Impact of new on-farm technologies in dairy cattle breeding

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Questions

- What should we be thinking about to prepare for the future?
- How can we best exploit technology that is/will be available?
- How can we minimize the impact of negative trends?

Dairy Industry Trends

- Consolidation - fewer and larger herds
- Decreasing profit margins
- Increasing…
  - production per cow
  - productivity per labor unit
  - use of technology/automation (robots and computers)
  - demand for data (farms and industry)
  - demand for specialized services (nutrition, health)
  - demand for specialized "production" (e.g.. Organic)

General trends
Canadian Dairy Farming

	1983	2007	% Change
NUMBER OF FARMS	49,936	14,660	- 71%
NUMBER OF MILK COWS (thousand heads)	1,736	988	- 43%
COWS PER FARM	35	67	+ 91%
VOLUME OF MILK PRODUCED (million hectoliters)	72.3	75.8	+ 5%
VOLUME OF MILK PER FARM (hectoliters)	1,449	5,173	+ 257%

Source: Statistics Canada and Canadian Dairy Commission

History of innovation

- 1950s Computerization
- 1960s Laboratories for component testing
- 1970s Computer from farm to mainframe for input and reports
- 1980s Electronic data transfer from farms and laboratories; on-farm data entry
- 1990s Robotic/voluntary milking systems
- 2000s Handheld devices for data collection and access; RFID
- 2010s ???

2010 ... On-farm milk analyzers

- **S.A.E. Afikim** – afimilk™ afilab
  - On-Line real time milk analyzer
  - Fat, protein, lactose, SCC indicator
  - Monitors for blood in the milk
  - Combination of above parameters serve as indicators for nutrition and health management
- **lattec** – Herd Navigator™
  - 50:50 Partnership of FOSS and DeLaval
  - Udder health (LDH, enzyme for early detection of CM)
  - Nutrition (urea and BHB, a ketone body)
  - Reproduction monitoring (progesterone)

Electronic milk meters

- Currently supply 7% of data
- Can provide
  - Total yield
  - Milking speed
  - Milk conductivity
- May provide
  - Progesterone levels
  - Milk temperature
  - Component concentration
- RFID may improve reliability of cow ID associated with meter data

Voluntary milking systems

- Also known as robotic parlors
- Most common in Europe
- Depend heavily on automatic data collection
- Require adaptation by DHI to be included
- May provide data not available elsewhere

Other data collection devices

- Electronic scales
- Handheld computers to record health
- Activity monitors
- Weather stations

Why farms should invest in automatic data collection

- Better management
  - More accurate data
  - More characteristics
  - Greater quality control
- Food quality assurance and traceability
- Help genetic improvement?

Trends

- More traits recorded
- Larger herds
- Improved equipment for electronic recording
- Increased worldwide competition among AI organizations
  - Demand for increased data accuracy and comprehensiveness, especially for traits with low heritability

Needs of genetic improvement program

- Continued participation
- Maintained or improved data quality
- Adaptation to change

Benefits to genetic improvement from automatic data collection

- Improved accuracy
- Reduced cost
- More traits

Tradeoffs in adding traits

- Low heritability
- Recording errors
- Difficulty in estimating economic value
- Dissipation of selection differential

Why more traits?

- Goal of a profitable cow
- Selection index
  - Evaluations weighted by economic contribution
- More precise measurement of profitability
  - More accurate profit tracking
  - More accurate selection

How to connect genetic improvement to on-farm data

- Provide value
  - Genetic evaluations
  - Data backup
  - Data quality control
- Compensate for data as a dairy product (like milk)
- Promote connection ease and security

On-farm software

- Must be maintained
- Support
  - Extremely labor intensive
  - Expensive if many platforms
- Central control of updates attractive
- Dedicated uniform hardware?

Systems for farms to provide data

- Current system
  - AI organizations pay for progeny-test daughters
  - Bundled with DHI program
- System managed by AI organizations
  - AI organizations connect to on-farm computers
  - Data quality monitored by AI organizations
- Farm as data vendor
  - Farm markets data to AI organizations
  - Compensation based on quality

Who is in charge?

- AI organizations
  - Establish data connection with progeny-test herds
- DHI
  - Offer test plans that provide desired data
- Farm
  - Market data based on quality
- Cooperation
  - Establish mechanism for equitable resolution of competing interests

Measures of data quality

- Consistency
  - Milk weights vs. milk shipped
  - Calving, progeny birth, breeding, dry dates
- ID accuracy from parentage verification
- Electronic ID
  - Protocols to detect misreads
  - Portion of duplicate or missing cows
- Within-herd heritability

Management vs. genetic improvement

- Large-herd management based on cow groups
- Selection based on evaluation of individuals
- Genetic improvement needs data from individuals

Where genetic improvement needs to go beyond herd mgmt needs

- Accurate ID
- Access to all data
  - Allow efficient research and development of new trait evaluations
- Sufficient incentive for herds to participate

Herd of the future

- Recording of every milking and determination of components
- DNA from all calves and possibly genotyped
  - Parentage verification
  - Genomic-based evaluation
  - Traceability
- Data delivered to evaluation center daily

The promise of SNP (single nucleotide polymorphisms)

- Provide large number of markers
- Inexpensive to read
  - May allow calculation of EBV at birth
  - May make parentage verification/ determination inexpensive

Hurdles for SNP

- Benefits justified by cost
- Convenient DNA collection and accurate labels
- Timely and adequately accurate genomic prediction
- For parentage verification/discovery, genotypes from same SNP required for potential parents

Evaluations on demand

- Estimates of SNP effects updated several times each year
- Genomic prediction calculated as soon as genotype available

Best practice

- Collection of accurate data for all relevant traits
- Seamless transfer to evaluation center
- Evaluations calculated with test-day model and including genomic data
- Results available as needed

What to expect from automatic data collection

Incentives

- Quality data have value
- Computer capacity on farm minimizes need for central computing
- Economic incentive required for dairies to contribute data to national evaluations
- Appropriate to have incentive based on data quality

Benefits to herds

- Improved management information
- Incentives from AI organizations for providing data
- Improved pedigree accuracy from parentage validation

Impact on national evaluations

- Higher accuracy of current analyzed traits
  - Higher number of records
  - Transcription errors eliminated
  - Computer detection of abnormal values expected
- More traits
  - Body condition score based on electronic scales
  - Mobility
  - Fertility based on progesterone levels
- Higher quality
  - Electronic recording and monitoring
- Lower cost
  - Less labor required as technician cost on test-day eliminated
  - On-farm component determination

Conclusions

- Automated data collection
  - Growing
  - Can improve data quality
- Genetic improvement programs
  - More traits
  - Better inputs
  - Tighter connection to sources