New Phenotypes for Dairy Cattle Breeding

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Terminology

- **Phenomics**
  - Discipline which focuses on methods to accurately characterise and individual

- **Phenotype**
  - Term to describe the characteristic of an animal (e.g., milk yield, growth rate, health status)
  - Fancy word for “trait”
Categories of phenotypes

1. Producer scored
2. Professionally scored
3. Technological
4. Statistical
5. Genomics
6. Next Generation
7. Monitoring / sentinel
1. Producer scored

• Producers know their animals best...and they know what they like!
• The critics
  • "Every farmer's opinion differs...."
    • Is the trait heritable?
  • "No farmer will say they've bad cattle..."
  • Genetic evaluations are based on contemporary comparison
  • Farmers also feed different diets
  • "They won't score it properly!!"
  • "That's not scientific!!"
Producer scored – examples
(Evans and Pabjou, tomorrow)

• Farmer satisfaction/workability
  - Heritability – 0.12 to 0.23
  - Genetically correlated with survival

• Dystocia
  - Heritability – 0.24

• Docility
  - Heritability – 0.07 to 0.36
Producer scored – pros and cons

• **Advantages**
  - Simple!
  - Producers know their animals the best
  - Good genetic predictor traits
  - Little marginal cost

• **Disadvantages**
  - Low heritability because of subjectivity??
    - Not true!
  - Need an easy to use low-cost system
    - SMART phones??
2. Professional

- Linear type classification
- Veterinary events
- AI services
- Hoof trimmers
- ......
Professional – pros and cons

• Advantages
  • Well trained professionals
    • Better quality?
  • Can fit in nicely into business plan – two-way communication avoiding duplication and generating service demand

• Disadvantages
  • Cost
    • Cost:benefit – linear type classification
    • Automation/technological alternatives?
3. Technological

• Data automatically captured although might currently not be used in phenotyping

• Milk recording
  • Milk yield, fat, protein and lactose composition
  • Milk fatty acid, lactoferrin, processing ability, energy balance, methane…….
Technological - example MIR
Technological – pros and cons

• Advantages
  • Relatively low running cost (depreciation)
  • No paper trail
  • Potentially huge data flow

• Disadvantage
  • Possible high capital cost (unless already available – milk analyser)
  • Usually high calibration cost
4. Statistical

- **BLUP**
  - Prediction of genetic merit of individuals while simultaneously adjusting for systematic environmental effects (e.g., herd, parity)

- **BLUE**
  - Estimates of systematic environmental effects

- How is your herd (first parity animals) doing even after accounting for your superior genetics?
Statistical – pros and cons

• Advantages
  • They are a by-product of genetic evaluations!!

• Disadvantages
  • Difficult to explain to end user
  • What’s the difference between BLUPs and BLUEs and herd effects??
5. Genomics

- Contribution to breeding decisions discussed elsewhere
- Personalised medicine in humans
  - BRCA1 and BRAC2 genes and link to cancer
  - Greater monitoring / prophylactic treatment
- What about cattle?
  - DNA is present from birth
    - Should we manage cattle differently based on genotype
    - We already do!!!
Genomics - examples

- Greater susceptibility to disease
  - Manage differently?
- Feed utilisation / growth rate
  - Feed differently?
  - Group similar animals together
- Milk properties
  - Product differentiation
  - Already underway - A1/A2
Genomics - pros and cons

- **Advantages**
  - Has massive potential - DNA is available from birth (and before!)

- **Disadvantages**
  - Requires huge initial investment - GxE
  - Animals are not as simple as we think
    - Technology and our biological understanding is improving
6. Next generation

Gene → transcript → protein → trait

Farmer/recorder “noise”

Phenomics

The Irish Agriculture and Food Development Authority
Next generation – pros and cons

• **Advantages**
  - Removes (some) residual noise
    - More heritable and therefore greater $\Delta G$
  - Inexhaustible source of information

• **Disadvantages**
  - **Cost**
    - Not an issue in the future
  - Procurement of biological sample
7. Monitoring

- Breeding is cumulative and “permanent”
  - Good ???
  - Bad ???
- Why did fertility deteriorate in the Holstein?
  - But we’re now improving fertility!
- Lessons for beef breeders?
7. Monitoring

• What is the impact of current breeding goals on traits not in the breeding goal
  • Health/disease susceptibility, feed intake, environmental load, welfare....
  • How will they animals perform in the futuristic production systems (post-2015)

• Options
  • Large scale phenotyping + selection index
  • Controlled experiments
  • Selection lines
7. Monitoring - pros and cons

• **Advantages**
  - A vital insurance policy

• **Disadvantages**
  - Well-powered controlled experiments are expensive
  - Type II errors can be misleading
Conclusions

• Phenotypes have been, are, and will continue to be the most important component of a profitable production system

• Lots done….lots more to do!