Future dairy farm systems: a bio-economic analysis

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Introduction

• 2014: workshops involving dairy stakeholders to think strategically about the NZ dairy industry in 10-15 years

• Three possible, plausible Future Scenarios were conceptually developed*

• A further step was required to explore what these scenarios would look like at the farm-level

Objective & Method

• To develop a bio-economical analytical framework, to determine the on-farm adjustments required under each scenario

• These were modelled on a case study farm to quantify the potential bio-economic implications of each likely future scenario at a farm level
Analytical Framework

- Biophysical Data
  - Dairy No 1

- Base Farm System Model
  - FARMAX®

- Future Scenarios

- Financial Data
  - Dairy No 1
  - DairyNZ

- Consumer is King System
- Governments Dictate System
- Regulation Rules System
Base Farm System

✓ Single case study farm: *Massey Dairy No 1 (2016-17 season)*

- Historically town milk supply farm, converted to full-season OAD milking on 2013-14 season
- Managed as a low input, sustainable, pasture-based system (System 1 – 2)
- 120 effective hectares, divided in 61 paddocks (18 can be irrigated)
- 258 milking cows (stocking rate = 2.2), through a 24-a-side herringbone
- Milk solids produced on 2016-17 season: 92,299 (358 kgMS/cow)
FARMAX®

• An evidence-based modelling and decision support tool developed for NZ farmers and consultants

• Uses monthly estimates of pasture growth, farm and herd information, to determine the production and economic outcomes of managerial decisions

• Long-term mode was used for this study as it mimics a balanced system that allows farm systems to be analysed at a strategic level
Biophysical Data

Dairy No 1

Future Scenarios

Base Farm System Model
FARMAX®

Financial Data

Dairy No 1

DairyNZ

Consumer is King System

Governments Dictate System

Regulation Rules System
Biophysical Data

✓ *From the farm’s 2016-17 season records*

- **Land**: milking platform used, pasture covers & growth rates, crops, fertiliser applied, irrigated area, grazing off

- **Herd composition**: stock numbers, reproduction & replacement rates

- **Feed**: how much was offered, what and when

- **Production**: peak milking cows, milk solids supplied to factory
Using FARMAX helped in validating the physical changes needed to simulate the likely future scenarios at a farm-level.
## Biophysical Benchmark

<table>
<thead>
<tr>
<th>Season 2016-17</th>
<th>Massey Dairy No 1</th>
<th>DairyNZ*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective Dairying area (ha)</td>
<td>120</td>
<td>128</td>
</tr>
<tr>
<td>Peak cows milked</td>
<td>258</td>
<td>322</td>
</tr>
<tr>
<td>Stocking rate (Cows/ha)</td>
<td>2.2</td>
<td>2.5</td>
</tr>
<tr>
<td>Full time labour equivalent (FTE)</td>
<td>1.3</td>
<td>2.4</td>
</tr>
<tr>
<td>Cows/FTE</td>
<td>198</td>
<td>134</td>
</tr>
<tr>
<td>Milksolids (MS)</td>
<td>92,299</td>
<td>112,538</td>
</tr>
<tr>
<td>MS/ha</td>
<td>771</td>
<td>881</td>
</tr>
<tr>
<td>MS per cow</td>
<td>358</td>
<td>349</td>
</tr>
</tbody>
</table>

*Benchmark Group selected: Lower North Island, Owner operator, Low input (System 1 & 2)*
Financial Data

✓ From the farm’s 2016-17 season records

• Gross Farm Revenue (GFR): Milk income, stock profit, dividends

• Farm working expenses (FWE): Wages, animal health & breeding costs, feed costs, etc.

• University specific costs: R&M, overheads and grazing and run off costs had been adjusted from DairyNZ Economic Survey 2016-17
<table>
<thead>
<tr>
<th>Category</th>
<th>Massey Dairy No 1</th>
<th>DairyNZ*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total ($)</td>
<td>$/kgMS</td>
</tr>
<tr>
<td>Wages</td>
<td>123,946</td>
<td>1.34</td>
</tr>
<tr>
<td>Animal health &amp; breeding</td>
<td>38,111</td>
<td>0.41</td>
</tr>
<tr>
<td>Supplementary feed</td>
<td>47,817</td>
<td>0.52</td>
</tr>
<tr>
<td>Grazing &amp; support block leasing</td>
<td>43,216</td>
<td>0.47</td>
</tr>
<tr>
<td>Fertiliser, irrigation, regrassing, W&amp;P</td>
<td>69,203</td>
<td>0.75</td>
</tr>
<tr>
<td>Maintenance &amp; running</td>
<td>79,002</td>
<td>0.86</td>
</tr>
<tr>
<td>Overheads</td>
<td>36,868</td>
<td>0.40</td>
</tr>
<tr>
<td>Depreciation</td>
<td>34,359</td>
<td>0.37</td>
</tr>
<tr>
<td>Operating Expenses</td>
<td>472,522</td>
<td><strong>5.12</strong></td>
</tr>
</tbody>
</table>

*Benchmark Group selected: Lower North Island, Owner operator, Low input (System 1 & 2)
Financial Benchmark

**GROSS FARM REVENUE ($/HA)**
- Massey Dairy No 1: $1,771
- DairyNZ*: $5,705

**OPERATING EXPENSES ($/HA)**
- Massey Dairy No 1: $1,256
- DairyNZ*: $3,934

**OPERATING PROFIT ($/HA)**
- Massey Dairy No 1: $1,771
- DairyNZ*: $5,045

*Benchmark Group selected: Lower North Island, Owner operator, Low input (System 1 & 2)*
Biophysical Data
Dairy No 1

Future Scenarios

Base Farm System Model
FARMAX®

Financial Data
Dairy No 1
DairyNZ

Consumer is King System
Governments Dictate System
Regulation Rules System
Future Scenarios: at a glance

✓ “Consumer is King”
• A consumer-driven scenario and a shift in focus to value
• Dairy products produced in direct response to consumers demand
• Consumers are better informed and more engaged in the world of food
• Farm more visible and exposed to the public
• Milk price expected to be very high and variable
• Most positive environment for NZ Dairy: more choices where to trade high-value products

✓ “Government Dictates”
• A highly-intervened and chaotic scenario
• Back to undifferentiated commodity dairy products focusing on efficiency
• Consumers are price sensitive
• Trade dictated by governments focused on protecting the domestic industry
• Milk price expected to be low and stable
• Most restricted environment for NZ Dairy

✓ “Regulation Rules”
• A highly-regulated scenario
• Greater transparency and compliance required, specially on environment and animal welfare
• Constant pressure from consumer right activists
• Ban on the slaughter of bobby calves and on the use of antibiotics
• Milk price expected to be variable
• Restricted but provides opportunity for NZ Dairy

✓ “Consumer is King”
✓ “Government Dictates”
✓ “Regulation Rules”
Future Scenarios: farm-level assumptions

• A farm system was developed for each scenario with its corresponding physical and economic inputs and outputs

• The changes introduced to the Base farm system for each scenario involved: cow numbers, calving pattern, milking frequency, breed, milk price, and supplements costs

• As technologies from the future are not yet known, they were surmised based on technologies that already exist

• As FARMAX® does not go beyond bioeconomic simulations, there were limitations in modelling the social elements of the new systems
CK System Model: main changes

- Split-calving to allow for all-year-round milking, needed for constant supply of consumer products

- OAD milking frequency as consumers are more aware of the benefits that it brings in terms of animal and human welfare

- Entire Jersey breed herd on farm due to its better adaptability and performance to OAD system

- Precision Variable Rate Irrigation system in place that allows for better pasture production needed to support the split-calving, while decreasing the environmental footprint
Biophysical Data
Dairy No 1

Financial Data
Dairy No 1
DairyNZ

Base Farm System Model
FARMAX®

Future Scenarios

Consumer is King System
Governments Dictate System
Regulation Rules System
GD System Model
GD System Model: main changes

• Automatic Milking System (AMS) in place that allows cows to be milked twice- to thrice-a day, increasing production significantly

• Higher stocking rate as dictated by the government in need of high volume of bulk milk

• Pastures genetically modified allowed to produce extra tonnes of DM/ha, needed to increase SR and reduce the application of nitrogen
RR System Model
RR System Model: main changes

• Young and dry stock are not sent off-farm as required by a regulation on biosecurity

• Bobby calves reared till 11 month old and then sold to the beef industry

• Increase in costs due to the ban imposed on the use of antibiotics, fertiliser and irrigation

• Solar technologies introduced into the system to reduce dependence on external sources of energy
# Models outcomes set-up summary

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Base Farm System Model</th>
<th>Consumer is King</th>
<th>Governments Dictate</th>
<th>Regulation Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main system change</td>
<td>-</td>
<td>All-year-round milking</td>
<td>Automatic milking system</td>
<td>All stock on farm</td>
</tr>
<tr>
<td>Cows (milk peak)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring-calving</td>
<td>258</td>
<td>166</td>
<td>330</td>
<td>220</td>
</tr>
<tr>
<td>Autumn-calving</td>
<td>-</td>
<td>71</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stocking rate</td>
<td>2.2</td>
<td>2.0</td>
<td>2.8</td>
<td>1.8</td>
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<tr>
<td>Grazing off</td>
<td>Dry mob and young stock</td>
<td>Only young stock</td>
<td>Dry mob and young stock</td>
<td>No</td>
</tr>
<tr>
<td>Milking Frequency</td>
<td>Once-a-day</td>
<td>Once-a-day</td>
<td>Twice to thrice-a-day</td>
<td>Twice-a-day</td>
</tr>
<tr>
<td>Breed</td>
<td>Cross-bred</td>
<td>Jersey</td>
<td>Cross-bred</td>
<td>Cross-bred</td>
</tr>
<tr>
<td>Calving pattern</td>
<td>Spring Calving</td>
<td>Spring and Autumn calving</td>
<td>Spring Calving</td>
<td>Spring Calving</td>
</tr>
<tr>
<td>Production system</td>
<td>System 1-2</td>
<td>System 1 - 2</td>
<td>System 3</td>
<td>System 2 - 3</td>
</tr>
<tr>
<td>Milk price</td>
<td>$5.92 per kgMS</td>
<td>$7.92 per kgMS + $3.15 per kgMS (winter)</td>
<td>$3.92 per kgMS</td>
<td>$5.92 per kgMS</td>
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</table>
## Physical KPI comparison

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Base System Model</th>
<th>CK System Model</th>
<th>GD System Model</th>
<th>RR System Model</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm</td>
<td>Peak Cows Milked</td>
<td>258</td>
<td>237</td>
<td>330</td>
<td>220</td>
<td>cows</td>
</tr>
<tr>
<td></td>
<td>Stocking Rate</td>
<td>2.2</td>
<td>2.0</td>
<td>2.8</td>
<td>1.8</td>
<td>cows/ha</td>
</tr>
<tr>
<td></td>
<td>Nitrogen Use</td>
<td>111</td>
<td>111</td>
<td>80</td>
<td>-</td>
<td>kg N/ha</td>
</tr>
<tr>
<td>Production</td>
<td>Milk Solids total</td>
<td>92,289</td>
<td>97,638</td>
<td>136,385</td>
<td>69,100</td>
<td>kg</td>
</tr>
<tr>
<td></td>
<td>Milk Solids per ha</td>
<td>771</td>
<td>816</td>
<td>1,139</td>
<td>577</td>
<td>kg/ha</td>
</tr>
<tr>
<td></td>
<td>Milk Solids per cow</td>
<td>358</td>
<td>438</td>
<td>413</td>
<td>314</td>
<td>kg/cow</td>
</tr>
<tr>
<td>Feeding</td>
<td>Pasture Offered per cow</td>
<td>3.9</td>
<td>4.7</td>
<td>3.2</td>
<td>3.2</td>
<td>t DM/cow</td>
</tr>
<tr>
<td></td>
<td>Supplements Offered per cow</td>
<td>1.2</td>
<td>1.3</td>
<td>1.6</td>
<td>2.0</td>
<td>t DM/cow</td>
</tr>
<tr>
<td></td>
<td>Total Feed Offered per cow</td>
<td>5.3</td>
<td>6.0</td>
<td>5.0</td>
<td>5.2</td>
<td>t DM/cow</td>
</tr>
</tbody>
</table>
## Financial KPI comparison

<table>
<thead>
<tr>
<th></th>
<th>Base System Model</th>
<th>CK System Model</th>
<th>GD System Model</th>
<th>RR System Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gross Farm Revenue ($/kgMS)</strong></td>
<td>6.54</td>
<td>8.61</td>
<td>4.43</td>
<td>7.06</td>
</tr>
<tr>
<td><strong>Farm Working Expenses ($/kgMS)</strong></td>
<td>4.54</td>
<td>4.69</td>
<td>3.96</td>
<td>6.44</td>
</tr>
<tr>
<td><strong>Gross Farm Revenue ($/ha)</strong></td>
<td>5,045</td>
<td>7,022</td>
<td>5,044</td>
<td>4,076</td>
</tr>
<tr>
<td><strong>Operating Expenses ($/ha)</strong></td>
<td>3,789</td>
<td>4,123</td>
<td>5,586</td>
<td>3,994</td>
</tr>
<tr>
<td><strong>Operating Profit ($/ha)</strong></td>
<td>1,256</td>
<td>2,899</td>
<td>- 542</td>
<td>82</td>
</tr>
<tr>
<td><strong>Operating Profit Margin (%)</strong></td>
<td>25</td>
<td>41</td>
<td>- 11</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Return On Assets (%)</strong></td>
<td>2.5</td>
<td>4.2</td>
<td>- 1.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>
**Discussion**

<table>
<thead>
<tr>
<th>“Consumer is King System Model”</th>
<th>“Government Dictates System Model”</th>
<th>“Regulation Rules System Model”</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Requires further refinement</td>
<td>✓ Needs further adaptation</td>
<td>✓ Needs further refinement</td>
</tr>
</tbody>
</table>
| • A promising future scenario with lot of scope for New Zealand pasture-based systems | • Options:  
  - Scale: as current farm size and structure is not allowing metrics to work, this dairy farm could potentially merge with others  
  - Additionally, if technology becomes more affordable in the future, AMS could potentially become a solution to reduce costs of labour, which is the single highest cost after feed expenses in a dairy farm in NZ |  
  - Options:  
    - Finding a market niche for the potential new class of beef product – derived from rearing bobby calves that would ordinarily be sent to slaughter – may become a solution in the future for this system to deliver a more consistent result  
    - Economies of scale through expansion would help to reduce the relative cost of feed |
| • However, as specificity of consumer requirements mostly happens beyond the farm – and farm level bio-economic models cannot address questions faced by society that transcend agriculture – some really clear and defined value chain development must occur, which could, for the New Zealand dairy industry, mean fragmentation of current chains and structures |  |  |
Conclusions

• Modelling a case study farm and bioeconomic simulations enabled in-depth analyses and the impact of likely future scenarios to be quantified

• FARMAX® whole-farm system platform helped in modelling the physical and financial changes needed to simulate the likely future scenarios at a farm level

• A constant –both in the scenario analysis itself and then in this subsequent on-farm analysis– is that technology will be critical to the adjustments that are required at a farm level and beyond
Future research

• Further studies could adopt this approach to:

  ✓ apply the possible, plausible scenarios to other farming systems and;

  ✓ extend the analysis to explore the impact of future climate and/or economic shocks
Many thanks

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