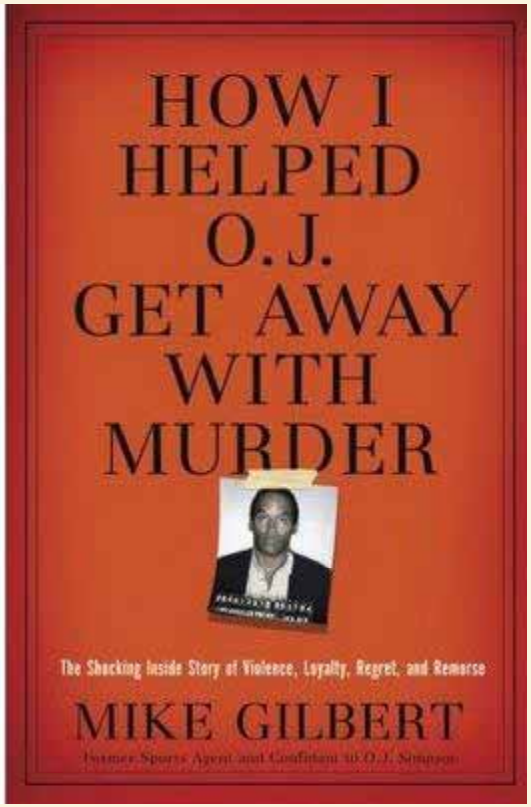
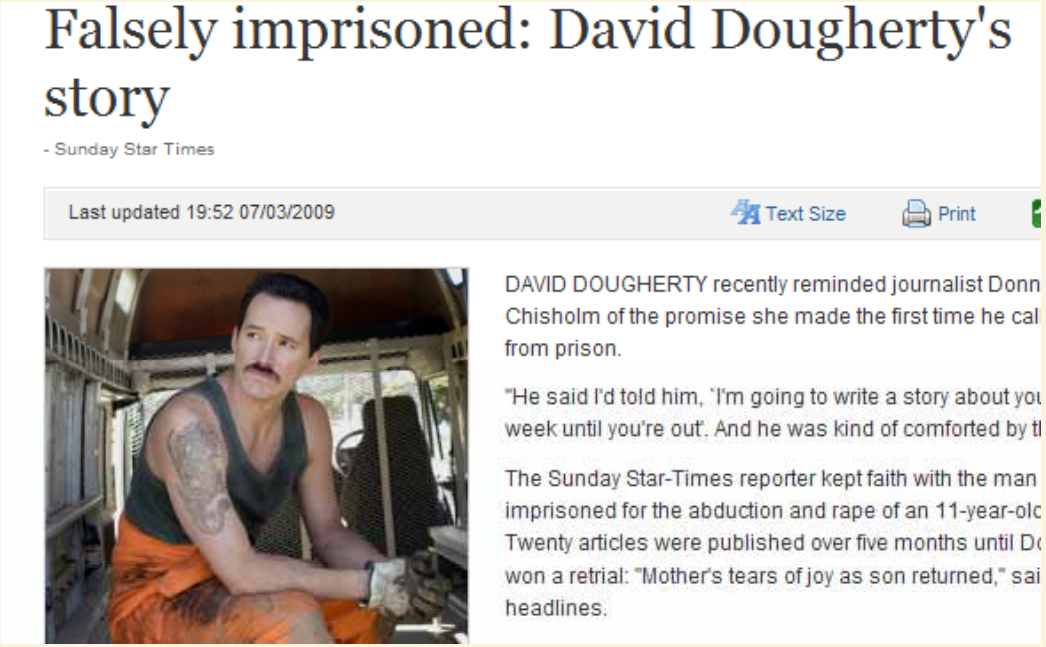
Application of DNA technology in dairy farming.

Richard Spelman

DNA Era

- Forensics





Falsely imprisoned: David Dougherty's story

- Sunday Star Times

Last updated 19:52 07/03/2009 Text Size Print

DAVID DOUGHERTY recently reminded journalist Donn Chisholm of the promise she made the first time he cal from prison.

"He said I'd told him, 'I'm going to write a story about you week until you're out'. And he was kind of comforted by t

The Sunday Star-Times reporter kept faith with the man imprisoned for the abduction and rape of an 11-year-olc Twenty articles were published over five months until D won a retrial: "Mother's tears of joy as son returned," sai headlines.

DNA Era

- Ancestry

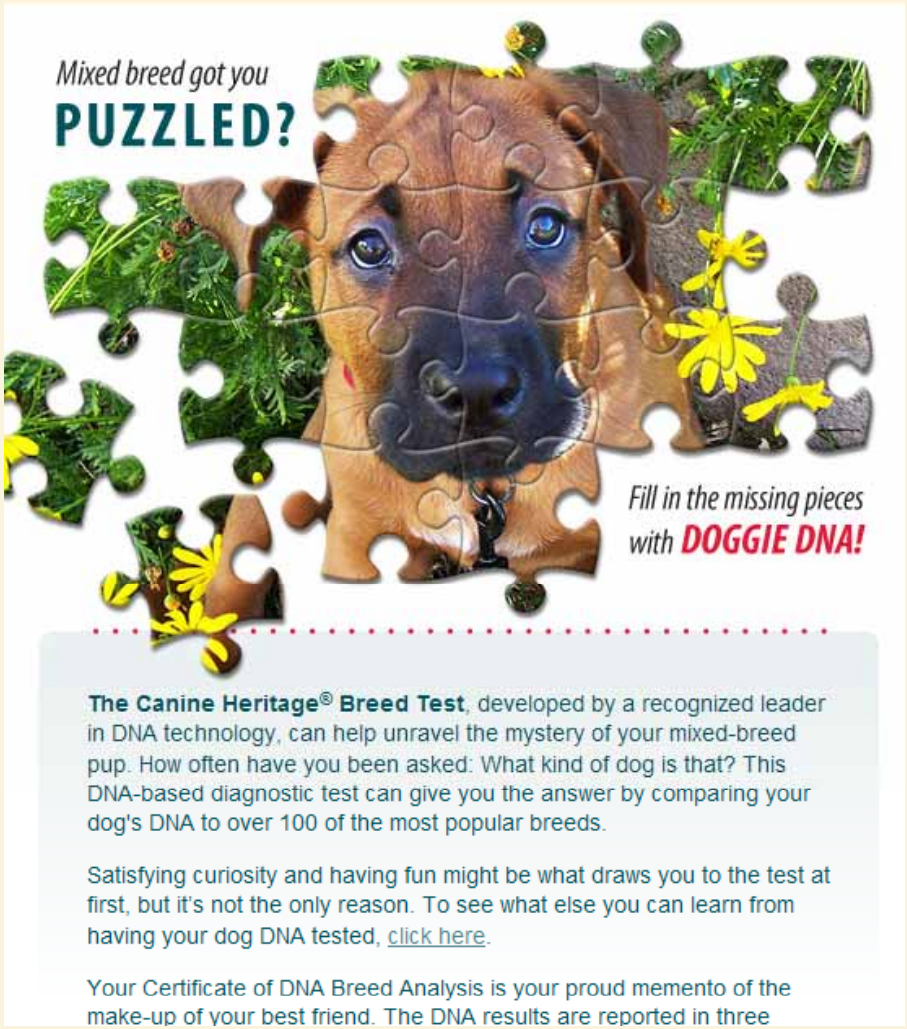
DNA ANCESTRY PROJECT:
Trace your ancestral origins.

Learn more about your ancestors, where they came from, and their ethnic origins. Studies have shown that all of us shared a common ancestor who lived in Africa approximately 65,000 years ago. As time passed, our ancestors migrated out of Africa into the Middle East, Asia, Europe, North America, and other parts of the world. During this period of time, mutations occured in their DNA, and each mutation links our ancestors to a specific time and place in history. By participating in the DNA Ancestry Project, you will embark on a dynamic journey to discover your ancestral origins.

2009 MDG Conference

DNA Era

- Ancestry

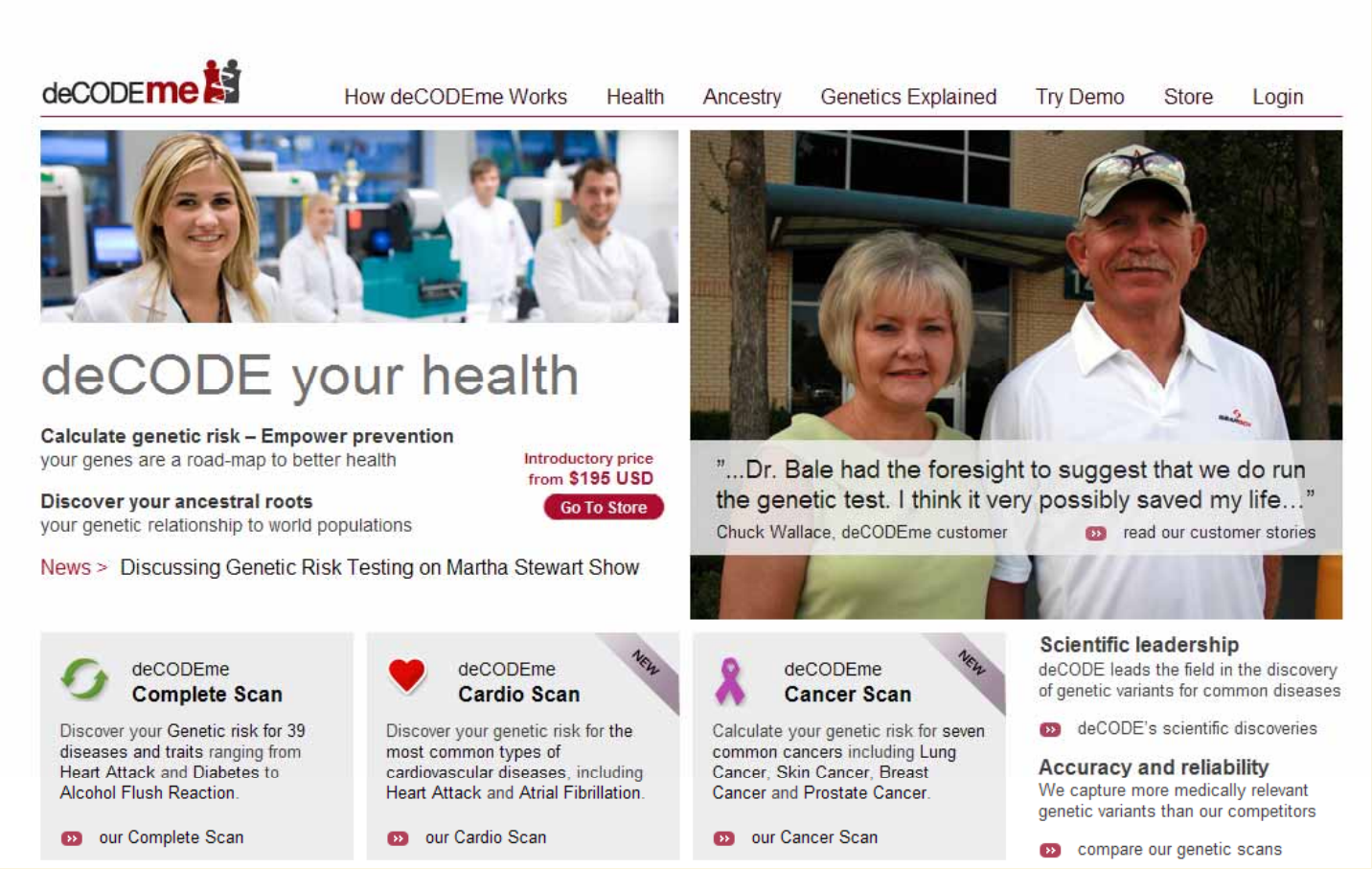


DNA Era

- Parentage

DNA Era

- Health



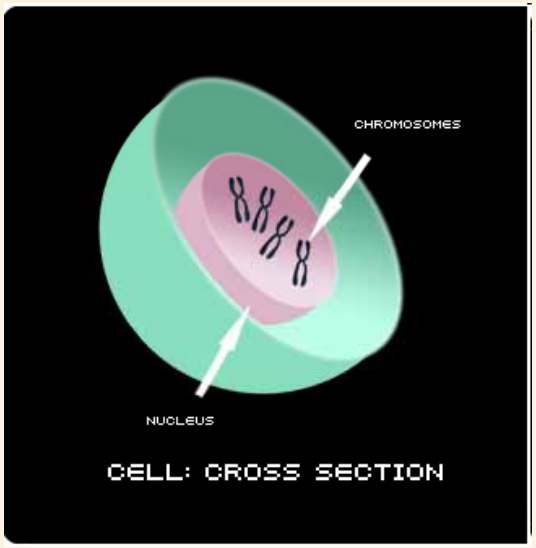
DNA Era

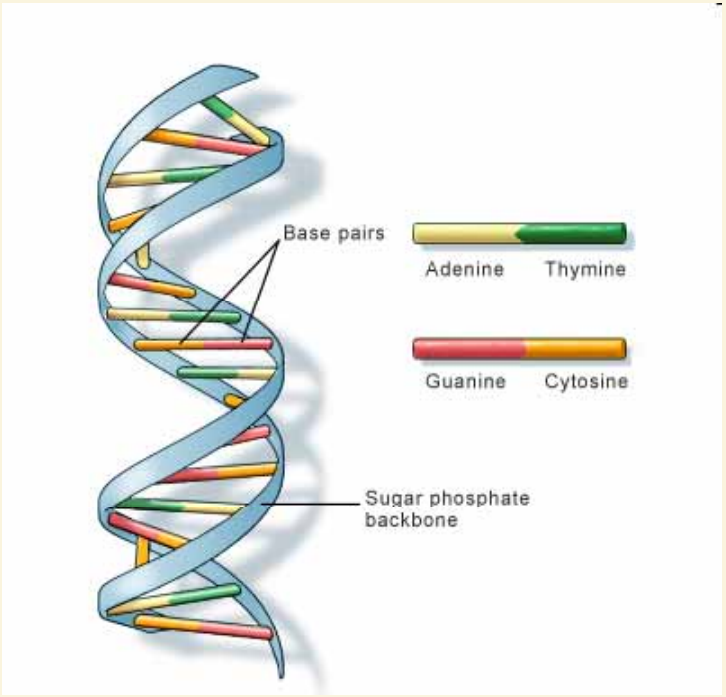
- Disease prevention
  - For example BLAD

+

- Will this technology be used for humans?
  - Already is for Thalassemia disease in Cyprus.

What is DNA?


CHROMOSOMES
NUCLEUS
CELL: CROSS SECTION


Base pairs
Adenine
Thymine
Guanine
Cytosine
Sugar phosphate backbone

What is DNA?

- 3 billion base pairs in the bovine and human genomes
- Approximately 20-25K genes
- Genes only make up 2.5% of the genome
  - Rest previously thought to be junk
  - Junk DNA now identified as controlling expression of the genes

DNA applied to dairy farming

- Genetic gain for milk production traits
- Different milk characteristics
- Pasture improvement

DNA applied to dairy cattle breeding

Animal performance

Variation at the DNA level influences animal performance

If one can identify “important” DNA variation then we can predict animal performance

DNA

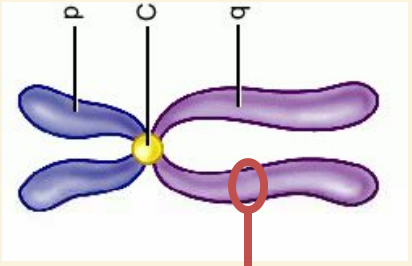
DNA research undertaken by LIC

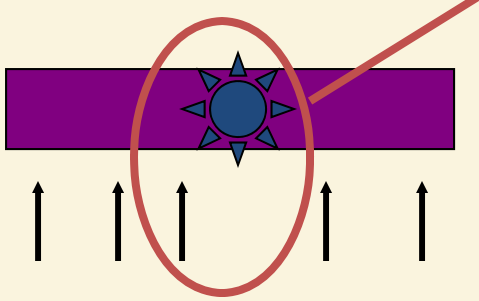
- 1994 started research with University of Liege, Belgium and Holland Genetics
- Identified 2 genes that influenced milk production
- Used to pre-screen bulls into SPS
- 2007-08 DNA research delivered

Why now & not 10 years ago?

- Bovine sequence in 2006
- Before bovine genome sequence
  - 1-5000 genetic markers
  - $2-3 per animal per genetic marker
- After bovine genome sequence
  - 100,000^{+} genetic markers
  - Less than 1 cent per animal per genetic marker

DNA applied to dairy cattle breeding





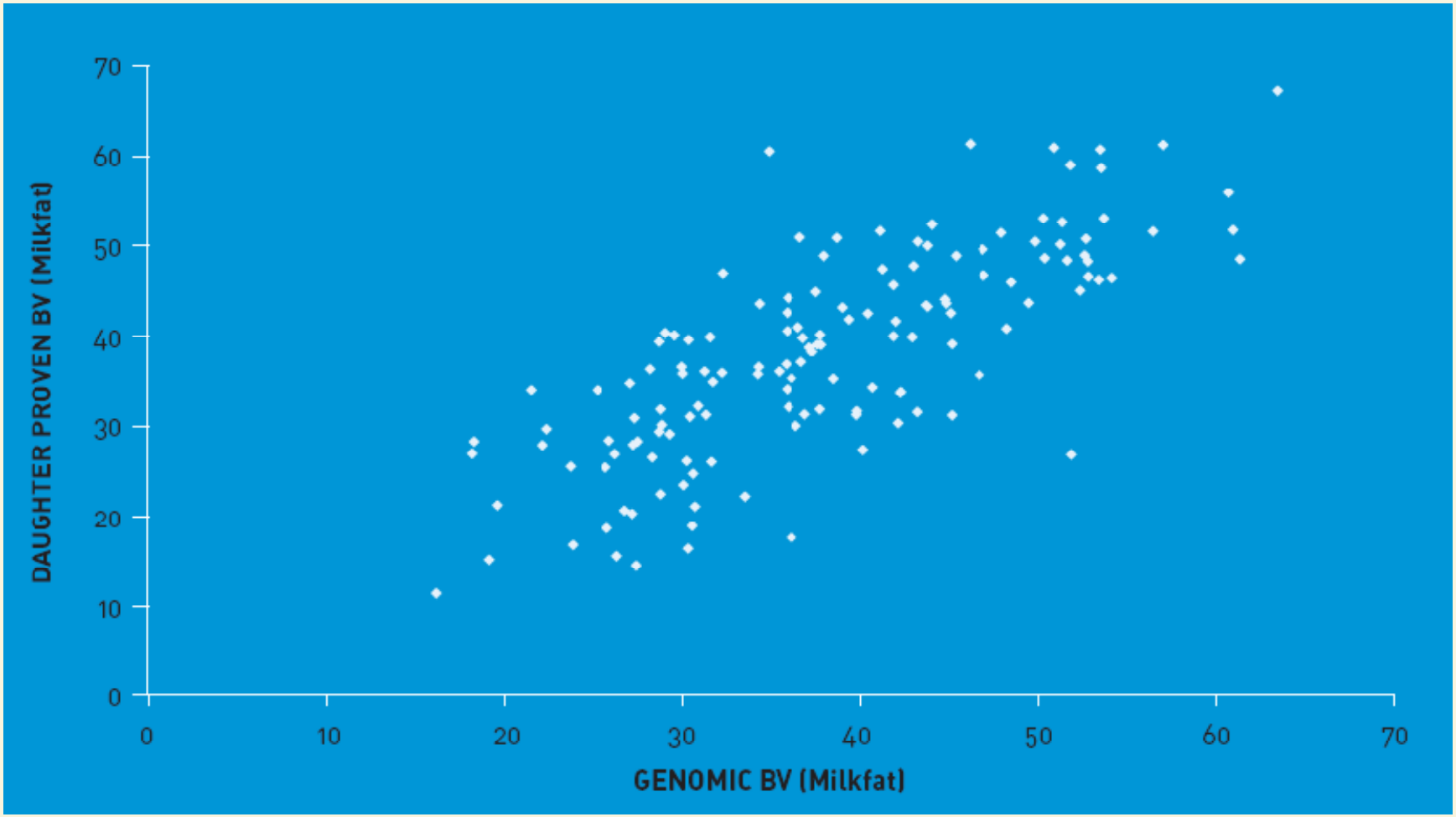
AA**T**GC…..Prot+

AA**G**GC…..Prot-

Genotype 3000 bulls

- bulls' daughters with T allele average 150kg protein
- bulls' daughters with G allele average 148kg protein

Genetic merit is well predicted



DNA proven team

- Bulls sold to farmers as 2 yr-olds rather than 5 yr-olds
- Individual DNA proven sires have reliability of 50-60%
  - Daughter proven 80-85%
- Used in a team increases reliability
  - 97% for team of 16
  - Average of 250 BW
    - 95% of the time will be ± 23 BW as a team
    - Daughter proven team ± 13 BW as a team

The world's first large scale commercial launch of "DNA Proven" genetics

Size of the prize

- Genetic gain is permanent and cumulative
- “Compounding returns is the greatest mathematical discovery of all time”
- Genetic gain in dairy cattle delivers the bulk of productivity improvement on NZ farms
- Genomics is expected to increase the annual rate of compounding gain by 30-40%
- It is the biggest development in genetics (and therefore on-farm productivity gain) in 60 years

DNA proven team

- Offered for the first time in 2008
  - NZ, UK & Ireland
- Increased choice for dairy farmers
  - 19% of inseminations by DNA proven team
    - 60% KiwiCross™
- Charge an extra $5 premium over daughter proven teams
  - Reflects genetic superiority of teams
  - 1 BW for a sire worth ~50 cents to farmer
  - 10 BW advantage break even

Milk characteristics

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NZ cows produce own skimmed milk

Experts at a biotechnology company in New Zealand have discovered that some cows have a gene giving them a natural ability to produce skimmed milk.

The finding could one day be used to breed "skimmed milk herds"

The finding could be used to develop a dairy herd that produces low-fat milk, Chemistry & Industry magazine reports.

A cow with the "skimmed milk" gene was identified in 2001, and the team have since been able to breed calves that also produce the low-fat variety.

They say it could have a significant impact on the dairy industry.

The original cow - called Marge - produces milk that is very low in saturated fats, and so should be high in healthier polyunsaturates and monounsaturated fats.

Milk with this composition could also be used to make more spreadable butter.

> **"When we found her daughters had the gene, that was the eureka moment"**
>
> Russell Snell, ViaLactia

Skimmed milk is currently made by removing much of the fatty cream contained in whole fat milk.

About 25% of milk sold in the UK today is full-fat. The rest is skimmed or semi-skimmed (skimmed milk with some fat added back).

Marge was discovered during a screening of milk compositions across New Zealand's four million cattle, carried out by

Milk characteristics

GENOMICS

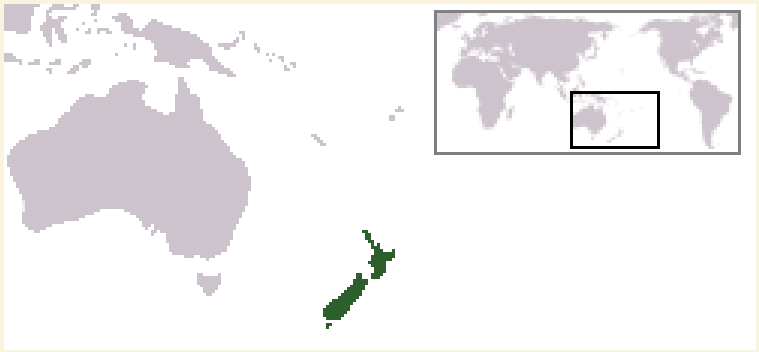
New: casein and healthy fat bulls

A new denotation for proven bulls is in the pipeline. They will receive the label casein bull or unsaturated fatty acid bull. This is thanks to research conducted by the Dutch Milk Genomics Initiative. The dairy industry can start working with the results today.

For some time already it has been known that the fat and protein component in milk varies from one cow to the next. Milk fat is made up of a large number of fatty acids. Milk protein consists of a large number of proteins with the largest portion of milk protein (90%) being formed by the caseins and the whey proteins -lactalbumin and -lacto globulin. Research in Wageningen has determined that not only the components, but also the composition of the milk fat and milk protein varies from one cow to the next. An important part can be attributed to the differences in genetic make-up. By using specific bulls, the composition of milk fat and milk protein can be influenced. Modern genetics makes it possible to detect such bulls quickly. When farmers use these bulls, they will get cows that give milk which is extremely suitable

Pasture

- Low-input mixed sward pasture-based farming on most farms
  - 70% perennial ryegrass (Lolium perenne) – hardy, palatable, productive, digestible obligate outcrosser
  - 30% white clover (Trifolium repens) – leguminous obligate outcrosser



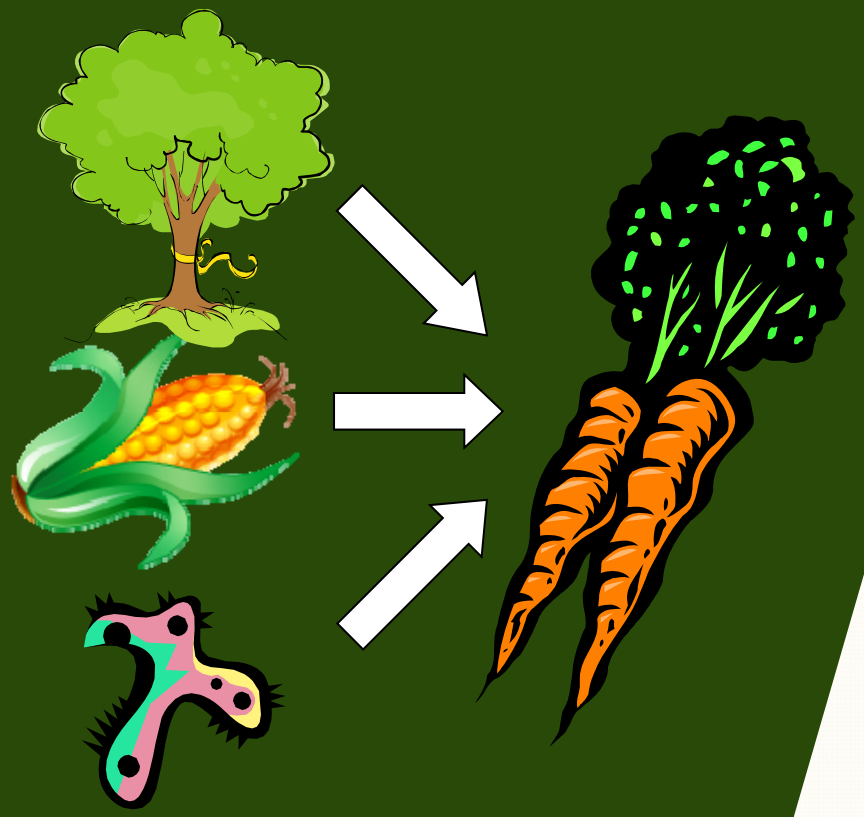
PG: smart sustainable forages for NZ

- Our Meat, Dairy, Wool and Deer industries **rely on the long-term productivity of pasture** for their international low-cost and high-quality positions.

- Biotechnology will give the **greatest stepwise and sustainable improvement** in pasture productivity. We will use our in-depth knowledge of pasture genomes to **enhance conventional breeding**. And we will use ryegrass genes in ryegrass, clover genes in clover to capture the **untapped genetic potential** in pasture plants.

DairyNZ Fonterra Dairy for life MEAT & WOOL NEW ZEALAND agresearch DEERresearch FOUNDATION FOR RESEARCH SCIENCE & TECHNOLOGY 2009 MDG Conference

Transgenic with added genes



Cisgenic® with no new genes

PG's targets

PRODUCTIVITY TARGETS - RESEARCH & APPLIED DISCOVERY

Minimum 25% increase in forage biomass from cultivars

More pasture Condensed Tannins to increase animal production

Improved drought tolerance in forages

Increased persistence of clovers

Increased quality of forages

Discover → Develop → Commercialize

SUSTAINABILITY TARGETS - APPLIED DISCOVERY & DEVELOPMENT

Nitrogen use efficiency

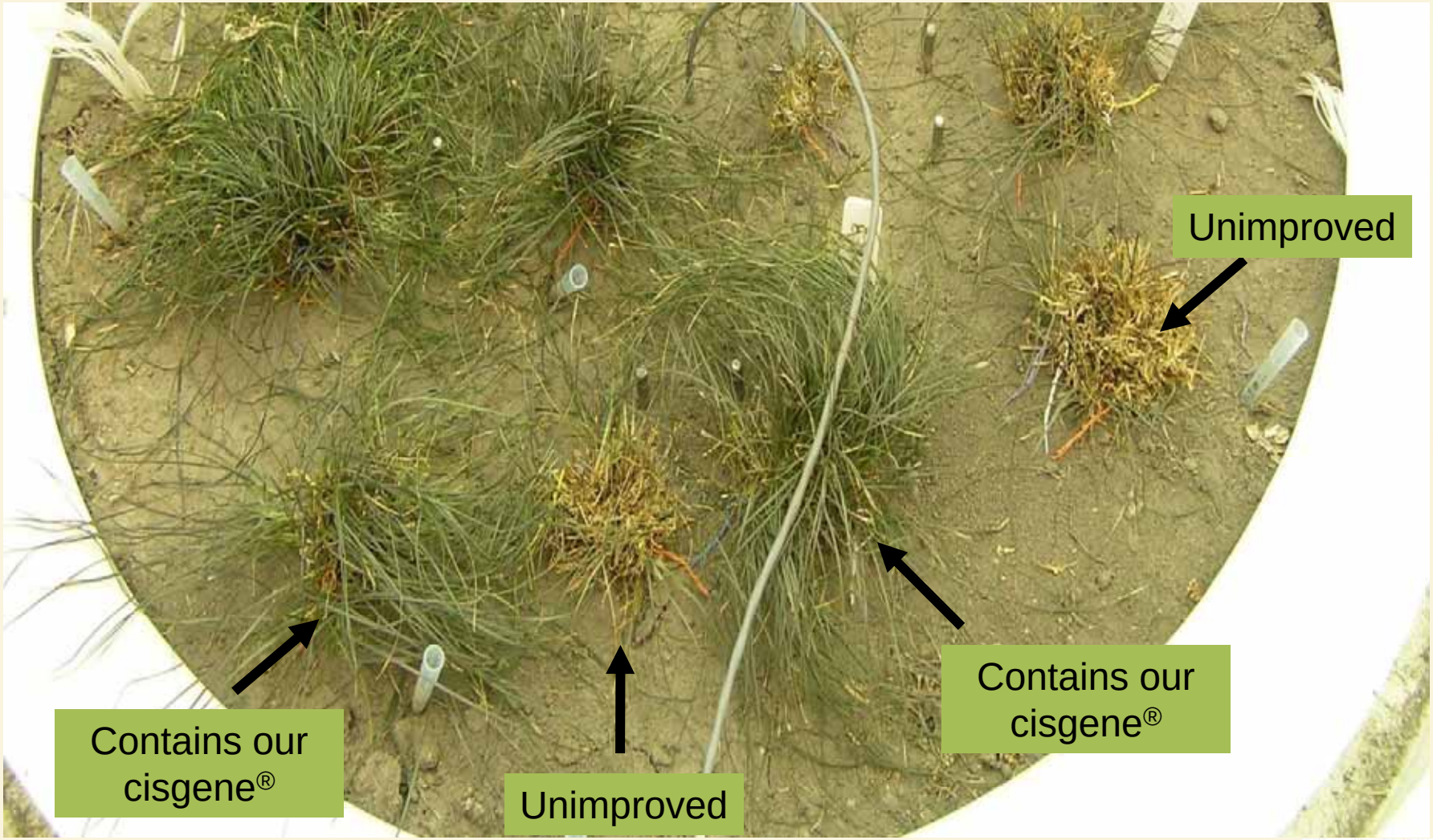
Phosphorus use efficiency

Water use efficiency

Whole-farm biotechnologies

2009 MDG Conference

Drought tolerant cisgenic® ryegrass



What next for DNA technology

- Zinc finger nucleases
- Specific gene extraction
- Use DNA technology to extract a gene or a particular variation of the gene
  - One cell embryo
  - Heritable

What next for DNA technology?

- Sequencing
  - Human genome (2000)
    - $4 billion
  - Bovine genome (2006)
    - $50 million
  - Ovine genome (2008)
    - $2-3 million
  - Human
    - 1000 genome project
      - $100K each (2 weeks to complete)
    - $1000 genome 2012
- Bulls bought by LIC will be sequenced in the next 5-10 years

Summary

- Living in a DNA era
- Dramatic technology and cost changes over the last 5 yrs
- Utilised the technology with biological resources
- Bulls available to market as 2 yr olds rather than 5 yr olds.
  - Rate of genetic gain to increase by 30-40%
- Cows selected and bred based on DNA profile for specific milk characteristics.
- Pasture enhanced through cisgenics
- Sequencing the next “big” technology
- Life on and off the farm will be affected by DNA