Sustainable intensification of dairy in SE Australia 2050

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The Primary Industries Climate Challenge Centre is a joint venture between the University of Melbourne and the Victorian Department of Environment and Primary Industries

THE UNIVERSITY OF MELBOURNE

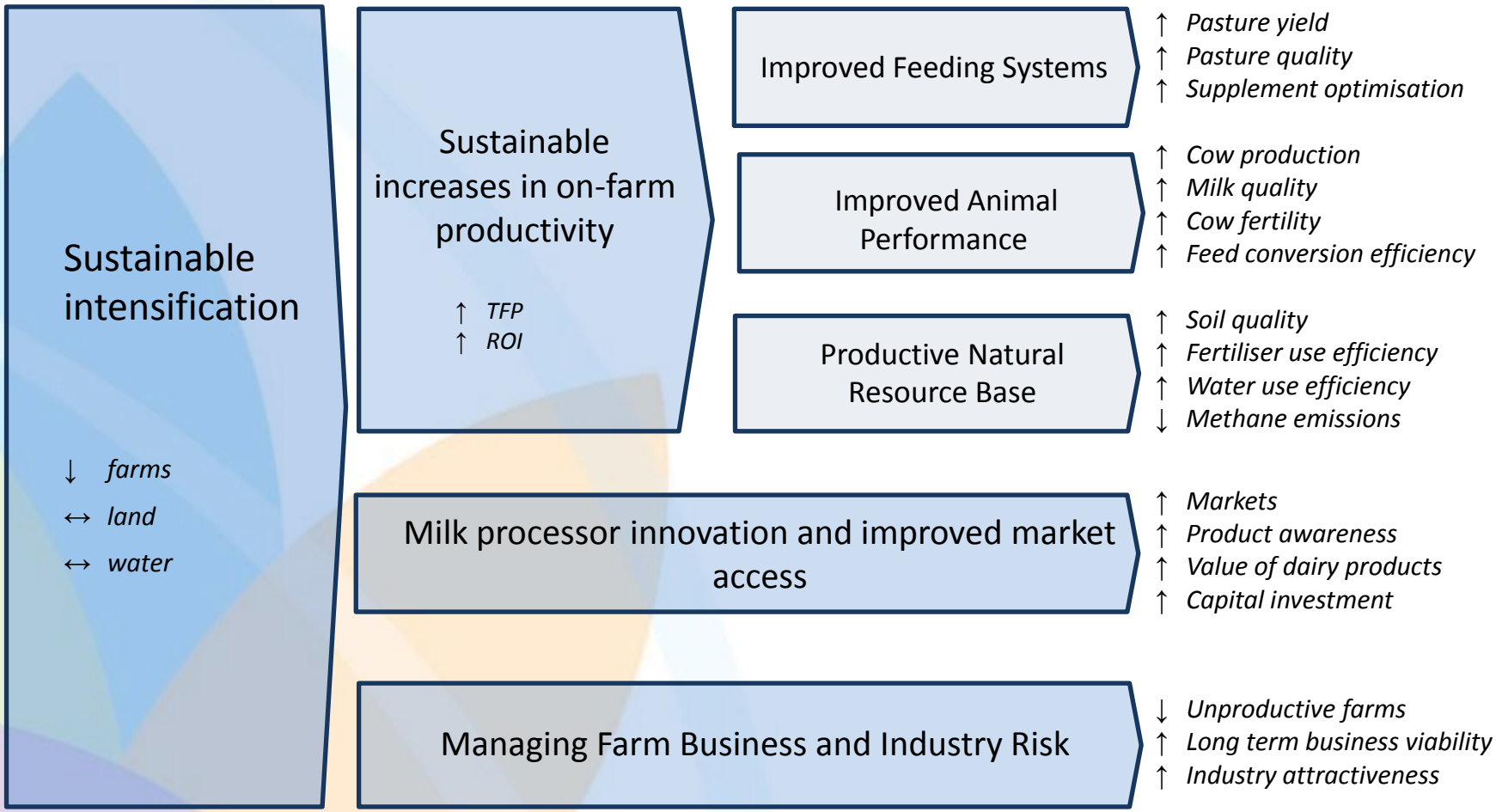
State Government Victoria Department of Environment and Primary Industries

Introduction

It is now 2050 and we are looking back at the past 35 years and identifying the key innovations, research, policies and practices, adopted by industry, that allowed us to increase productivity in the dairy industry, while not increasing our impact on the environment or degrading the natural resource base

In other words, we have achieved
Sustainable Intensification

Overview

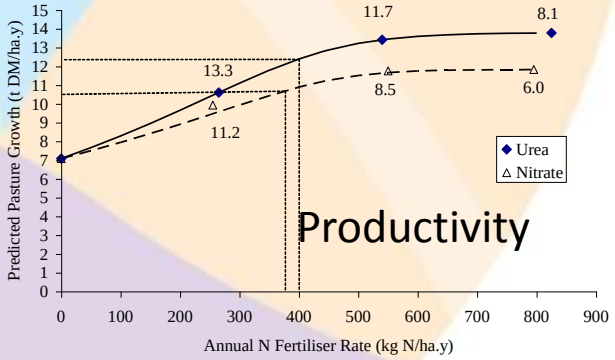

Sustainable intensification
↓ farms
↔ land
↔ water
Sustainable increases in on-farm productivity
↑ TFP
↑ ROI
Improved Feeding Systems
↑ Pasture yield
↑ Pasture quality
↑ Supplement optimisation
Improved Animal Performance
↑ Cow production
↑ Milk quality
↑ Cow fertility
↑ Feed conversion efficiency
Productive Natural Resource Base
↑ Soil quality
↑ Fertiliser use efficiency
↑ Water use efficiency
↓ Methane emissions
Milk processor innovation and improved market access
↑ Markets
↑ Product awareness
↑ Value of dairy products
↑ Capital investment
Managing Farm Business and Industry Risk
↓ Unproductive farms
↑ Long term business viability
↑ Industry attractiveness

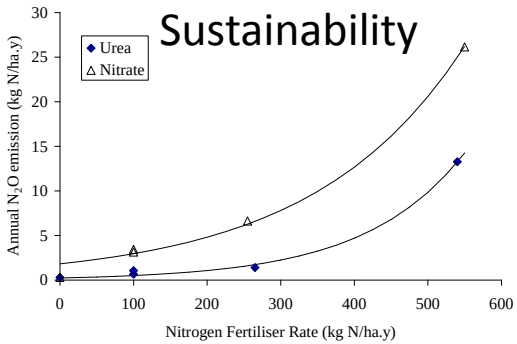
Core principles

- Research has improved the efficiency of dairy farming
  - Still a predominantly pasture based industry
  - Nitrogen & water
    - 50% more forage per L water (rain & irrigation) and kg N inputs
    - 50% less water used per litre of milk
  - Genetics (plants and animals)
    - 50% improvement in feed conversion efficiency
    - 20% improvement in 6 week in calf rates
    - 50% improvement in pasture nutritive characteristics and NUE
  - Labour and time
    - Precision technologies = reduced labour costs and increased labour use efficiency
    - Dairy farmers have more time for strategic planning and lifestyle
  - Energy efficiency
    - 50% of dairy farms are no longer connected to the grid

Nitrogen - 2014

- Dairy farm systems are highly N-dependent
  - Total N cycling can be over 600 kg N/ha/y
    - Whole farm N efficiency = 14 – 50%
    - Total N losses = 50 – 86%
    - Animal NUE = ~24% (18 – 35%)
- Further fertiliser N inputs to current systems
  - May produce more pasture – but not economically
  - But will lead to much higher environmental impact



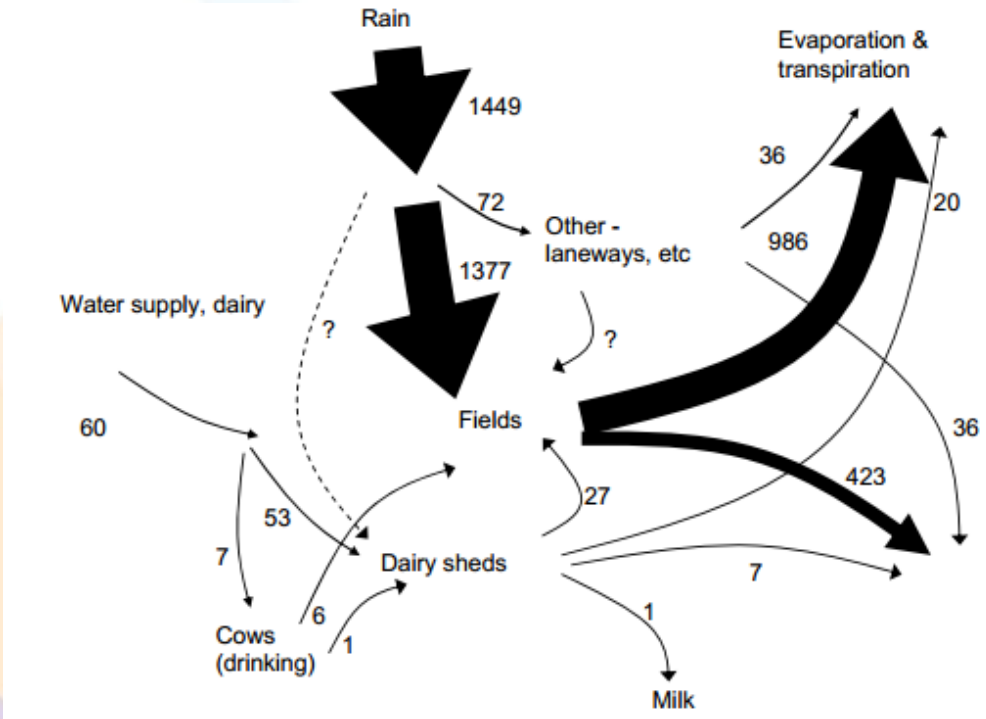


Nitrogen - 2050

- Milk production requires less N input per kg milk solids output
  - Whole farm NUE above 50%
    - Enhanced fertiliser technologies
    - Precision timing and placement of N
    - Ammonia and urinary N is captured and recycled
  - Animal NUE improved by 50%
    - Changed the slope of the N input vs milk output
    - Dietary balance / synchrony
    - Ruminal and post ruminal digestion
    - Genetics

Water - 2014

- Between 500 to 1600 litres of water/L milk
- Gross revenue ~$200/ML in 2005



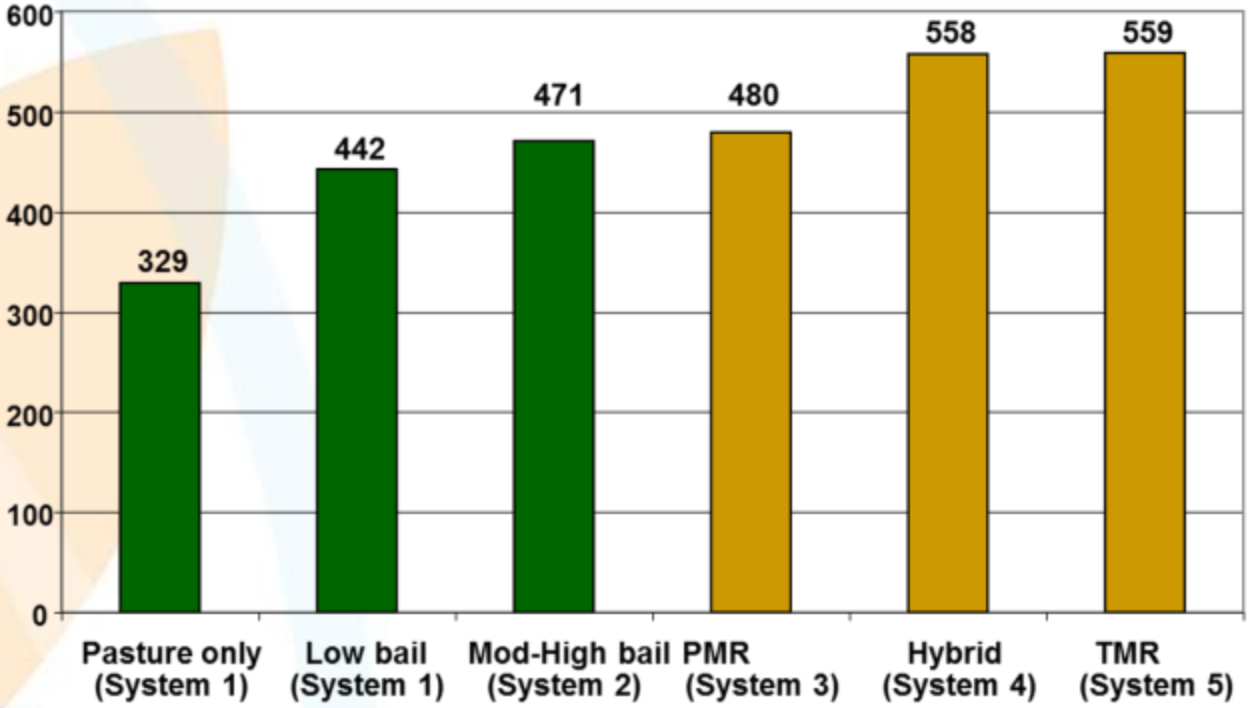
CSIRO 2005

Water - 2050

- Milk production requires less water per L milk
  - 50% of dairy farms use less than 500 L of water/L milk
  - 50% less water for wash-down through efficient recycling processes
  - 50% less water per t DM forage consumed (1.5 t DM consumed per 100 mm water)
  - Irrigation decisions based around *in situ* sensor networks

Nutrition – 2014 Feeding systems

1. Low bail - Grazed pasture, < 1.0 t grain in dairy
2. Mod.- High bail - Grazed pasture, > 1.0 t grain in dairy
3. Partial mixed ration - Grazed pasture all year, PMR on feed pad
4. Hybrid - Grazed pasture < 9 mths + PMR on feed pad
5. Total mixed ration

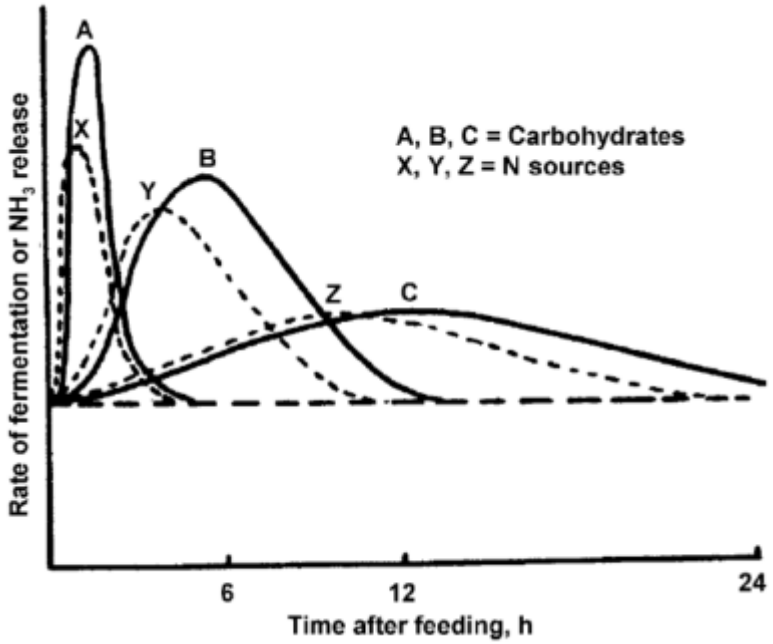


Nutrition – 2014

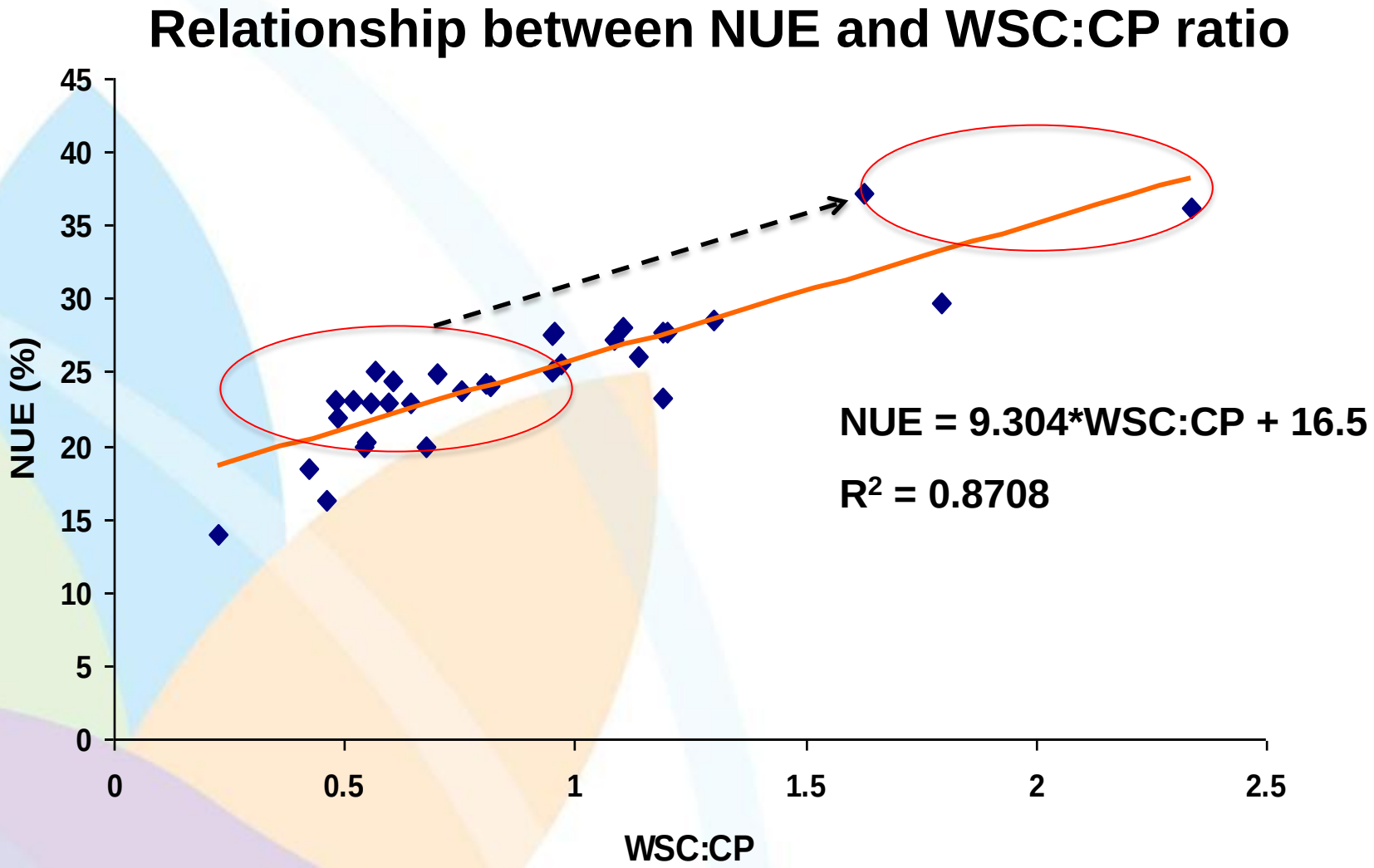
- ~80% of industry slug feeding supplements
- Feeding to herd average
- Variable pasture supply, utilisation and nutritive characteristics
- Sub optimal pasture-supplement matching
- High reliance on perennial ryegrass monocultures

Nutrition – 2050

- Management of rumen microbial populations
  - Increase feed and N use efficiency
  - Improved feed WSC:N ratios
  - 25% less energy loss through methane
- Targeted diets
  - Energy / protein synchrony
  - Ruminal and post ruminal
- Higher value milk products



Nutritional approaches



Data from Miller *et al.* 2001, Trevaskis *et al.* 2004, Taweel *et al.* 2005,2006, Moorby *et al.* 2006, Tas *et al.* 2006

Genetics - 2050

Animals

- All heifers, bulls genomically tested, rumen profiled early in life (birth?)

- 50% greater feed conversion efficiency, through
  - 30% improvement in cow efficiency
  - 20% improvement in rumen microbiome efficiency (including ability to remain productive with rapid changes in diet)

Genetics - 2050

Animals

- Reduced methane (30%)
- Improved heat tolerance
  - less drop in milk production and fertility with heat stress events
- 20% improved six week in calf rates, 20% improved longevity, livestock health
  - Reduced replacement rates, labour and costs

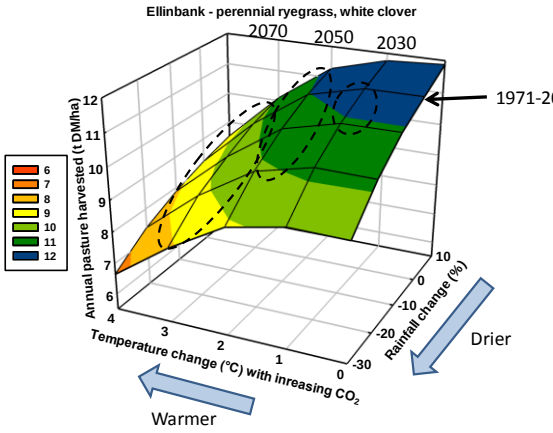
Genetics - 2050

Plants

- Improved management of biotic and abiotic stresses
  - Pastures more heat tolerant
  - Improved disease and pest resistance
- 50% improvement in pasture nutritive characteristics
  - Forage chemical composition manipulated to supply limiting nutrients
- Higher DM yields

Climate - 2050

- Dairy farms in 2050
  - Gippsland more like West Vic in 2014
  - West Vic more like SA/WA in 2014
  - NIR more like Californian dairy?
- Dairy farms have adapted by
  - Securing their forage supply
    - Consortia own cropping properties in multiple bio-climates
  - Changing the seasonal emphasis on pasture
    - More focus on cool season pasture growth
    - Deeper rooted, more heat tolerant pastures
    - Diverse forage systems
  - All farms have heat stress management practices in place and secure stock water

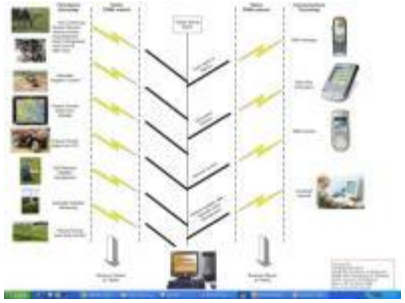


Climate - 2050

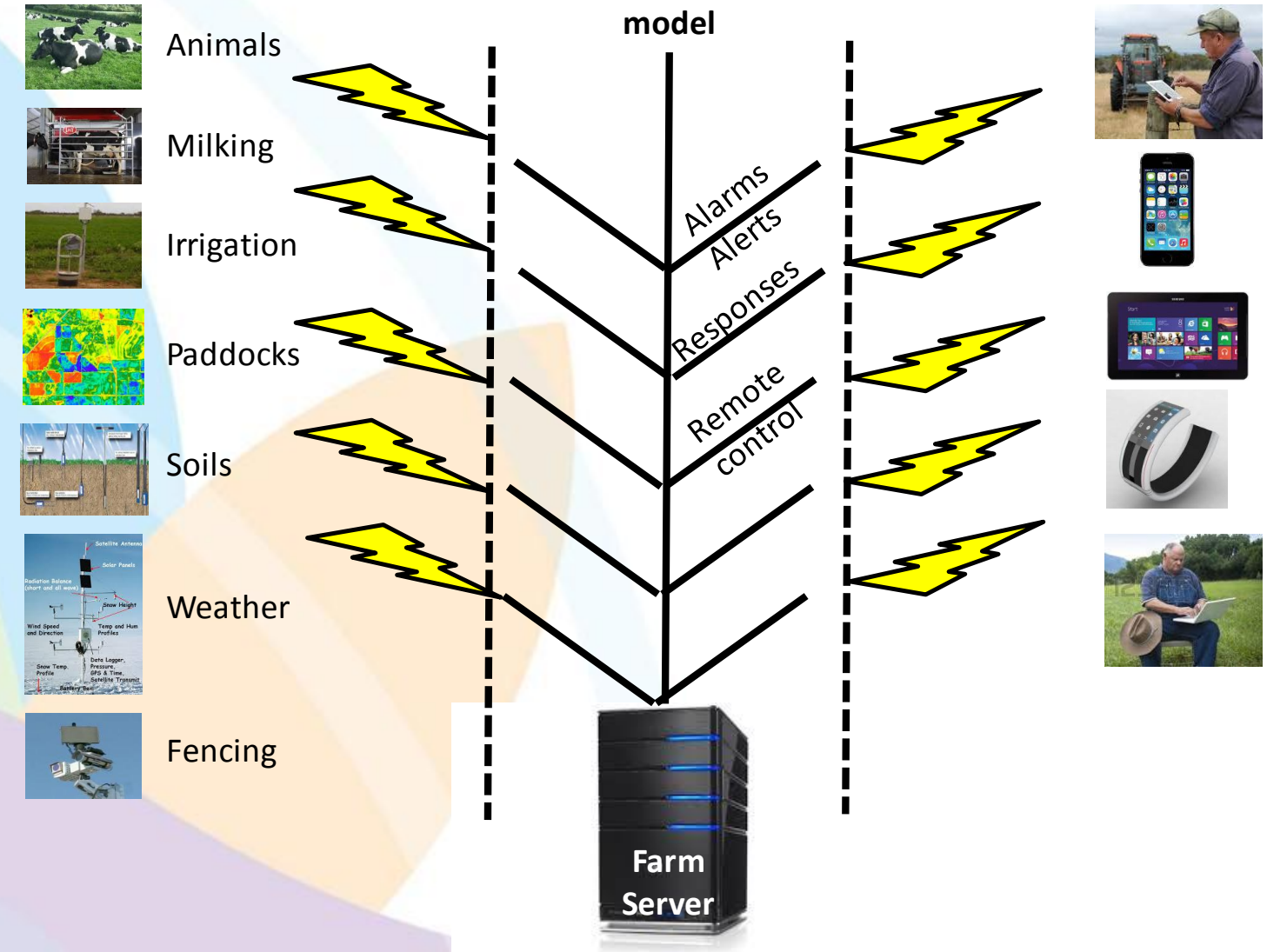
- Climate ready dairy farms
  - Increased (bio)diversity across farms
    - 5% of all paddocks to shade, shelter, carbon storage, riparian habitat, energy capture, but intensified on the rest
  - Dairy pasture soils have 5 to 7% soil organic matter
    - More buffered against extreme events
    - Higher nutrient cycling capacity
- Mitigation
  - 50% less methane through rumen manipulation
  - Dairy farms are energy independent

Precision Dairy

- Wireless sensor networks connected to a dynamic model
  - Allows precision timing of events
    - N fertiliser rate, timing and placement
    - In situ irrigation technologies
    - Real time pasture mass and nutritive characteristics
    - Dynamic allocation of cows to paddocks based on pasture growth
    - Dynamic adjustment of feed rations, based on pasture parameters and cow physiology and climate
    - Precision timing of milking



Precision Dairy



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