THE Efficient Dairy GENOME PROJECT

An international initiative to decrease the environmental footprint of dairy cattle using genomics

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Impact of Genomics on Sire Evaluations

- Need for large reference populations to achieve accurate reliabilities of young stock parent averages
  - 0.70 Reliability of GPA vs. 0.35-0.40 reliability of PA
- Competing AI organizations that share genotypes
  - **InterContinental Genomics Exchange Consortium**
    Canada, US, Italy, UK, Switzerland and Japan
  - **EuroGenomics**
    France, Germany, Netherlands, Denmark, Sweden, Finland, Poland and Spain
- Over 32,000 Holstein reference bulls per consortium

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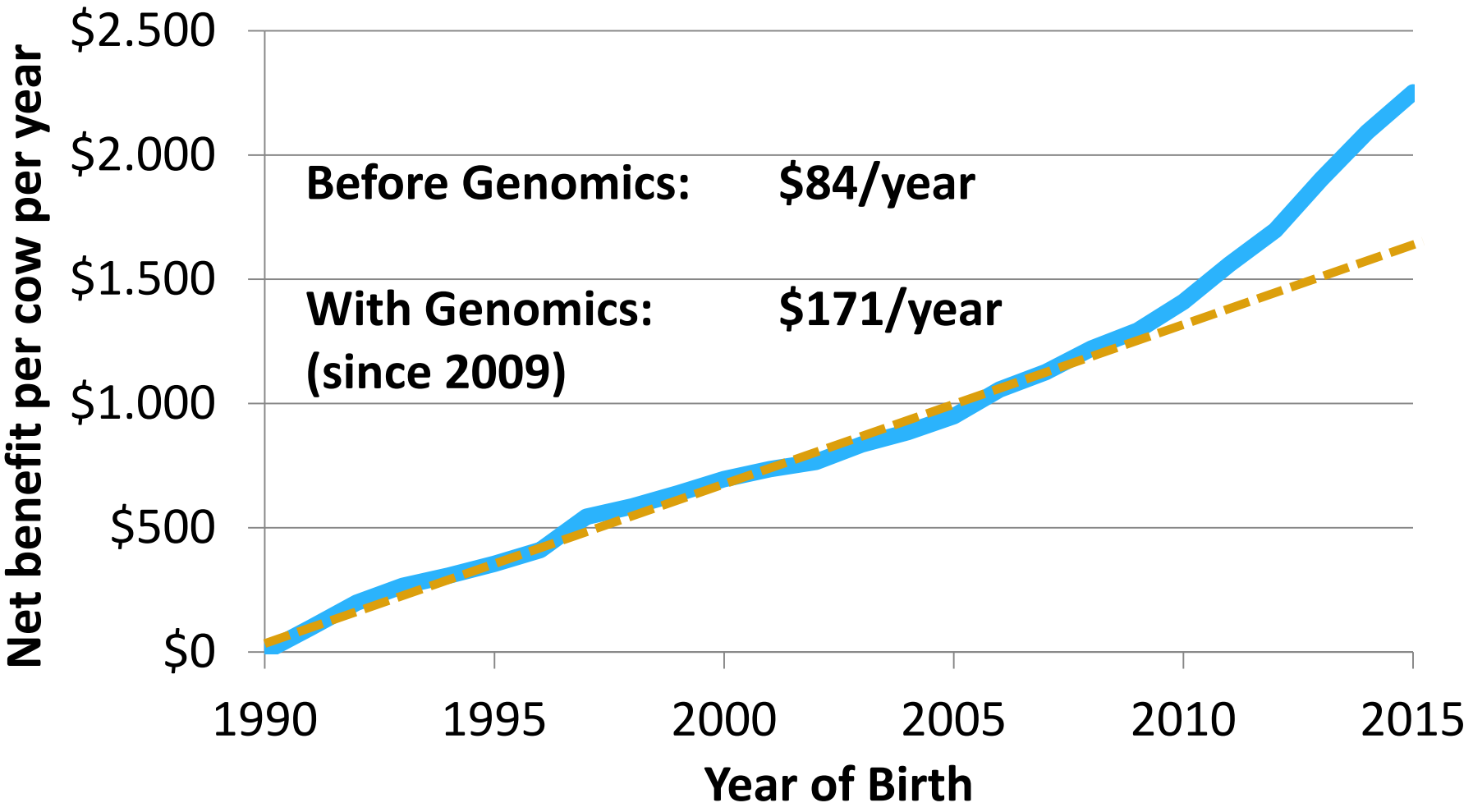
Strong impact due to immediate industry uptake



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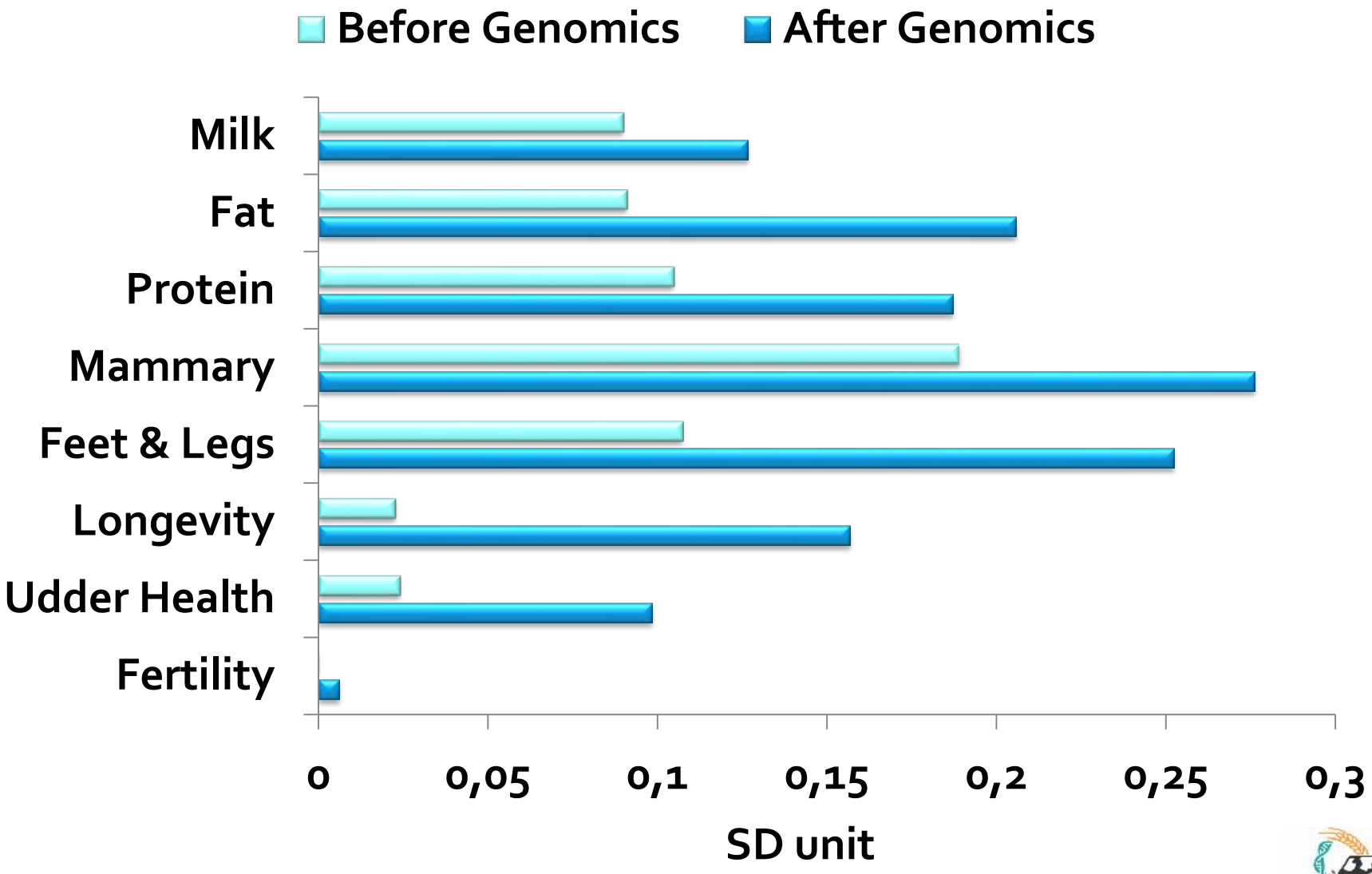
Annual Genetic Progress – Major Traits



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Integrated Solution for Greener Dairy

- Genomics provides an opportunity to select for higher feed efficiency and decreased methane emissions
- ➢ Will lessen the environmental impact of dairying
  - Reduction of emissions and feed waste
  - Less feeds (less land) used for dairying
- Compelling opportunity to make dairy greener worldwide, through strong collaboration
- Whereas at same time benefiting dairy producers
  - Reduction of feed costs
  - Potential credits for cutback in methane emissions

Efficient Dairy Genome Project

- Genome Canada Large Scale Applied Research Project
- Cash and in-kind funding from international and national partners to total CAD $10.3 million
  - Genome Canada, Genome Alberta, Ontario Genomics
  - ALMA, Ontario MRI, CDN
- Start date Oct 2015 – End date Sep 2019
  - Led by Filippo Miglior (Guelph) & Paul Stothard (Alberta)
- **Overall objective to improve feed efficiency (FE) and reduce methane emissions (ME) in dairy cattle using genomics**

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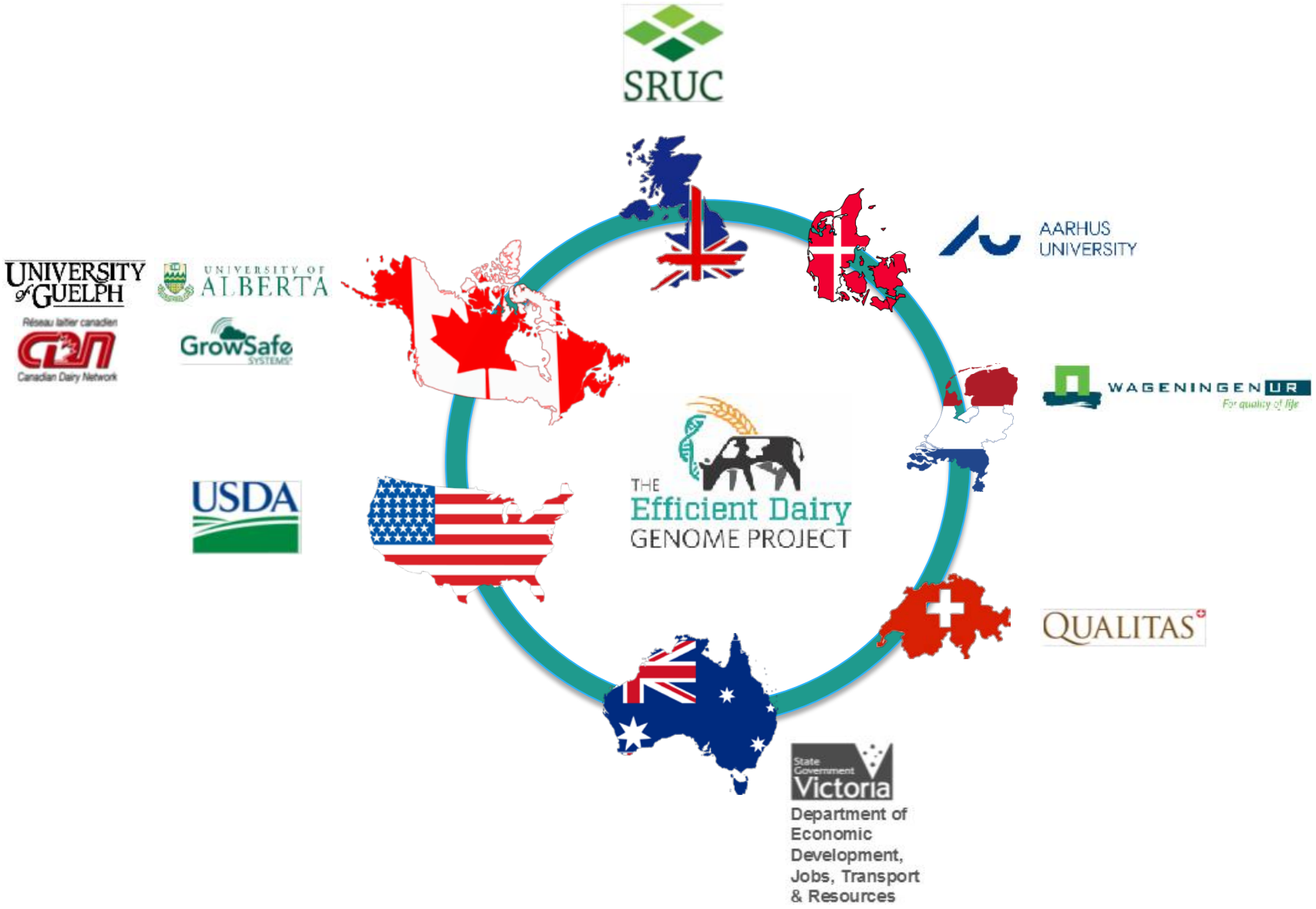
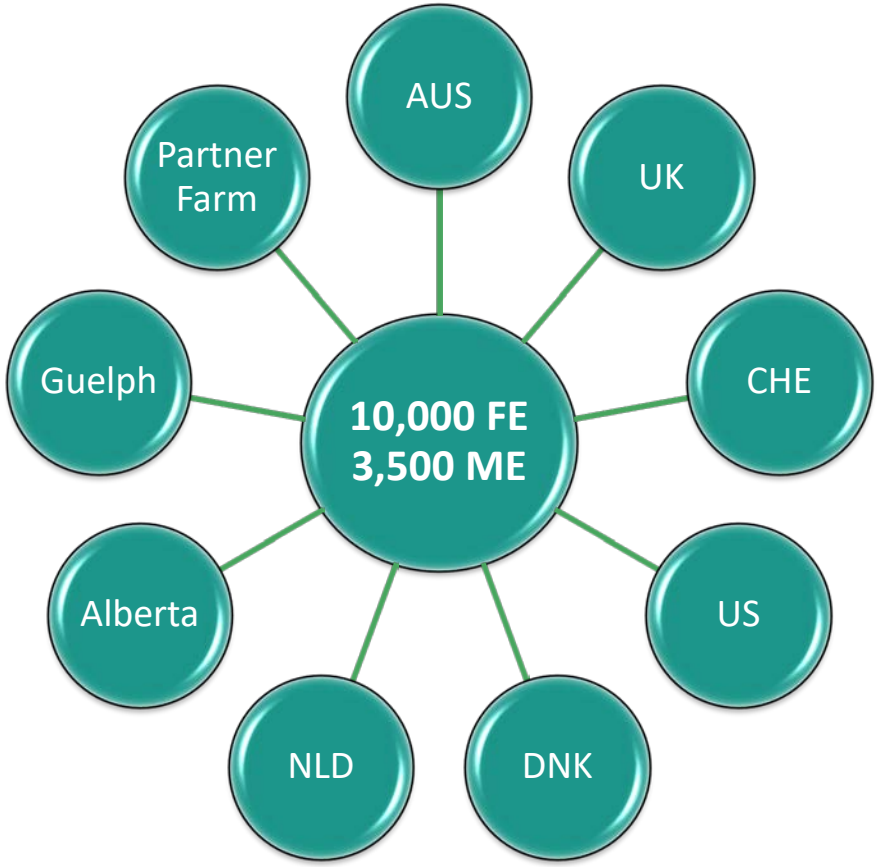
A Fully Integrated Partnership



Experimental Design



- **Cow reference population for SNP calculation for FE and ME**
- **Continuous sharing of SNP solutions among partners**
- **Using MIR to predict FE & ME**
- **Genomic evaluations in each country using cow FE & ME**
  - Adding relevant SNP
  - Multiple-trait evaluation adding MIR predicted FE and ME

Secure data base routinely updated and accessible by all partners

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Activities	Year 1	Year 2	Year 3	Year 4
GE^{3}LS Ethical, environmental, economic, legal and social aspects of genomics	Social benefits and costs of selection for FE and reduced ME			
	Societal acceptance and value of use of this new technology			
Data Consolidation	Feed Efficiency → 8,000-10,000 cows			
	Methane Emissions → 3,500 cows			
	Milk MIR data → 1,000,000 cows			
Genomics	Imputation & GWAS			
	Sequence	Variant Discovery	RNA-Seq & Functional Studies	
Implementation	Genetic Evaluation & Software Development			
	Profit Index		GEBV Delivery & Translation	

Tangible Deliverables to End Users

- **Weekly release of GEBV for FE and ME to producers and the AI industry integrated by**
  - *Newly-identified mutations or markers*
  - *New developed FE and ME predictions from MIR spectra*
  - *World's first database to routinely validate genomic predictions and continuous exchange among partners*
  - *Measurement of the farm level benefits from adopting the use of the GEBV for novel traits*
  - *Societal cost benefit analysis results from incorporating the new traits into national breeding programs*

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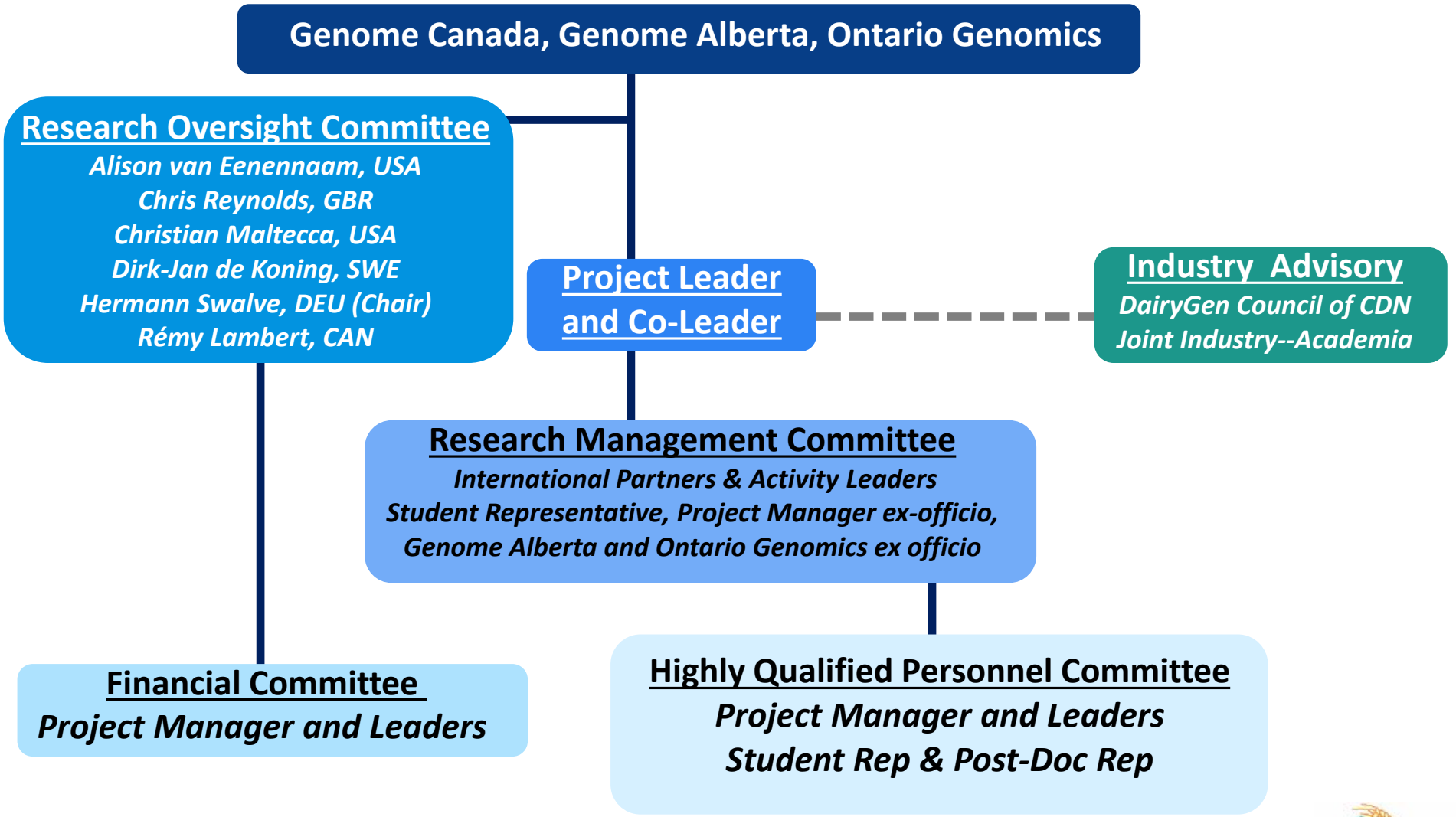
Governance



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Team

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Project Manager

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Post-Doc, Canada

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Post-Doc, Canada

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Post-Doc, Brazil

Pauline Martin
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PhD, Switzerland

Stephanie Lam
PhD, Canada

Dave Seymour
PhD, Canada

Caeli Richardson
MSc, Canada

Angela Wilson
MSc, Canada

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Plans for Guelph Research Herd

Calves (n = 180/year)

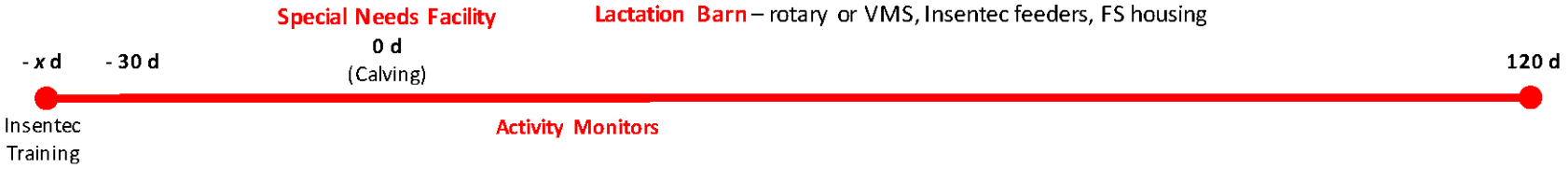
Calf Measurements

Duration: 0 – 60 d

Genotyped at birth.
BW recorded at birth, 1 month and 2 months.
Milk replacer intake, starter intake (normally recorded)

Primiparous Heifers:

Feed Efficiency (n = 180/year)



Methane Emissions (n = 75 – 100/year)

Methane Emission Measurements

Duration: 20 – 30 d GreenFeed System

Daily (M – F)

CH4 emissions measured every 4 hours.
Measurements taken 1 hr later each day .

Other

Rumination collars

Feed Efficiency Measurements

Duration: -30 d to +150 d

Daily

Daily yield
Daily feed activity
Daily feed intake

BCS (every milking, using 3D cameras)

Weekly

DHI (alternating am/pm recording):
- Milk yield
- Milk fat, protein
- Lactose
- BHBA
- MUN
- SCC

Feed Samples

Two Weeks

Body weight

Visual body conformation

Ongoing Measurements

Individual Cows

Health events

Reproduction events

Other

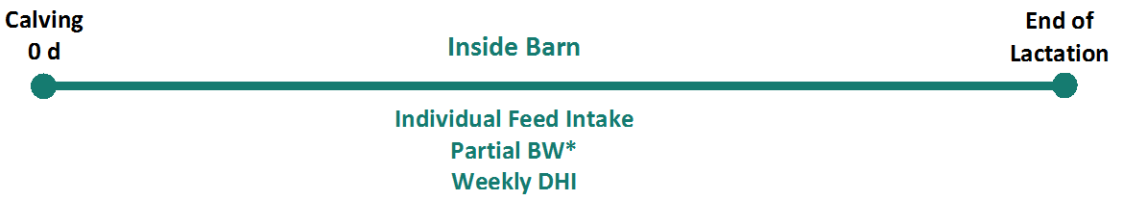
Environmental data (RH, temp, inside and outside CO2)

Plans for Partner Farm – 450 cows

Pregnant Heifers (n = 150/year)

First Parity Cows (n = 150/year)

High-Producing, Later Parity Cows (n ≈ 150/year)



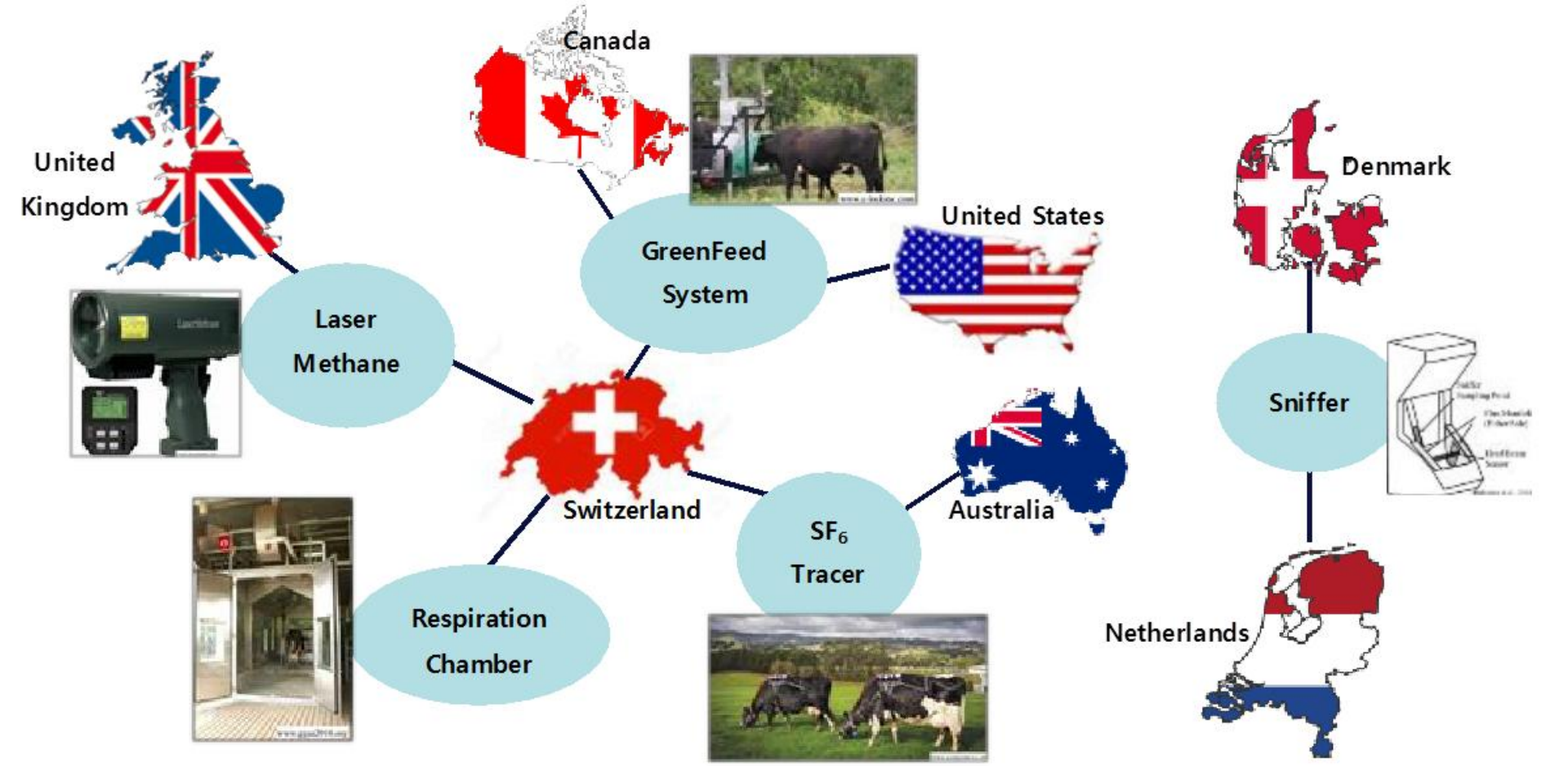
Possible Additions:

- Rumination Collars
- GreenFeed system

All animals genotyped with 50 K

*Body weight of cow measured from two front feet and is recorded multiple times per day

Methane Emissions



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Progress

- Data routinely collected from each partner
- Survey to partners for data base development
- Survey to ICAR members
  - Trait definition and standardization
  - Selection goals definition
- Identification of bulls to sequence
- Setup of economic studies
- Strengthening of collaboration with gDMI 2
- Complementary projects recently approved
  - Microbiome and system biology (Dr. Angela Canovas)
  - Breeding Strategies (Dr. Christine Baes)

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Participating Organizations

GenomeCanada

GenomeAlberta

Ontario Genomics

ALMA
Alberta Livestock and Meat Agency Ltd.

Ontario
MINISTRY OF RESEARCH & INNOVATION

Ontario
Ministry of Agriculture, Food and Rural Affairs

Réseau laitier canadien
Canadian Dairy Network

UNIVERSITY of GUELPH

UNIVERSITY OF ALBERTA

GrowSafe SYSTEMS®

USDA

SRUC

State Government Victoria
Department of Economic Development, Jobs, Transport & Resources

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AARHUS UNIVERSITY

WAGENINGEN UR
For quality of life

SEMEX ALLIANCE

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