New Phenotypes for Dairy Cattle Breeding

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Terminology

- **Phenomics**
  - Discipline which focuses on methods to accurate 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 Pabiou, 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**

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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??**

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2. Professional

- **Linear type classification**
- **Veterinary events**
- **AI services**
- **Hoof trimmers**
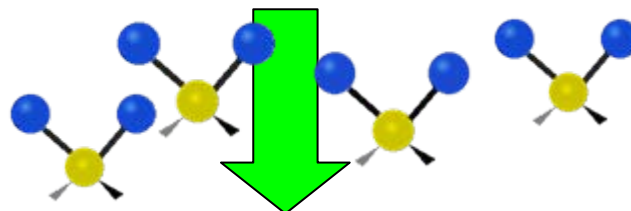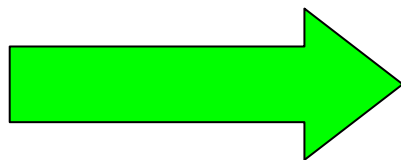- **…..**

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**
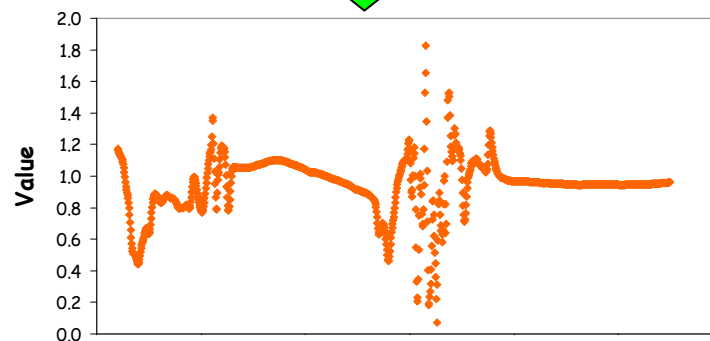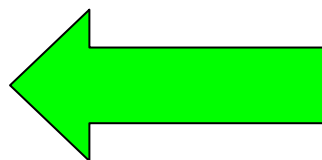   - **Automation/technological alternatives?**

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**
    - BRCA1and 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

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6. Next generation

Farmer/recorder "noise"
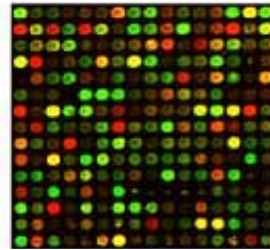
Gene → **transcript** → **protein** → **trait**

Phenomics

Next generation – pros and cons

- **Advantages**
  - **Removes (some) residual noise**
    - **More heritable and therefore greater ΔG**
  - **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!**