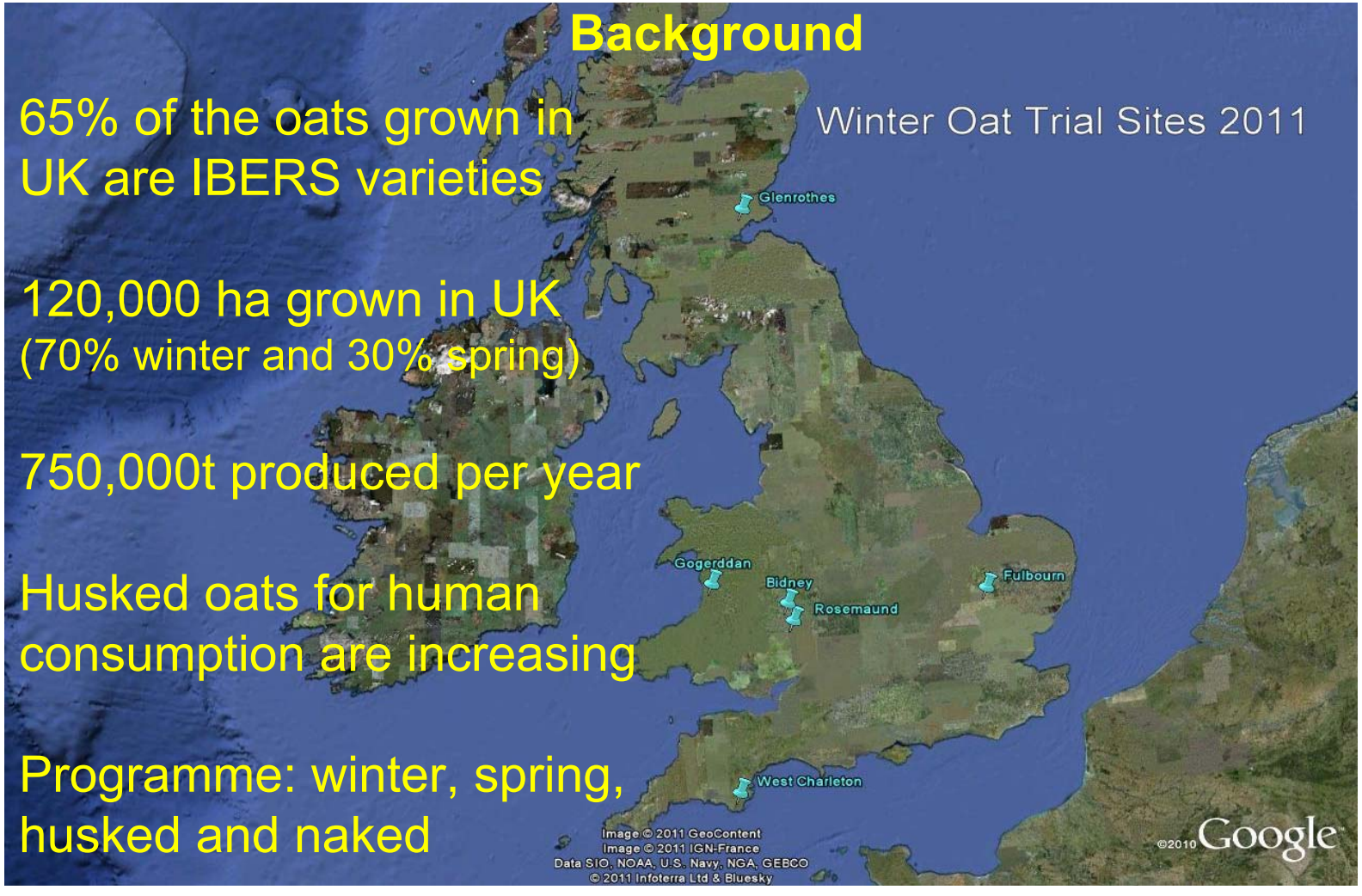
65% of the oats grown in UK are IBERS varieties

120,000 ha grown in UK
(70% winter and 30% spring)

750,000t produced per year

Husked oats for human consumption are increasing

Programme: winter, spring, husked and naked



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# HARNESSING NEW TECHNOLOGIES FOR SUSTAINABLE OAT PRODUCTION AND UTILISATION

Delivering a new generation of oats to the market

From breeder to plate, this LINK project aims to harness new technologies to advance the yield, value and functionality of oats.

The many uses of oats demonstrate the versatility and uniqueness of this important cereal crop.

Oats
Delivering diversity on farm and to the market

From breeder to plate, this LINK project aims to harness new technologies to advance the yield, value and functionality of oats. The many uses of oats demonstrate the versatility and uniqueness of this important cereal crop.

## YIELD

Varietal improvements on yield, disease resistance and reliability at harvest.

## HUSKED OATS

Big, bold grains to improve milling value. Increasing beta-glucan with its proven health benefits will sustain product innovation.

## NAKED OATS

Nutrient dense, 14% oil varieties are on the horizon for the poultry, livestock, horse and birdfeed sectors.

## STRAW

Changing the plant model. Improved straw characteristics mean assurance against lodging and the option for higher management approach minus PGR.

## DISEASE

Securing improved resistance to crown rust, mildew, OMV and understanding mycotoxins are key project research areas.

## LOW LIGNIN

Low lignin oats – a new plant model with reduced fibre aimed specifically at the dairy and livestock sectors to considerably reduce methane output and benefit the environment.

## AVENANTHRAMIDES

Highly active anti-oxidants in oats deliver unique properties for the pharmaceutical and cosmetic industries.

## PLATFORM CHEMICALS

Innovative research will bring platform chemicals for the plastic, cosmetic and food industries.

**Oats – delivering diversity on farm and to the market**



# Aims of oat genetic improvement

- To realise the benefits of oats in sustainable and flexible agriculture
- To exploit new opportunities for oats of various end-uses (food, feed and industrial uses)
- To capitalise on the value of oats as a valuable break crop

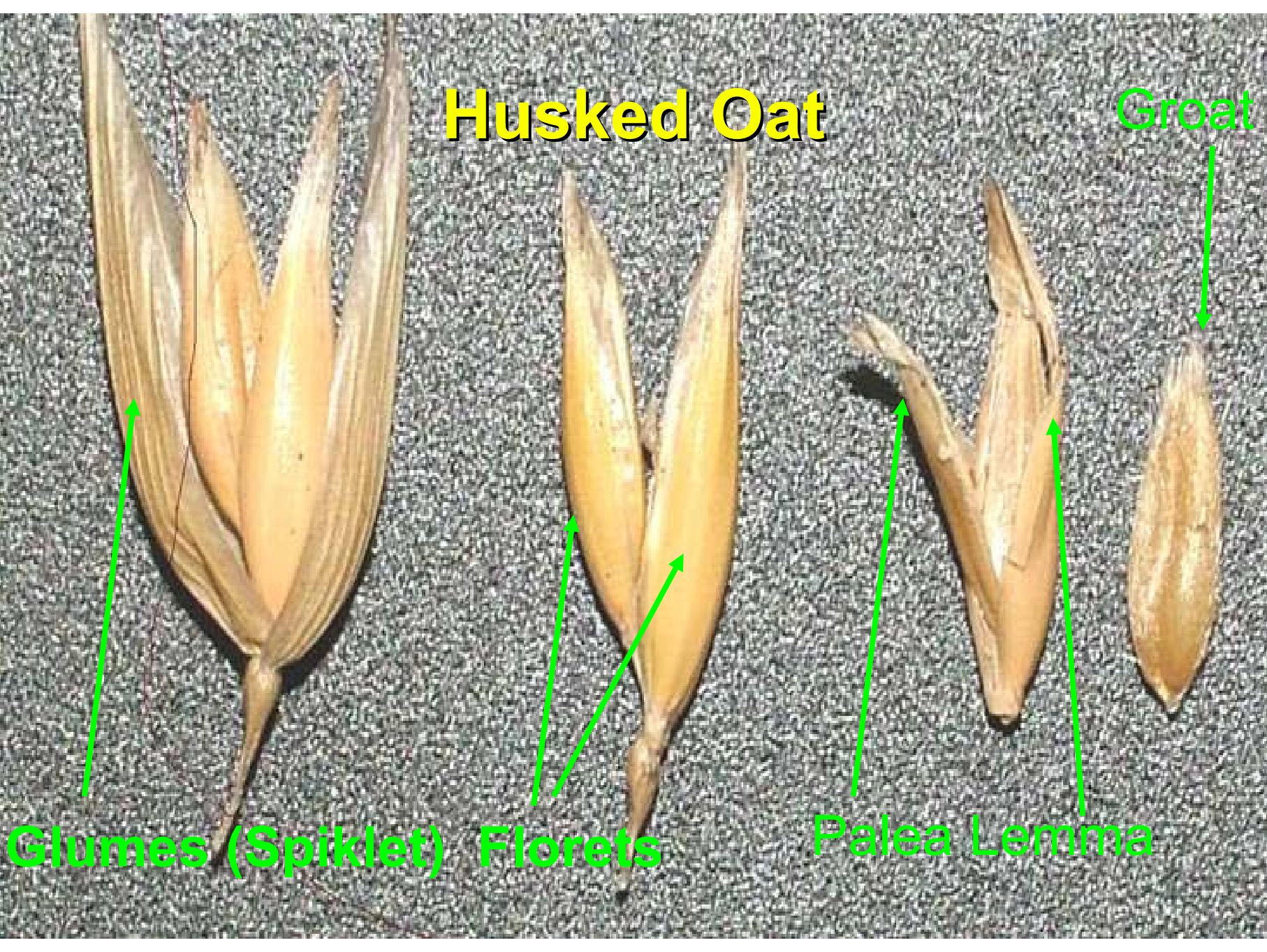


# Why Poultry and Livestock Sector interest ?

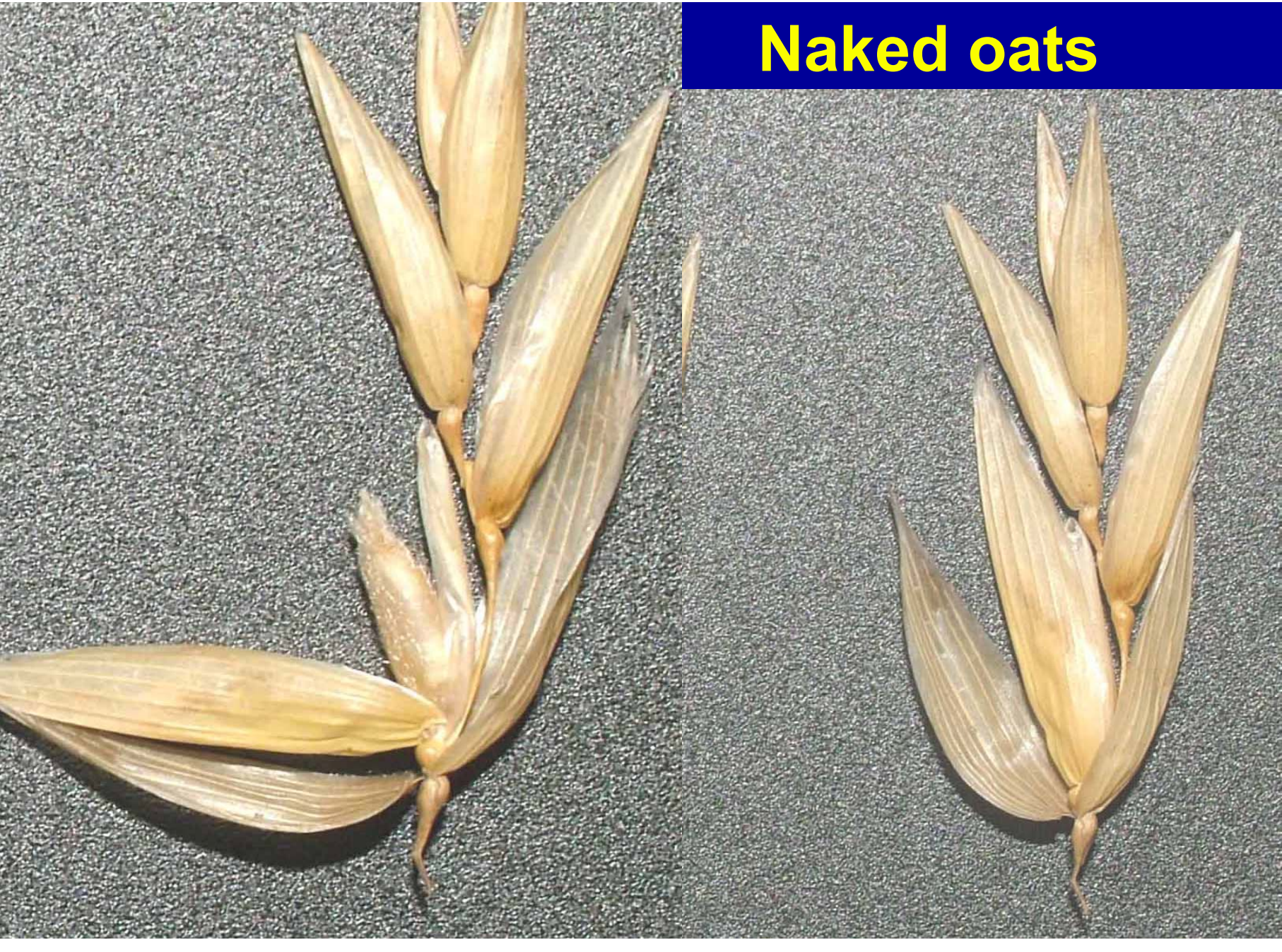
- Reduced environmental impact
- Alternative feedstock
  - High oil/low lignin/dwarf
- Support UK agriculture

# Breeding targets for Naked Oats

- ★ Economic competitiveness
- ★ Yield
- ★ Oil content
- ★ Disease resistance


Husked Oat
Groat
Glumes (Spiklet)
Florets
Palea Lemma

# Naked oats



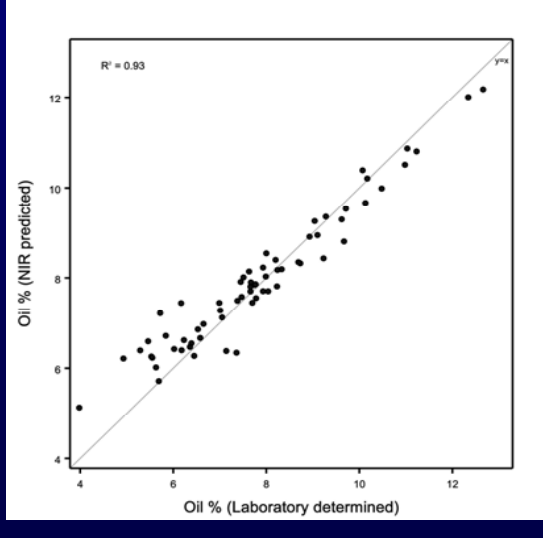
# Examples of use of markers in breeding programme

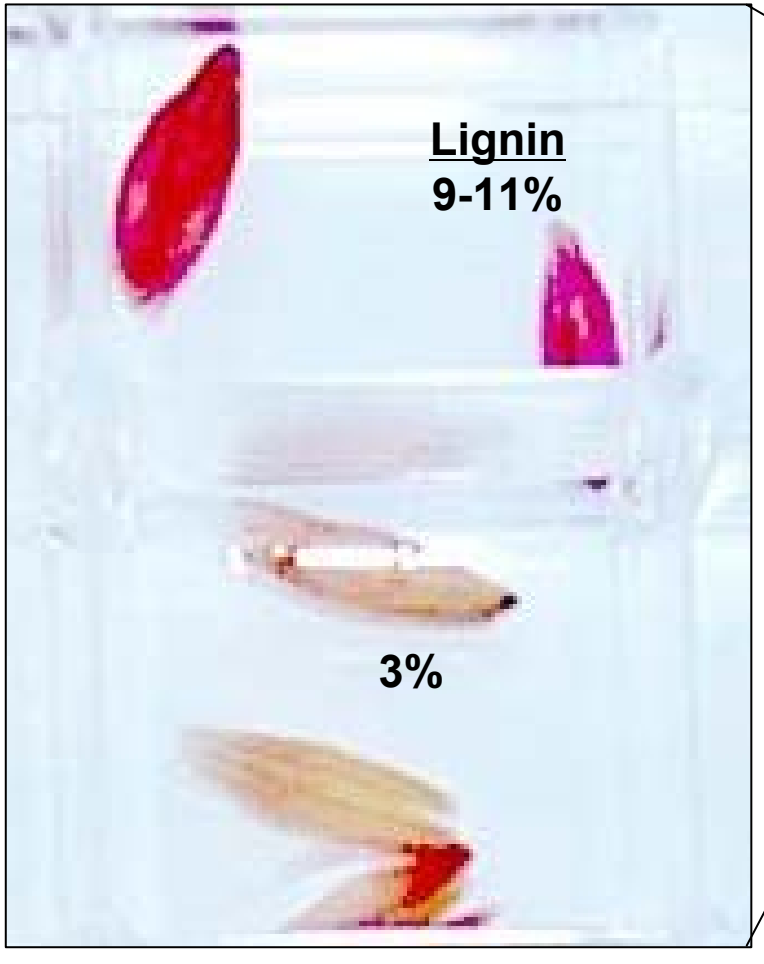
- Dwarf (reduced lodging)- OL0256
- Oil (increase feed value)
  - Markers have been used to select progeny from the breeding programme for subsequent field phenotyping.
  - Novel high oil alleles identified from *A. sterilis*

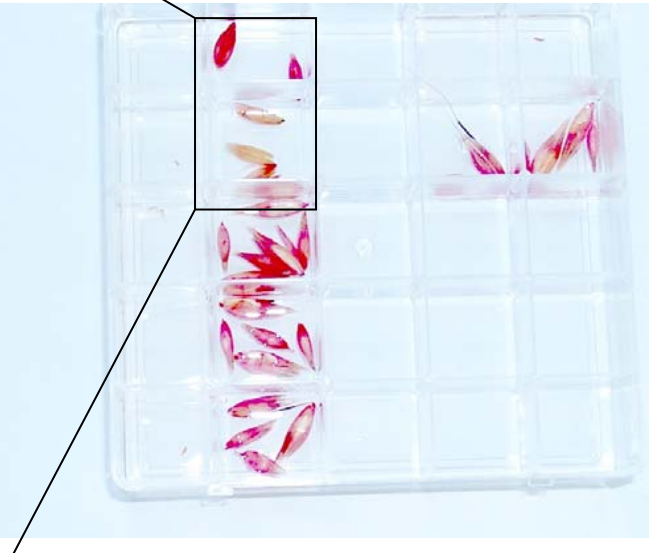
# High throughput phenotyping

Using Lab based NIR

| | type | N | Mean (%) | Range | R2 | SEC V |
|---|---|---|---|---|---|---|
| oil | Whole groat | 888 | 7.45 | 2.79-12.11 | 0.92 | 0.43 |
| n | Whole groat | 869 | 1.84 | 0.8-2.87 | 0.94 | 0.09 |



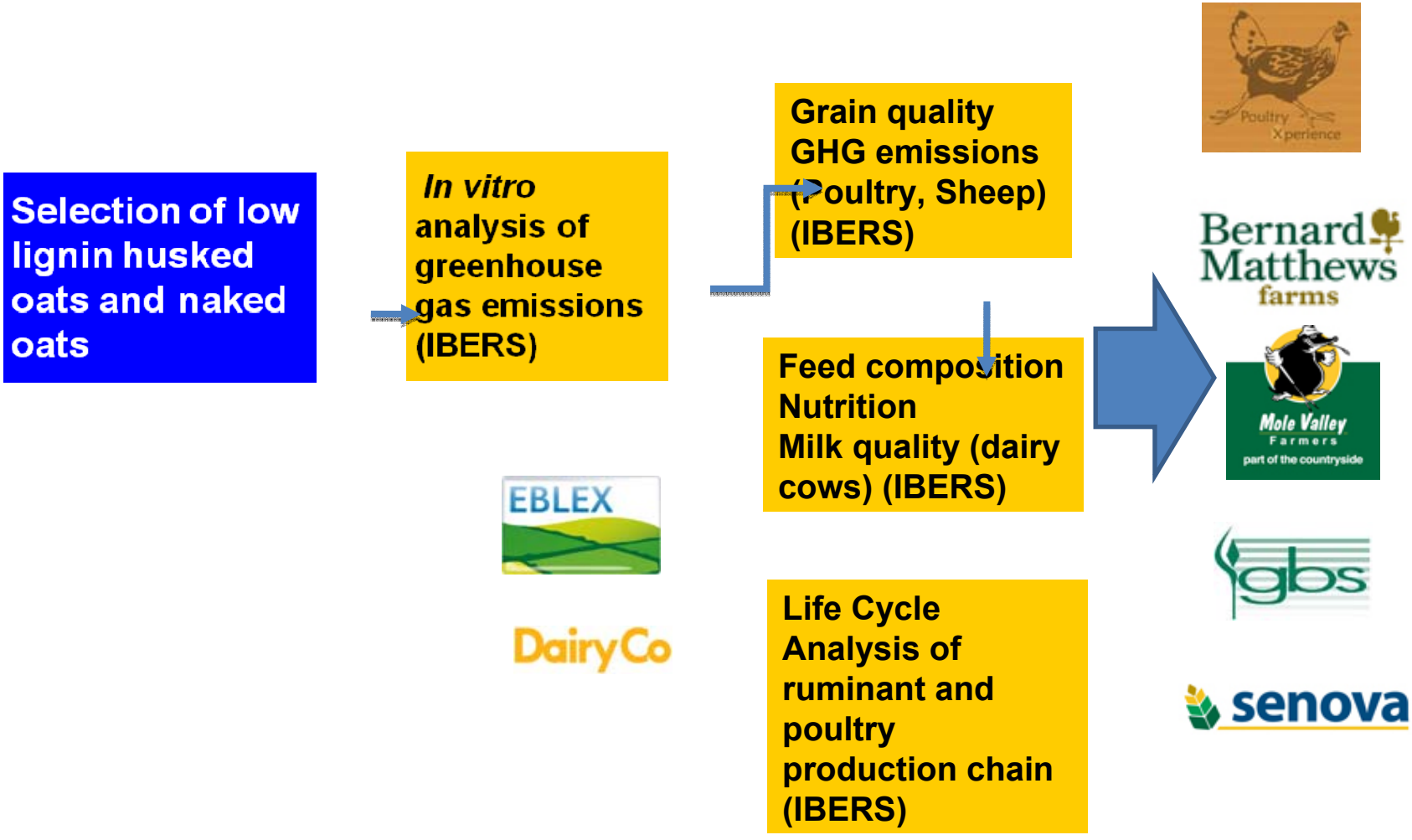


**Genetic variation for low husk lignin is being incorporated.**

# QUOATS WorkPackage 3

**Develop oats for sustainable livestock agriculture that will reduce greenhouse gas emissions and provide a high quality feed**



# Nutrient content of cereals

| | Carbohydrate (g/100g) | Protein (g/100g) | Fat (g/100g) | Dietary Fibre (g/100g) | Ash (g/100g) | Energy, kJ |
|---|---|---|---|---|---|---|
| Oatmeal | 58.7 | 14.0 | 8.0 | 9.0 | 1.8 | 1473 |
| Whole grain wheat | 60.2 | 13.5 | 2.1 | 10.6 | 1.6 | 1270 |
| Cornmeal | 70.6 | 8.8 | 3.5 | 4.8 | 1.1 | 1409 |
| Brown rice | 73.9 | 7.4 | 2.8 | 2.3 | 1.42 | 1412 |
| Rye | 58.7 | 11.2 | 2.3 | 12.8 | 2.0 | 1215 |
| Pearled Barley | 69.7 | 9.2 | 1.6 | 8.0 | 1.2 | 1331 |
| Sorghum | 65.6 | 11 | 3.3 | 6.9 | 1.6 | 1358 |

From R W Welsh 2011 in Oats :Chemistry and Technology 2nd Edition Eds FH Webster & PJ Wood

# Nutrient content of cereals

| | Palmitic (16:0) (g/100g) | Stearic (18:0) (g/100g) | Oleic (18:1) (g/100g) | Linoleic (18:2) (g/100g) | Linolenic (18:3) (g/100g) |
|---|---|---|---|---|---|
| Oatmeal | 19.0 | 2.0 | 36.0 | 38.0 | 2.0 |
| Whole grain wheat | 18.0 | 2.0 | 18.0 | 56.0 | 3.0 |
| Cornmeal | 12.0 | 2.0 | 32.0 | 50.0 | 2.0 |
| Brown rice | 22.0 | 2.0 | 34.0 | 38.0 | 2.0 |
| Rye | 15.0 | 1.0 | 17.0 | 58.0 | 7.0 |
| Pearled Barley | 22.0 | 1.0 | 13.0 | 56.0 | 5.0 |
| Sorghum | 13.0 | 1.0 | 34.0 | 46.0 | 2.0 |

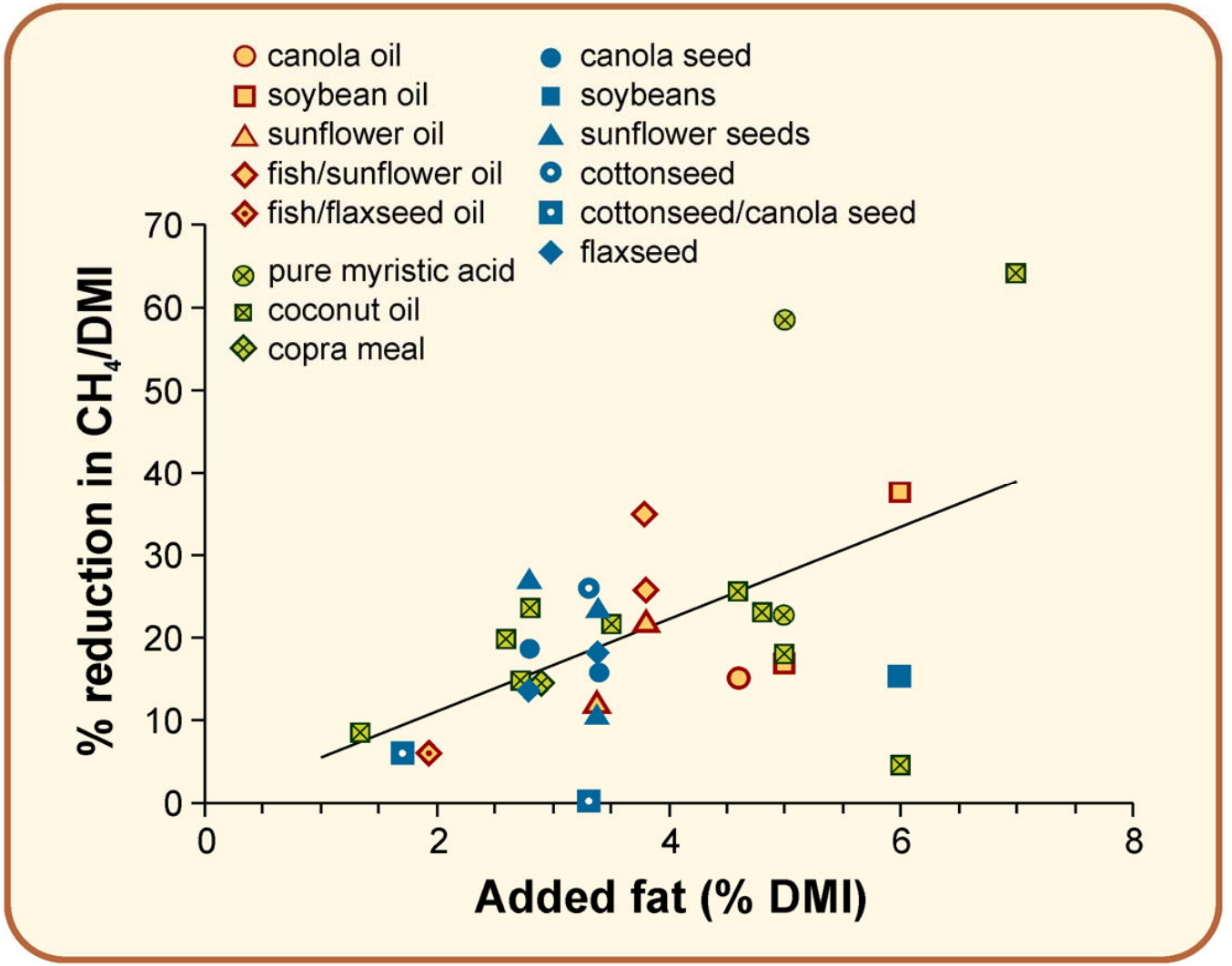
From R W Welsh 2011 in Oats :Chemistry and Technology 2nd Edition Eds FH Webster & PJ Wood

# Nutrient content of oats

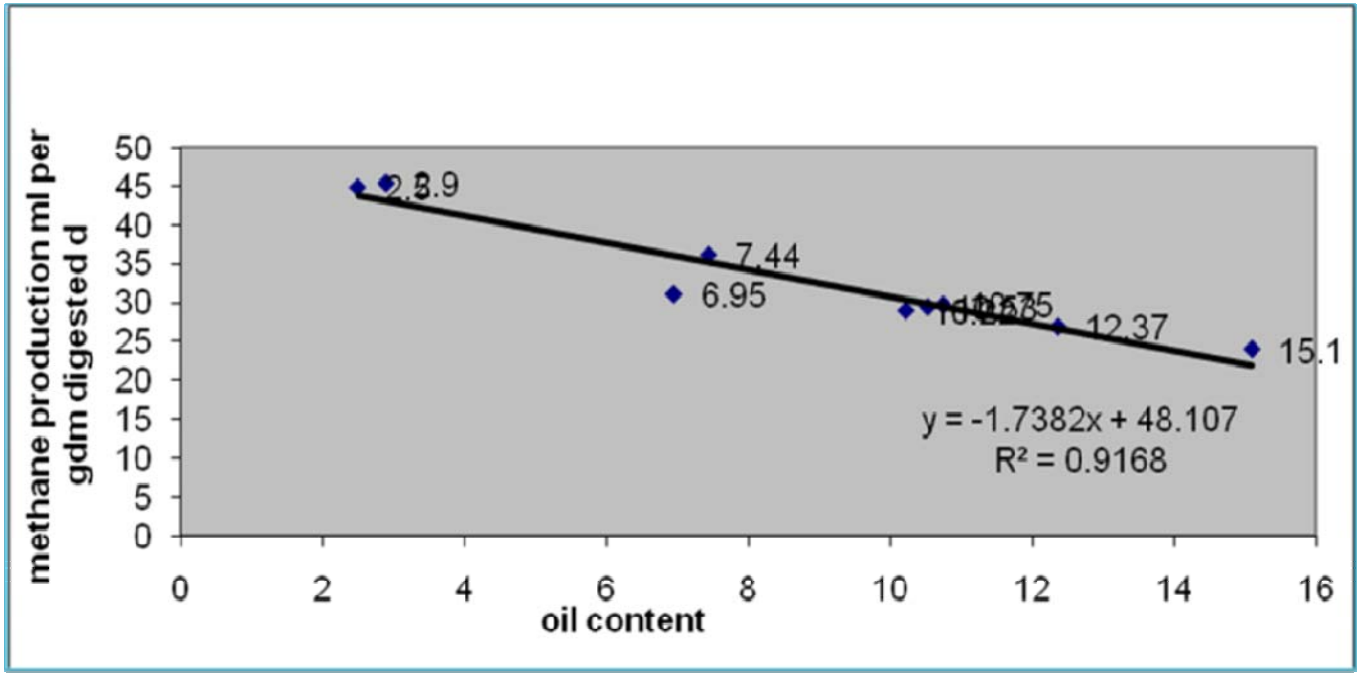
| Selection | Crude Protein | Oil (B) | TME MJ/kg as fed |
|---|---|---|---|
| Gerald | 11.6 | 8.1 | 11.5 |
| Brochan | 11.0 | 7.7 | 12.4 |
| *Hendon* | 11.3 | 10.2 | 15.3 |
| *Racoon* | 14.8 | 13.6 | 16.2 |
| *01-126Cn1* | 12.2 | 12.8 | 15.8 |
| *01-145Cn1* | 13.4 | 12.7 | 15.5 |
| *01-146Cn5* | 12.6 | 13.2 | 15.8 |
| *Zuton* | 14.0 | 9.0 | 15.4 |
| *Lennon* | 13.7 | 8.9 | 15.7 |
| Frontier (wheat) | 12.3 | 2.5 | 13.9 |

# Literature summary of added fat vs $CH_4$ production

Y = 5.562 (SE = 0.590) × % added fat; $r^2$ = 0.67; *P* = 0.004



# High oil content reduces methane emissions




Cowan et al., 2008. Livestock and global climate change, p. 192-194.


# Low lignin husk oats

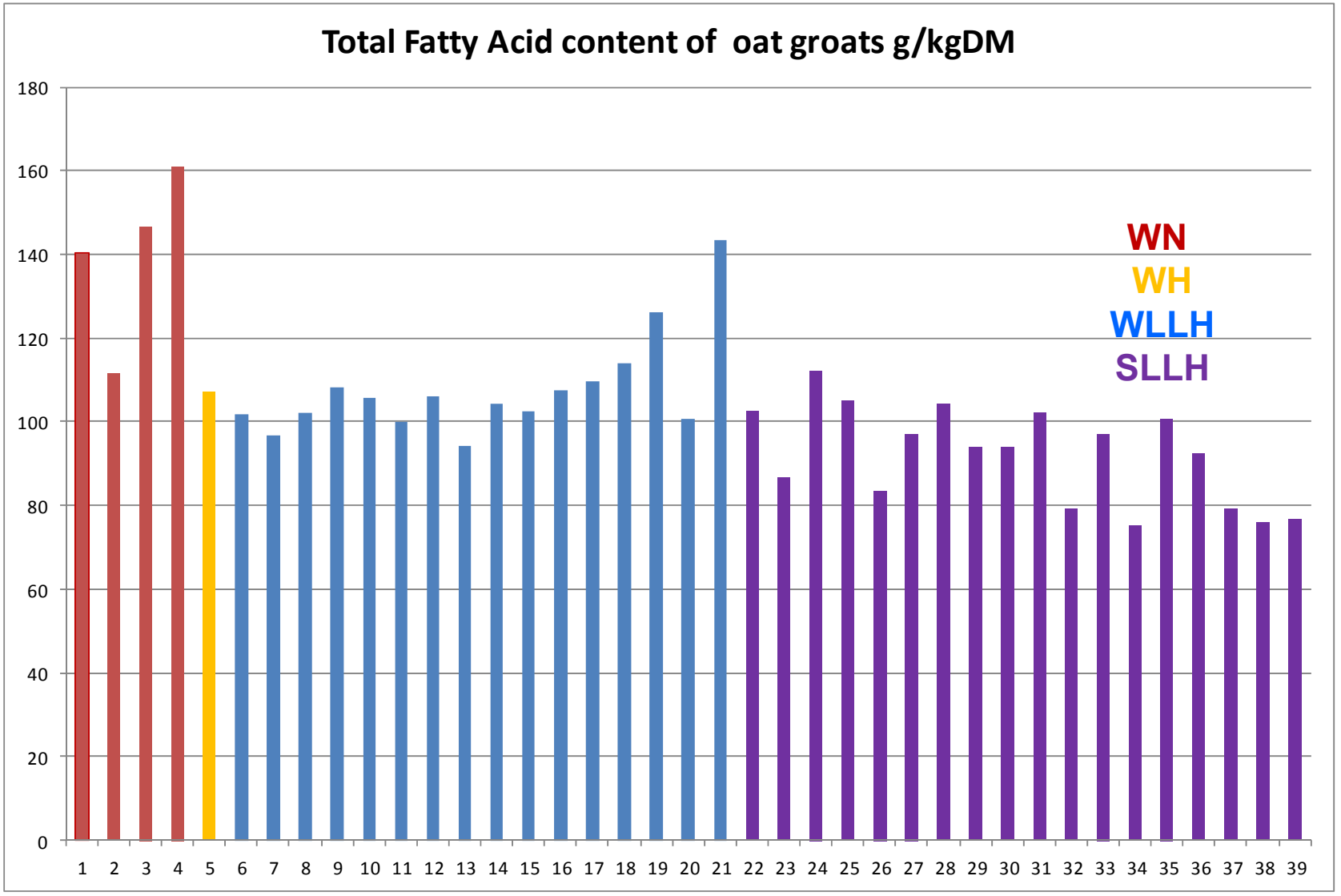
- It is hypothesised that a low lignin husked oat with a high oil groat would make an ideal poultry or ruminant feed



# Lines were and selected analysed for oil content using FAME method

# These have been grouped into 4 categories

- Winter Naked Oats (WN) n=4
- Winter Low Lignin Husked Oats (WLLH) n=16
- Spring Low Lignin Husked Oats (SLLH) n=18
- Winter Husked Oat (WH)  control




**Winter Naked Oats (WN)** **Spring Low Lignin Husked Oats (SLLH)**

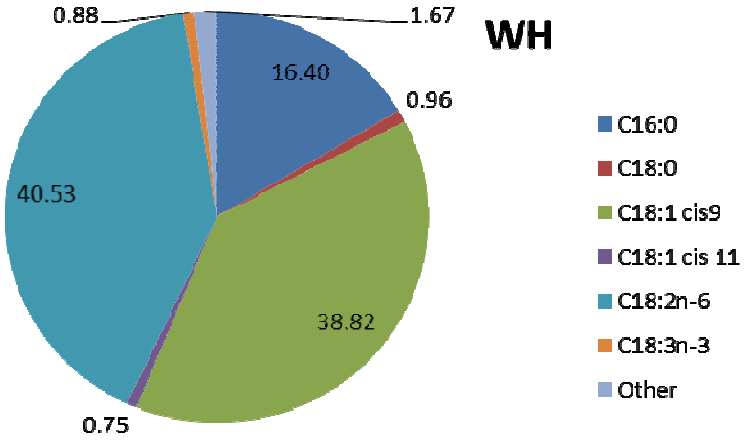
**Winter Low Lignin Husked Oats (WLLH)** **Winter Husked Oat (WH) control**

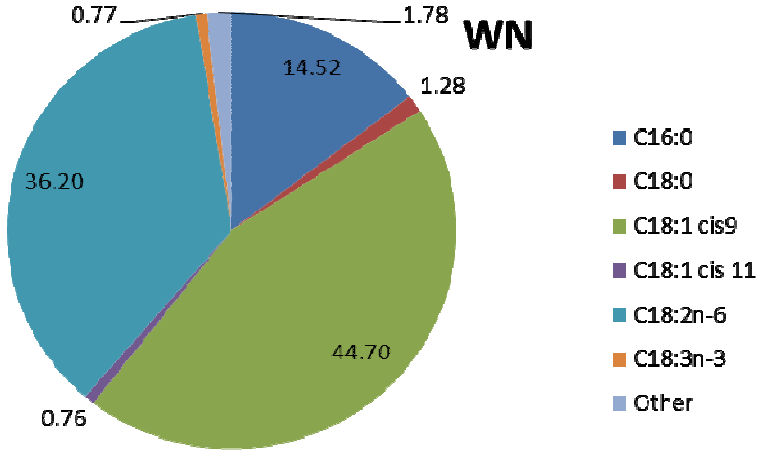
# Results of Fatty acids concentrations

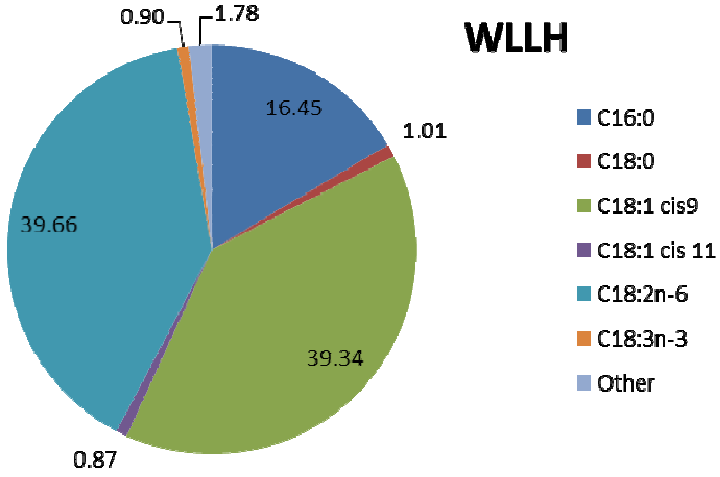
| | WN (n=4) | WLLH (n=16) | SLLH (n=18) | sem | Significance | WH (N-1) |
|---|---|---|---|---|---|---|
| TFA g/kg DM | 137.6c | 105.7b | 90.5a | 6.31 | *** | 107.1 |
| %C16.0 | 14.76a | 16.77b | 17.47c | 0.400 | *** | 16.39 |
| %C16.1 | 0.16a | 0.18a | 0.22b | 0.010 | *** | |
| %C18.0 | 1.30a | 1.03a | 0.97b | 0.100 | ** | 0.95 |
| %C18.1 | 45.5c | 40.1b | 36.0a | 0.980 | *** | 38.82 |
| %C18.2 | 36.8a | 40.ac | 43.6c | 0.821 | *** | 40.53 |
| %C18.3 | 0.78a | 0.92a | 1.20b | 0.069 | *** | 0.88 |

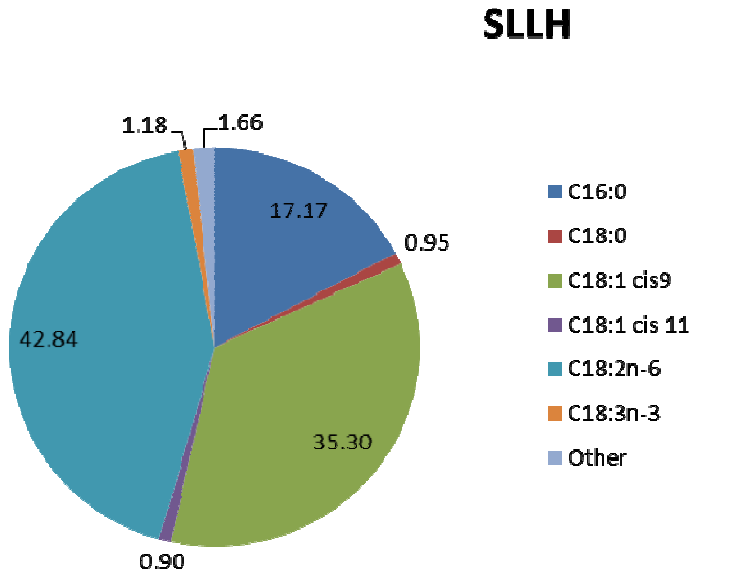
**Winter Naked Oats (WN)**
**Winter Low Lignin Husked Oats (WLLH)**
**Spring Low Lignin Husked Oats (SLLH)**
**Winter Husked Oat (WH) control**

# Main Components of Fatty acids in oat



# Ratios of Fatty acids

| | Polyunsaturated: Saturated | UFA: SFA | N-3: N-6 |
|---|---|---|---|
| WH | 2.38 | 4.66 | 0.021 |
| WN | 2.34 | 5.22 | 0.021 |
| WLLH | 2.32 | 4.62 | 0.022 |
| SLLH | 2.42 | 4.43 | 0.027 |
| Oatmeal * | 1.90 | 3.62 | 0.053 |
| Wheat * | 2.95 | 3.85 | 0.053 |

*From R W Welsh 2011 in Oats :Chemistry and Technology 2nd Edition Eds FH Webster & PJ Wood



# Conclusions

- A wide range in total oil content was observed from 7.5 to 16.1 %
- Generally greatest quantity of fatty acids found in C18.1, C18.2, C16.0,C18.0 (~97% of total)
- Some differences WN had highest concentration of monounsaturated and least saturated fatty acids



# Conclusions

**Ratios of unsaturated to saturated fatty acids alter depending on type of line studied. WN had greatest amount of unsaturated FA.**

**Shown variation which offers scope for future breeding and selection to develop high oil high quality oats which would be well suited as ruminant feed to improve meat and milk and may also reduce greenhouse gas emissions**



# Future work

- Feeding trial (Oct 2012 in sheep) to verify if reduction observed in gas production studies are confirmed in ruminants
- Feeding trial (August 2012 in turkeys) to verify the positive attributes of oats (especially naked oats with their high energy and good protein content ) are continued in production of turkeys

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HARNESSING NEW TECHNOLOGIES FOR SUSTAINABLE OAT PRODUCTION AND UTILISATION

The QUOATS project, led by Aberystwyth University (IBERS), is jointly sponsored by BBSRC, by Defra through the Sustainable Arable LINK Programme, by European Regional Development Funding through the Welsh Government's Academic Expertise for Business (A4B) Programme and through the Scottish Government Contract Research Fund with funding from AHDB and industry partners.

The project partners are: ADAS UK Ltd, Bernard Matthews Ltd, British Oat and Barley Millers' Association, Du Pont (U.K.) Limited, Felin Ganol Watermill, G B Seeds, Harper Adams University College, James Hutton Institute, Mole Valley Feed Solutions, Nairns Oatcakes Ltd, Oat Services, Organic Research Centre - Elm Farm, Phytatec (UK) Ltd, Poultry Xperience, Senova Ltd and the DairyCo, EBLEX and HGCA divisions of the Agriculture and Horticulture Development Board (AHDB).

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# Thank You