THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

Applying stochastic optimisation to the New Zealand dairy industry

Oscar Dowson

Supervisors
Andy Philpott, Andrew Mason, Anthony Downward

Outline

1. **Background**
   - What we perceive to be pain points
2. **MOO**
   - The PKE question
3. **Milk POWDER**
   - A model for the whole farm
4. **Future Directions**

East coast farmers grumpy that forecasters got El Nino predictions so wrong

MARTY SHARPE
Last updated 17:07, March 8 2016

Widely

they

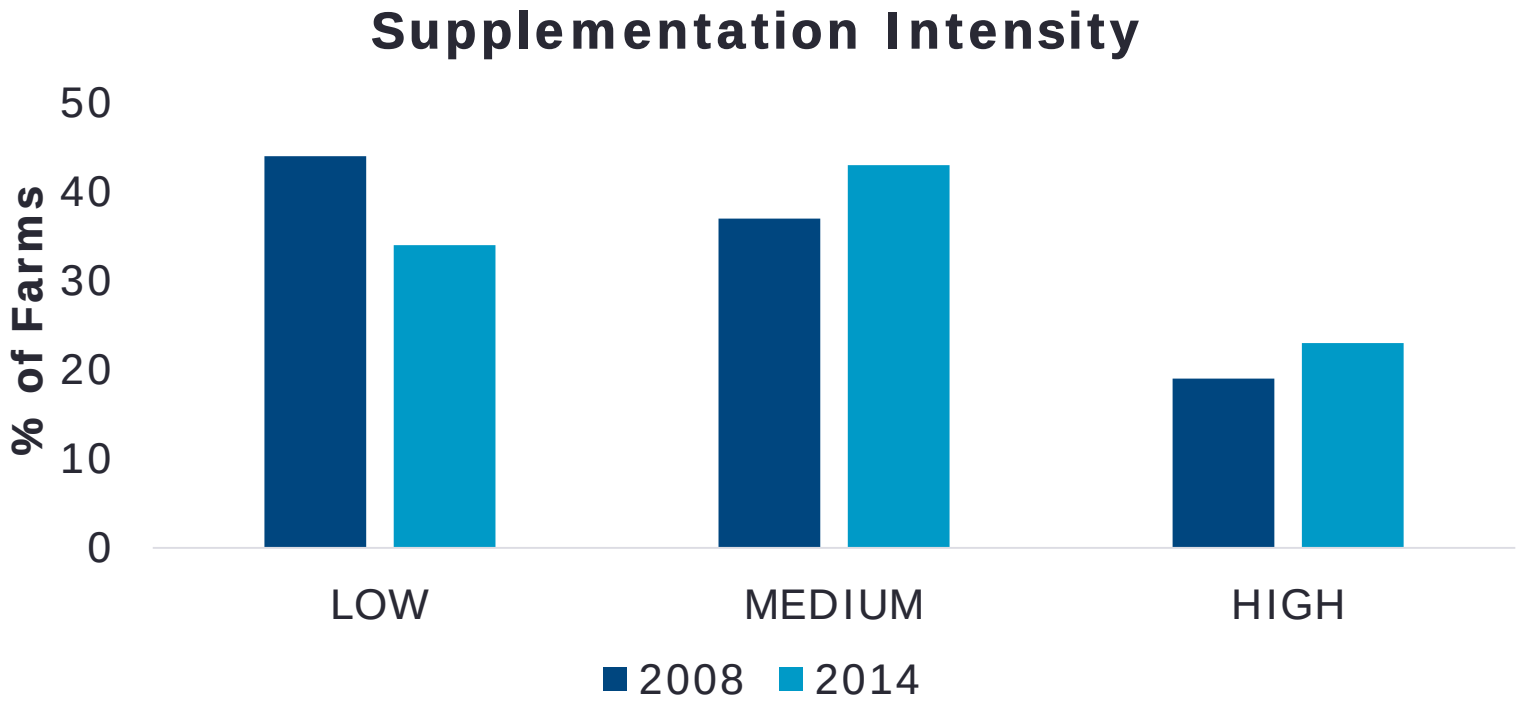
"There's some quite grumpy people around that made decisions based on the warnings and they feel that's cost them money, or a lost opportunity.

"They're wondering 'What can we do about it' or 'Should we take any notice next time'," Foley said.

many fa

Where's the drought that was forecast? ask east coast farmers.

What do they care about?



http://bizplan-uz.com/upload/medialibrary/d62/babcock_38.jpg

the
Milk
Output
Optimiser

Cows	Pasture	Stochasticity
Body Condition	Fertiliser	Weather
Lactation	Irrigation	Financial
Effluent	Silage	Biological
Stocking Rate	**Supplement**	

Environmental Parameters

E-Cow

Genetic Parameters

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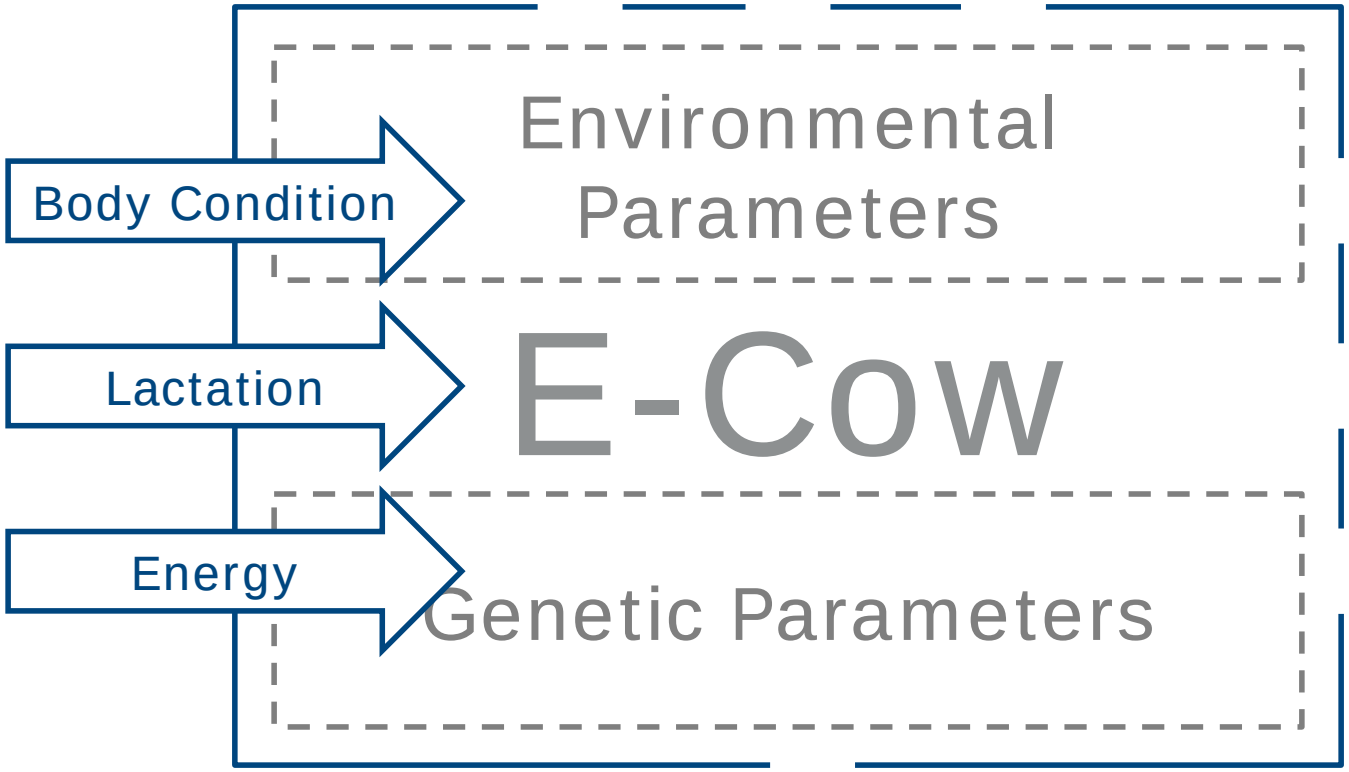

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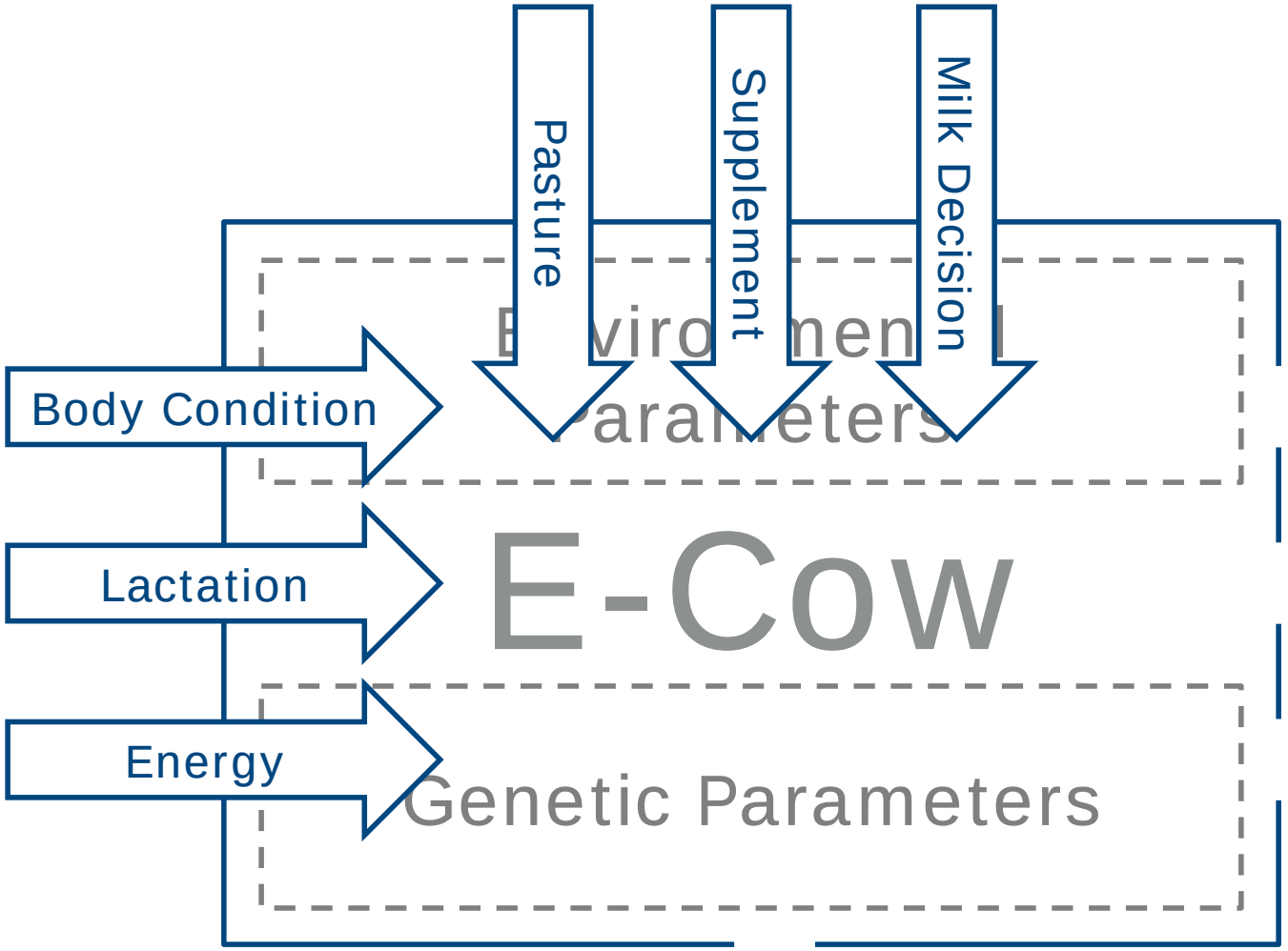

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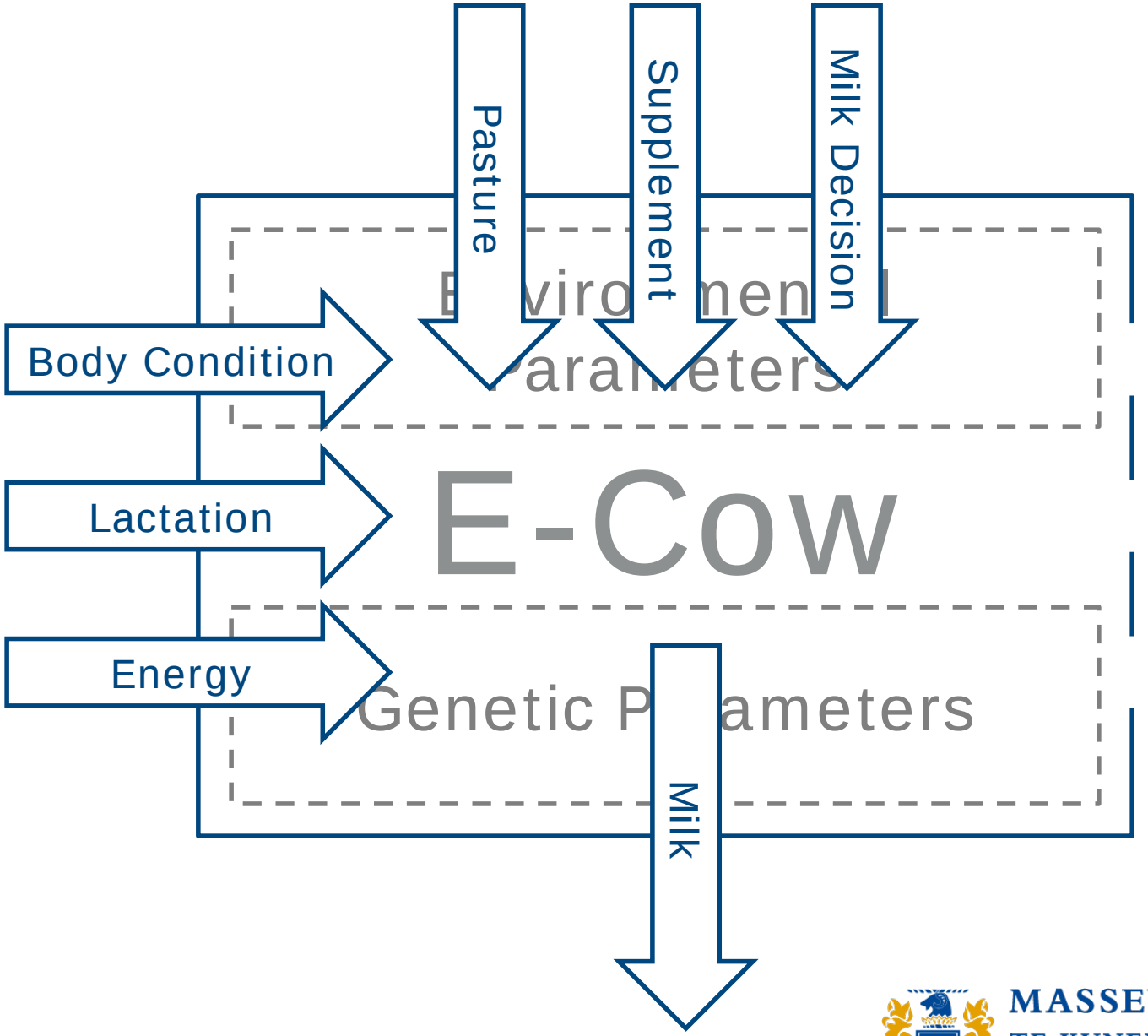

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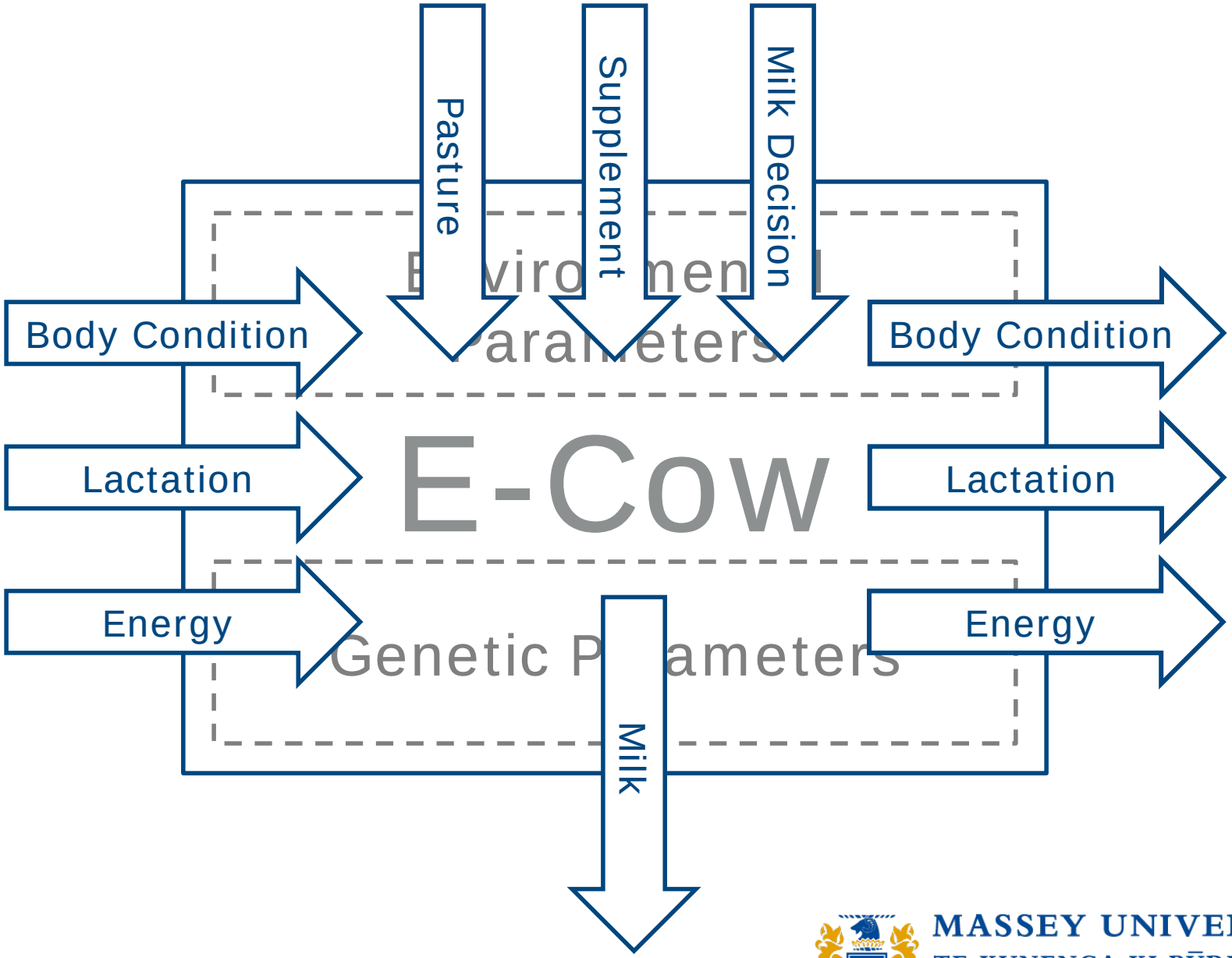

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MOO

Objective: maximise profit

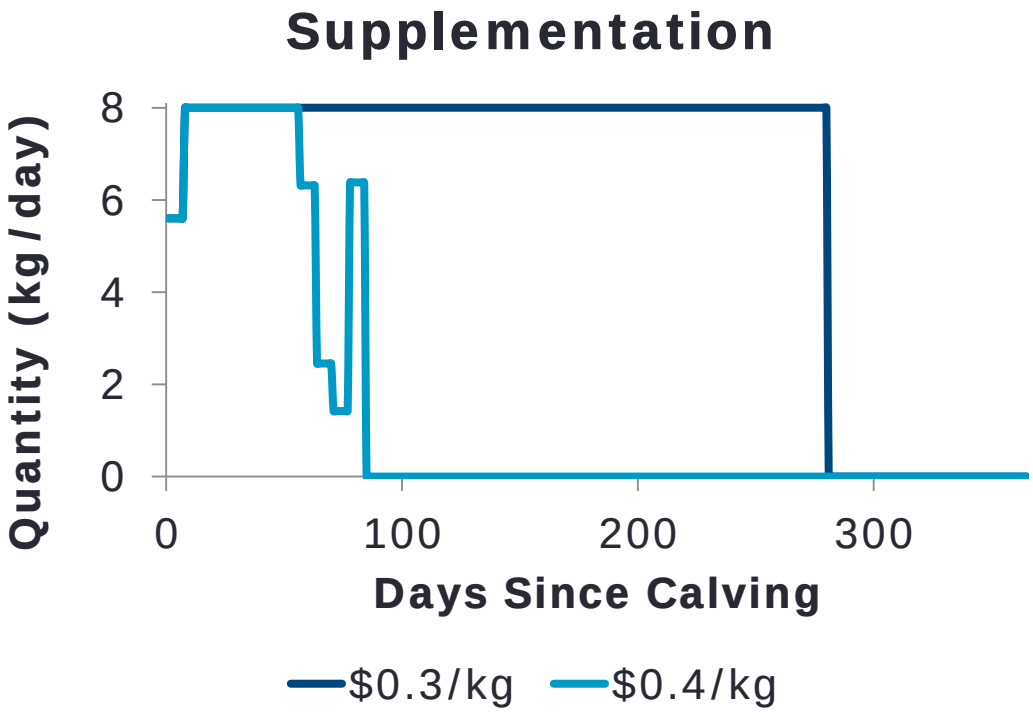
Subject to: exceeding a Body Condition Score target at the end of the year

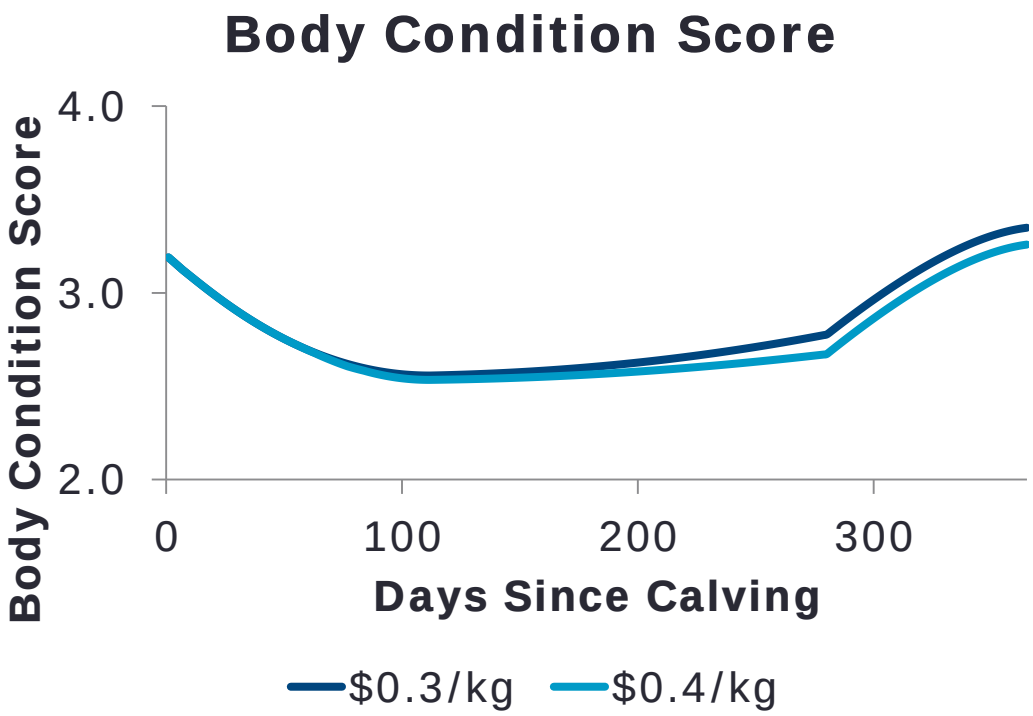
By Varying: the quantity of supplement each week and the length of lactation

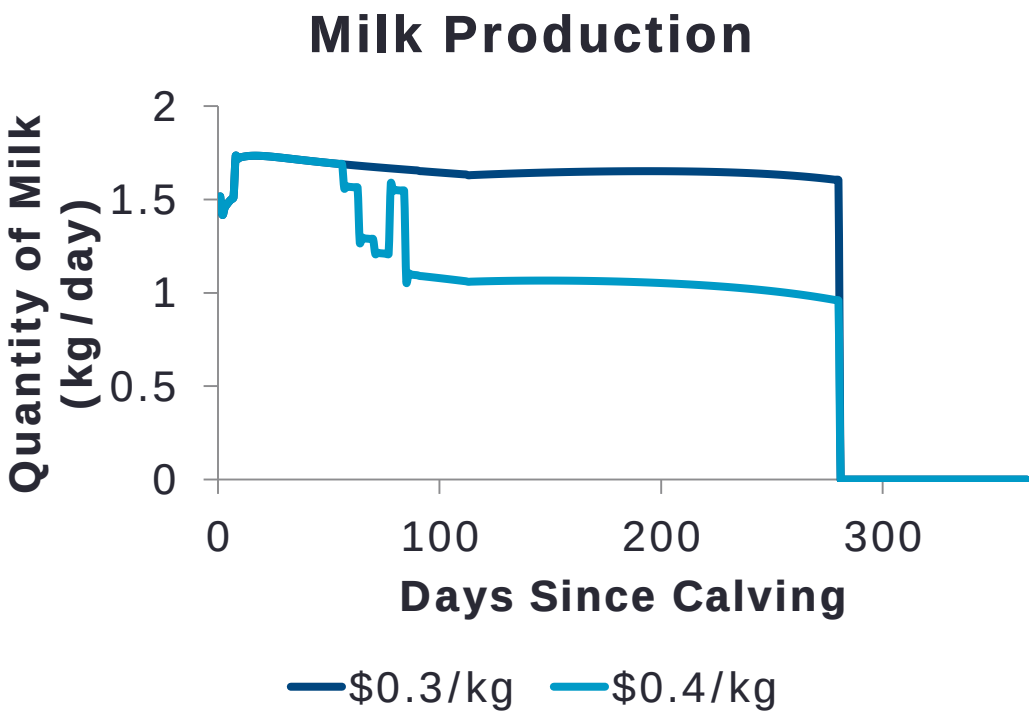
Assumptions

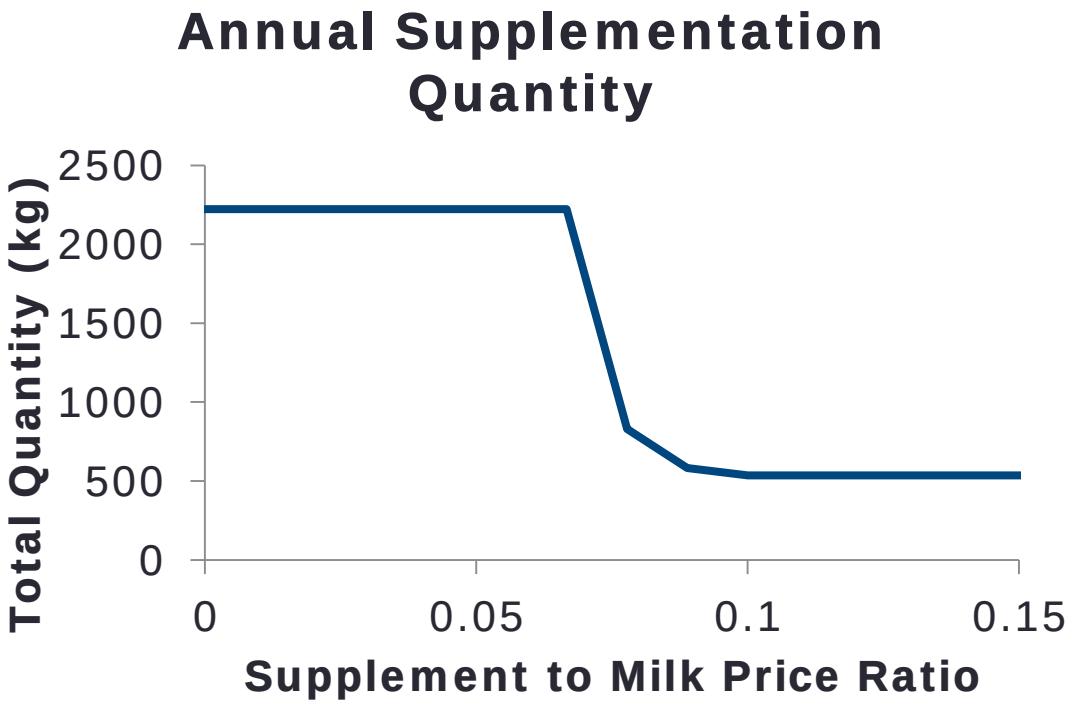
Dry off at day 280

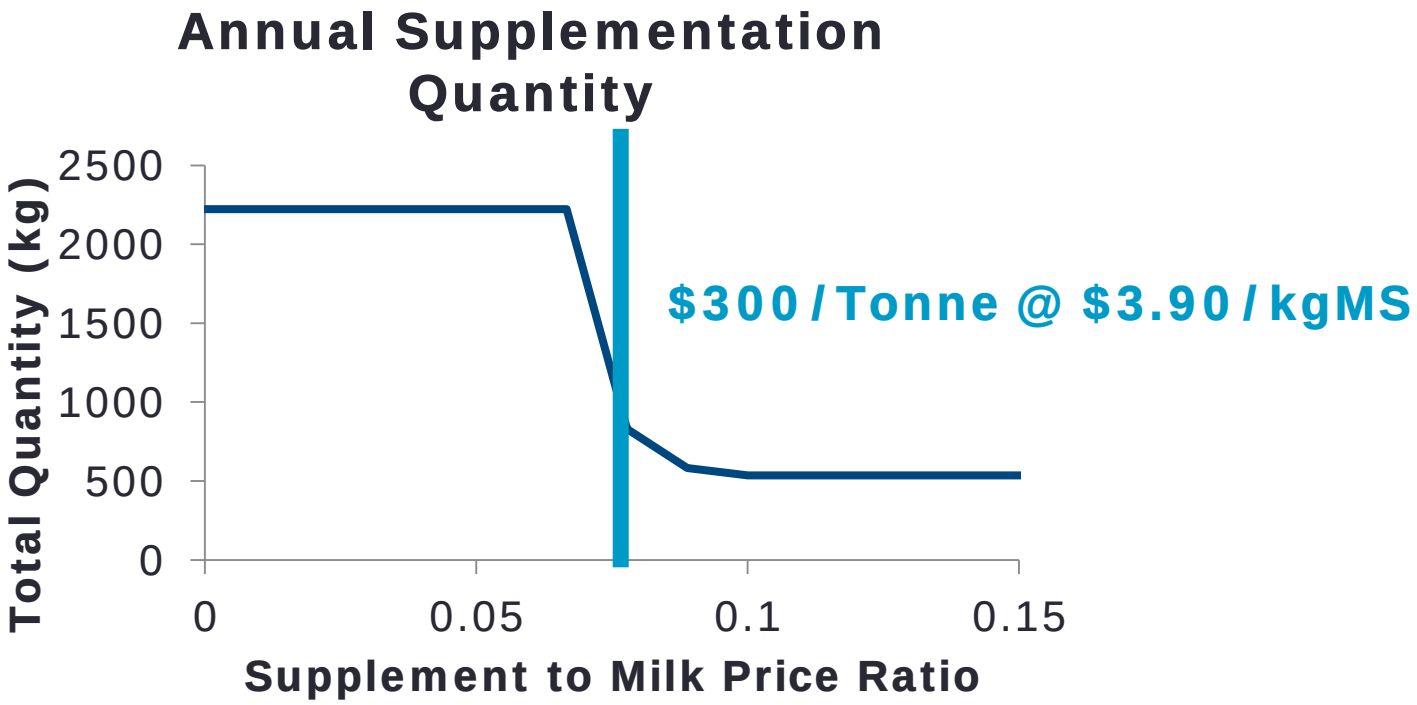
Maximum 8kg/cow/day


Supplementation
Quantity (kg/day)
8
6
4
2
0
0
100
200
300
Days Since Calving
$0.3/kg
$0.4/kg


Body Condition Score
Body Condition Score
4.0
3.0
2.0
0
100
200
300
Days Since Calving
$0.3/kg
$0.4/kg

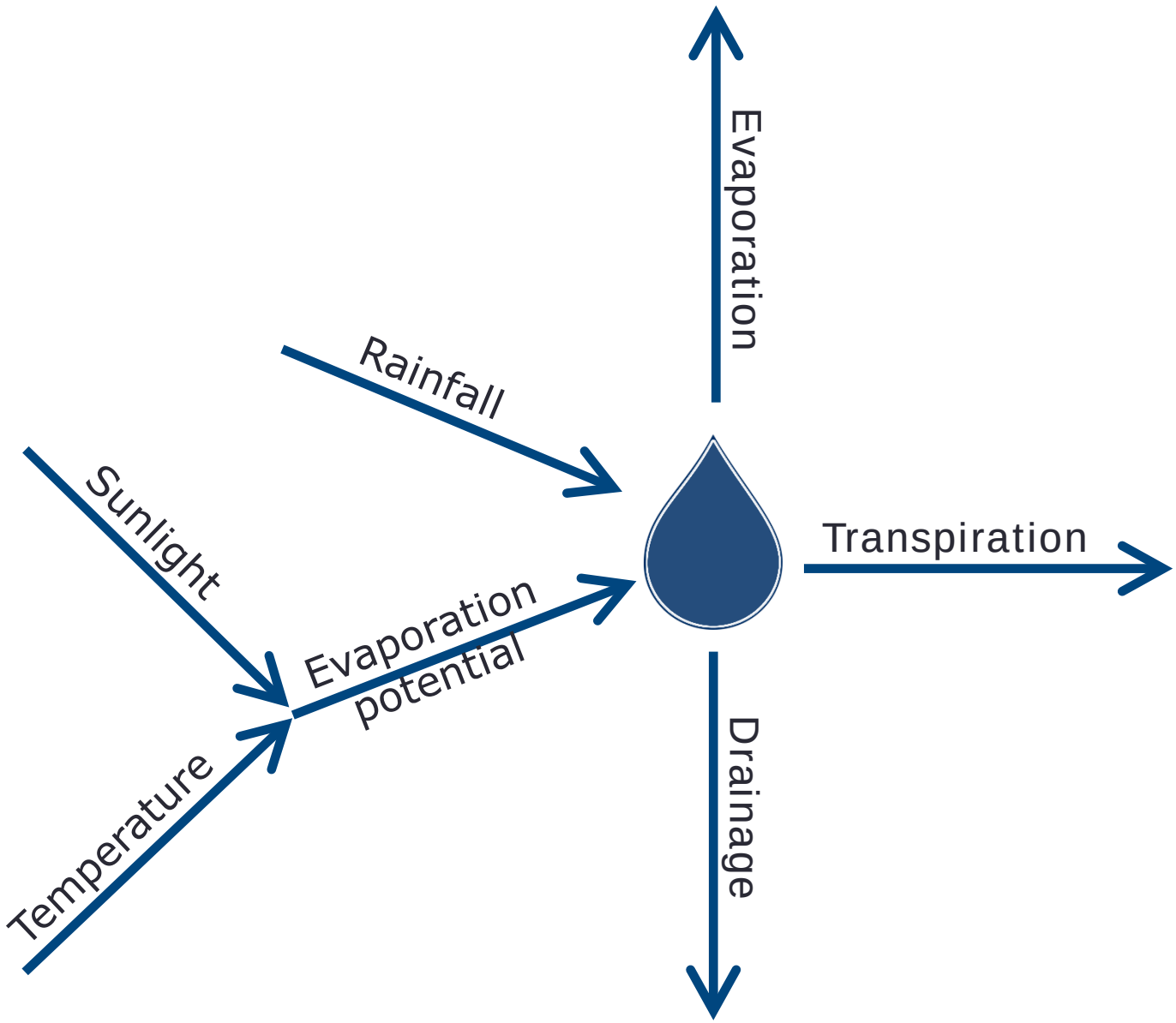

Milk Production
Quantity of Milk (kg / day)
2
1.5
1
0.5
0
0
100
200
300
Days Since Calving
$0.3/kg
$0.4/kg

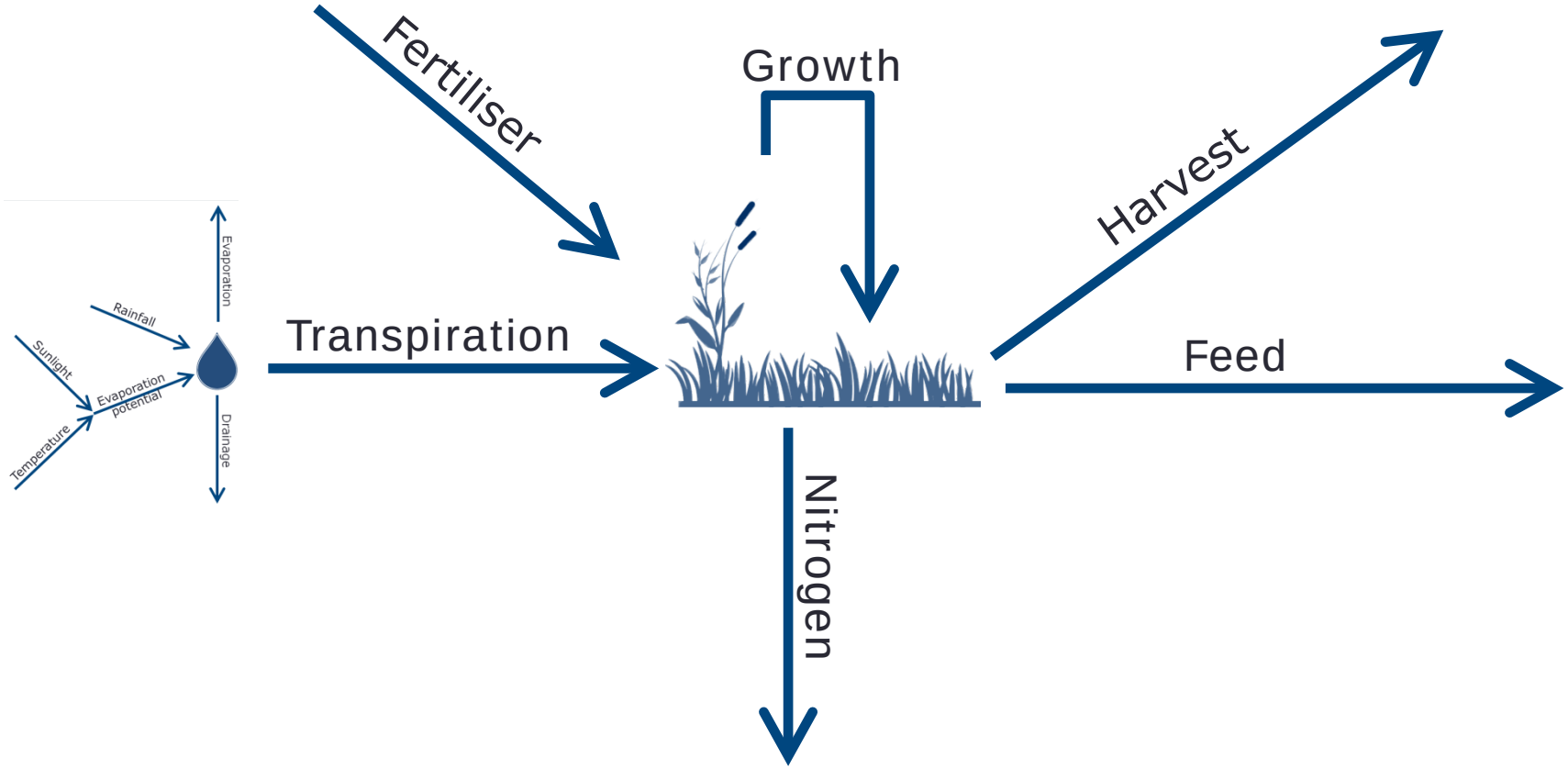

Annual Supplementation Quantity
Total Quantity (kg)
2500
2000
1500
1000
500
0
0
0.05
0.1
0.15
Supplement to Milk Price Ratio

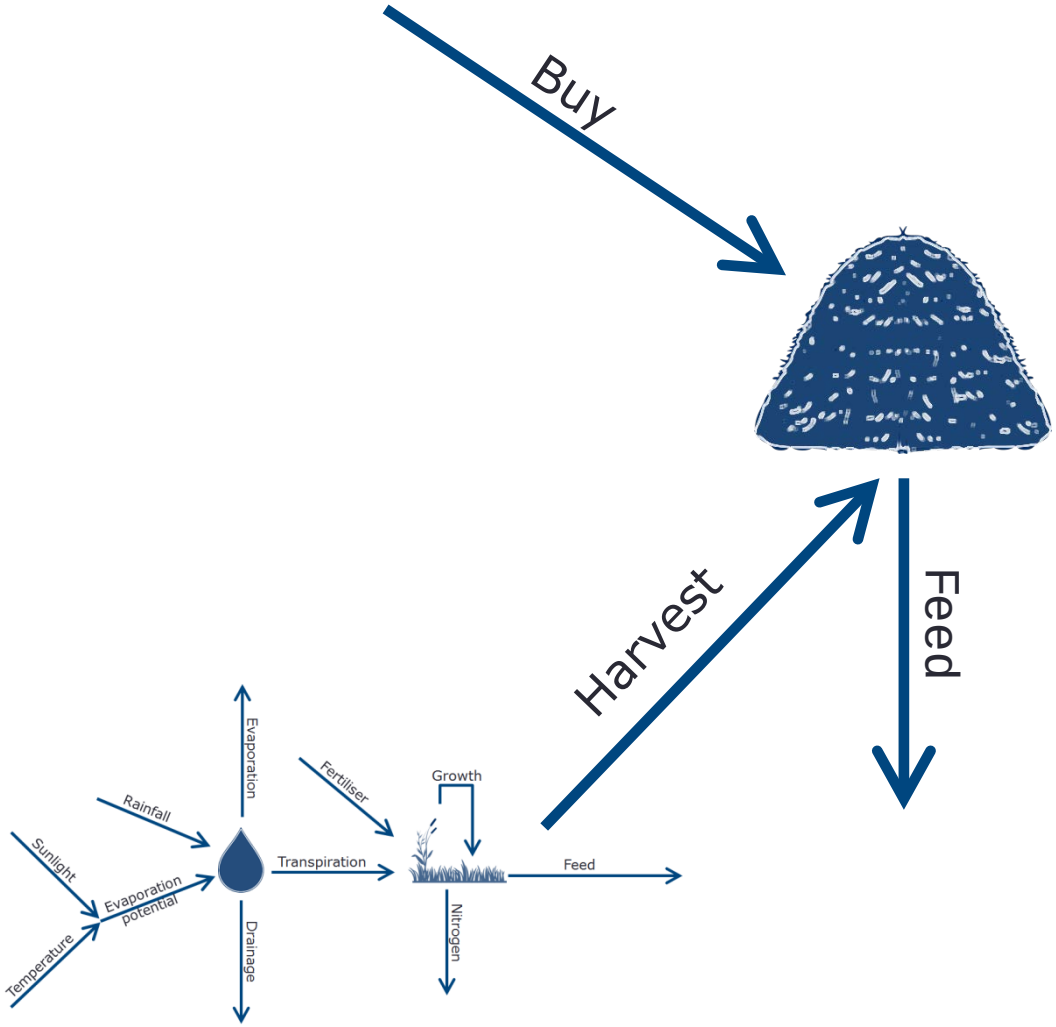

Annual Supplementation Quantity
Total Quantity (kg)
2500
2000
1500
1000
500
0
0
0.05
0.1
0.15
Supplement to Milk Price Ratio
$300/Tonne @ $3.90/kgMS

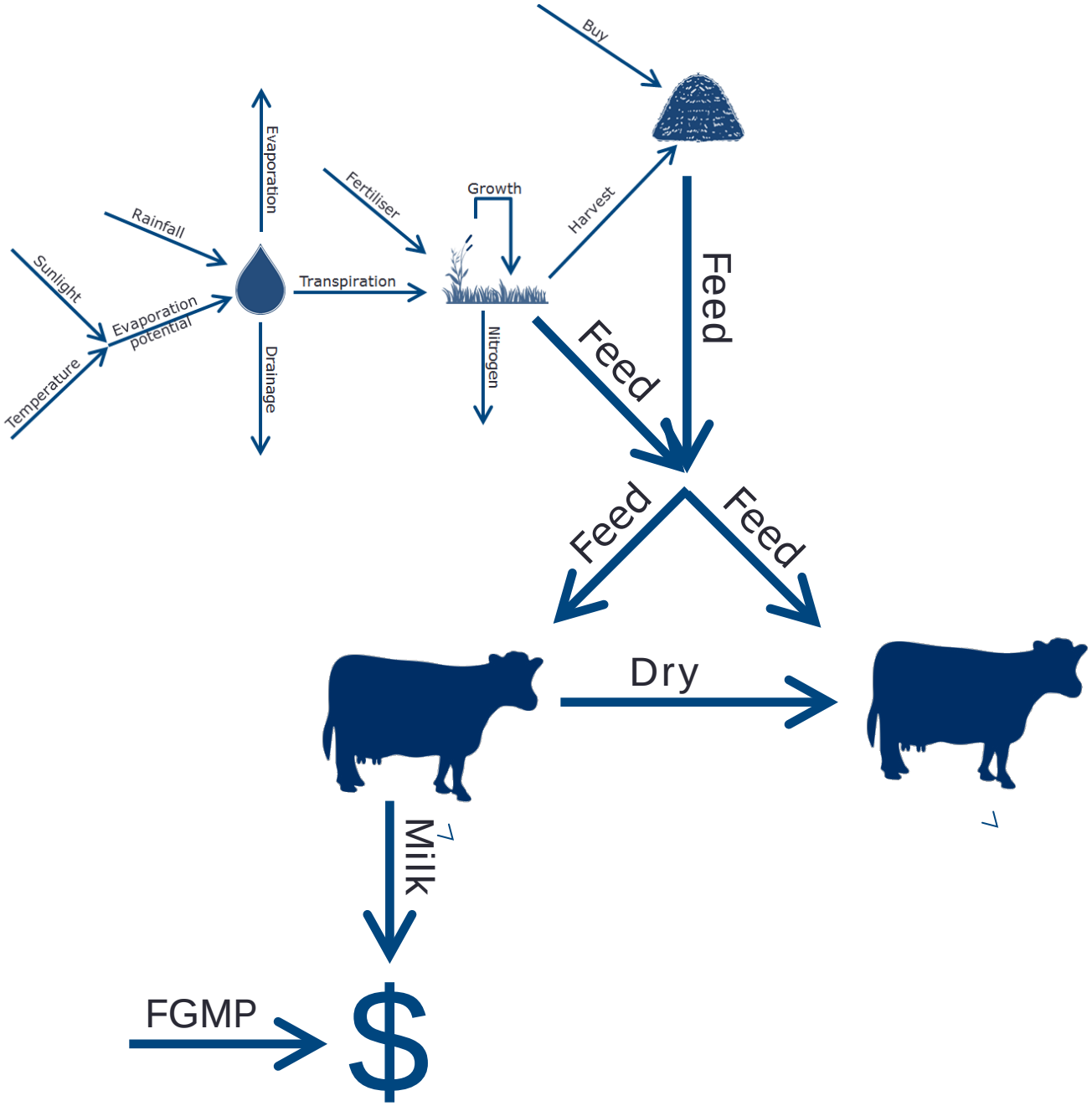
The **Milk**
Production
Optimiser with
Weather
Dynamics incorporating
Economic
Risk

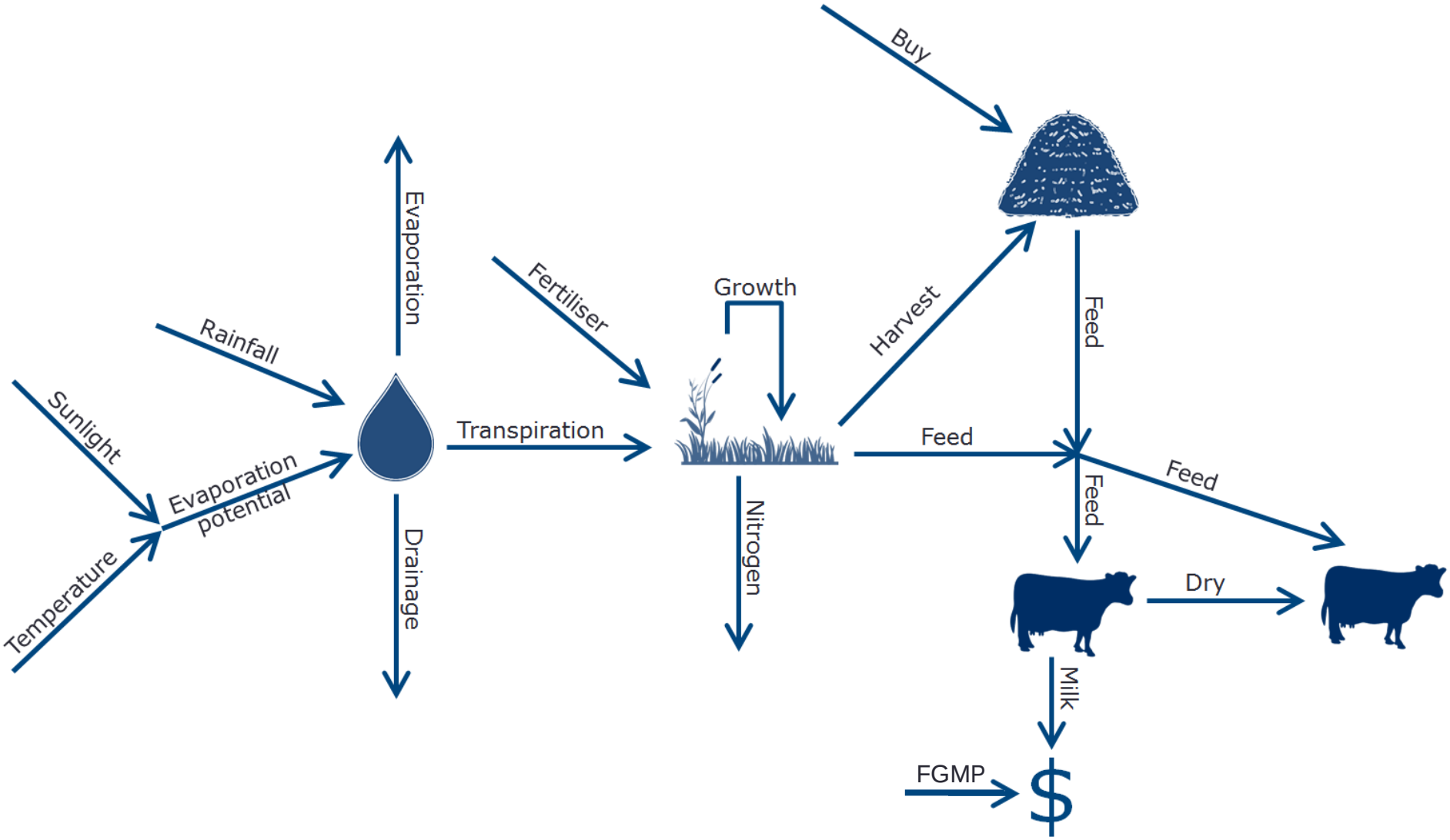
Cows	Pasture	Stochasticity
Body Condition	**Fertiliser**	**Weather**
Lactation	Irrigation	Financial
Effluent	**Silage**	Biological
Stocking Rate	**Supplement**	

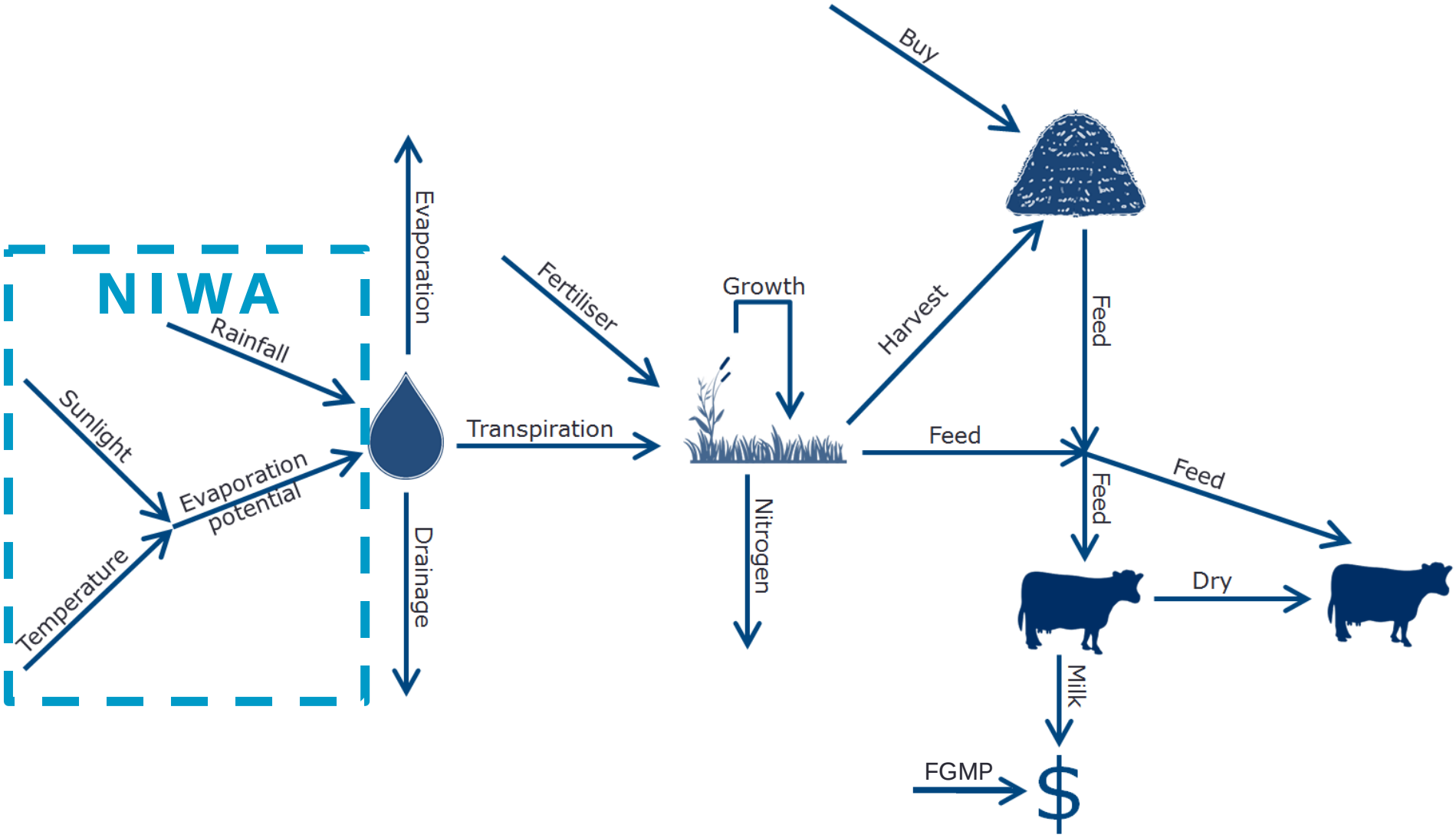

Evaporation
Rainfall
Sunlight
Transpiration
Evaporation
potential
Temperature
Drainage

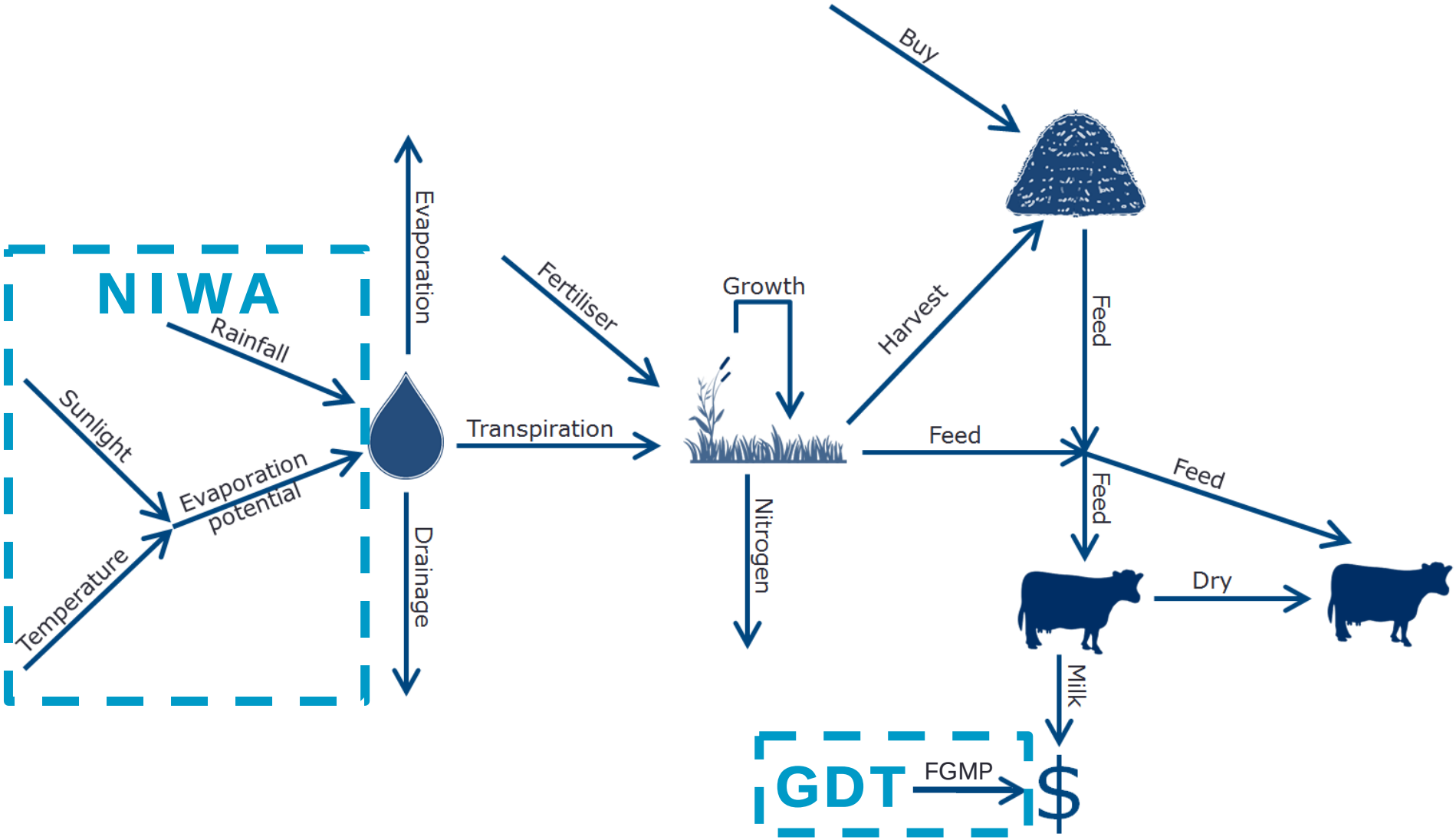

Fertiliser
Growth
Harvest
Transpiration
Feed
Nitrogen
Evaporation
Rainfall
Sunlight
Evaporation potential
Temperature
Drainage


Buy
Harvest
Feed
Evaporation
Rainfall
Fertiliser
Growth
Sunlight
Evaporation potential
Transpiration
Feed
Temperature
Drainage
Nitrogen


Buy
Evaporation
Rainfall
Fertiliser
Growth
Harvest
Sunlight
Evaporation potential
Transpiration
Feed
Feed
Temperature
Drainage
Nitrogen
Feed
Feed
Dry
Milk
FGMP
$


Buy
Evaporation
Rainfall
Fertiliser
Growth
Harvest
Feed
Sunlight
Evaporation potential
Transpiration
Feed
Feed
Feed
Temperature
Drainage
Nitrogen
Dry
Milk
FGMP
$


NIWA
Rainfall
Sunlight
Evaporation potential
Temperature
Evaporation
Drainage
Fertiliser
Transpiration
Growth
Nitrogen
Buy
Harvest
Feed
Feed
Feed
Feed
Dry
Milk
FGMP
$


NIWA
Rainfall
Sunlight
Evaporation potential
Temperature
Evaporation
Drainage
Fertiliser
Transpiration
Growth
Nitrogen
Buy
Harvest
Feed
Feed
Feed
Feed
Dry
Milk
GDT
FGMP
$

Inputs

- Random Drivers
  - NIWA Weather Data
  - GDT Prices

- Farm Parameters
  - “Grass growth” parameters
  - Stocking rate
  - Effective area
  - BCS curve
  - Milk curve

Outputs

In a given week, with some % of the herd milking, current pasture cover, feed on hand and soil moisture, we can recommend to the farmer how much

1. Pasture to feed
2. Pasture to turn into silage
3. Supplement to feed
4. Supplement to purchase
5. Nitrogen to apply
6. Cows to dry off

You could take this further

- How can a farmer in Rotorua minimise their Nitrogren usage yet maximise their profit?
- How can a farmer in Canterbury minimise their water usage yet maximise their profit?
- Is it economic to farm in Northland if the probability of a drought increases?

Risk Management

Situation: Forecasted Drought

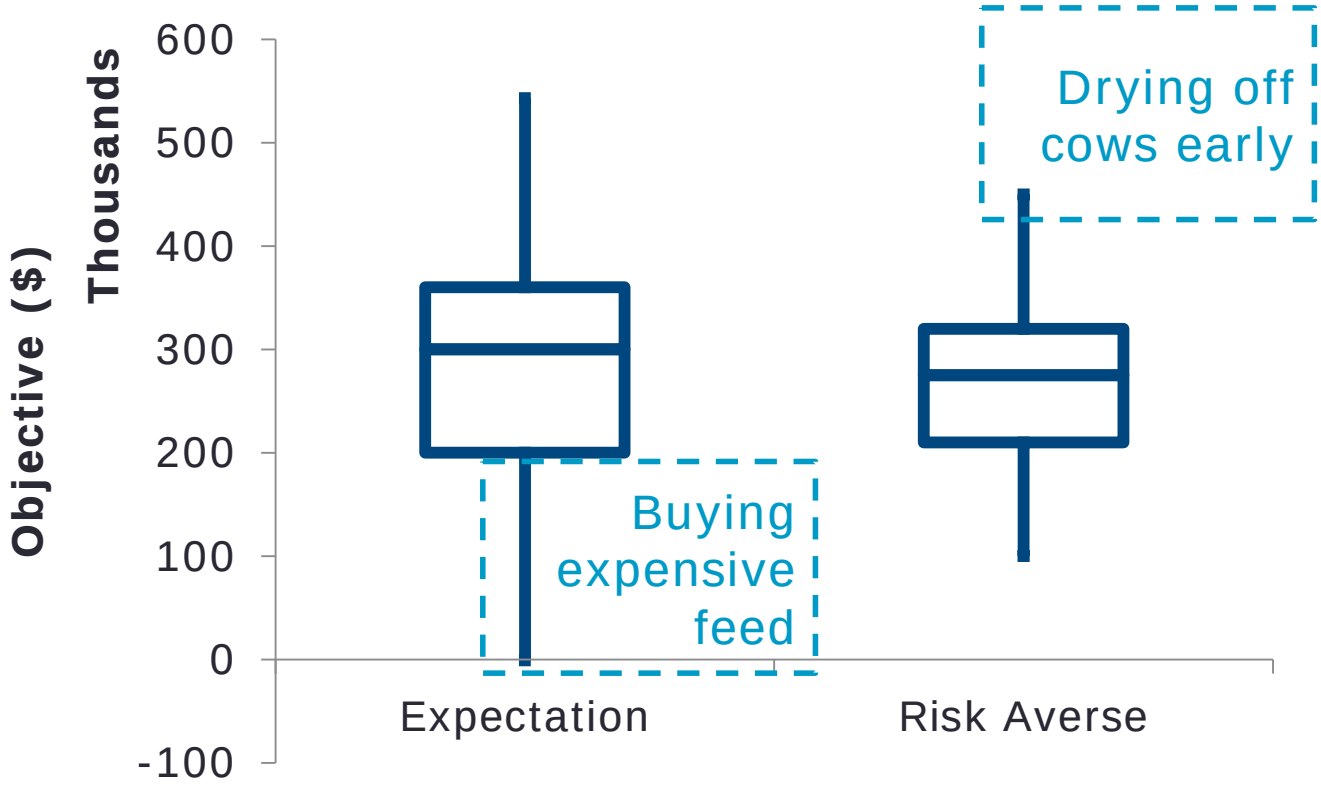
Should you

A) Dry off cows early

If so, how many

B) Buy in supplementary feed

If so, how much


Objective ($)
Thousands
600
500
400
300
200
100
0
-100
Expectation
Risk Averse
Buying expensive feed
Drying off cows early

The Future of Dairying

NZX milk price contracts welcomed

ANDREA FOX
Last updated 08:11, April 8 2016

SONITA CHANDAR

Having certainty about the price farmers will receive at the end of the season will remove a lot of pressure, Andrew Hoggard says.

NZX's new milk price futures and options contract offer will put New Zealand dairy farmers on a more level playing field with international competitors who already have such tools, says Federated Farmers

Future Questions

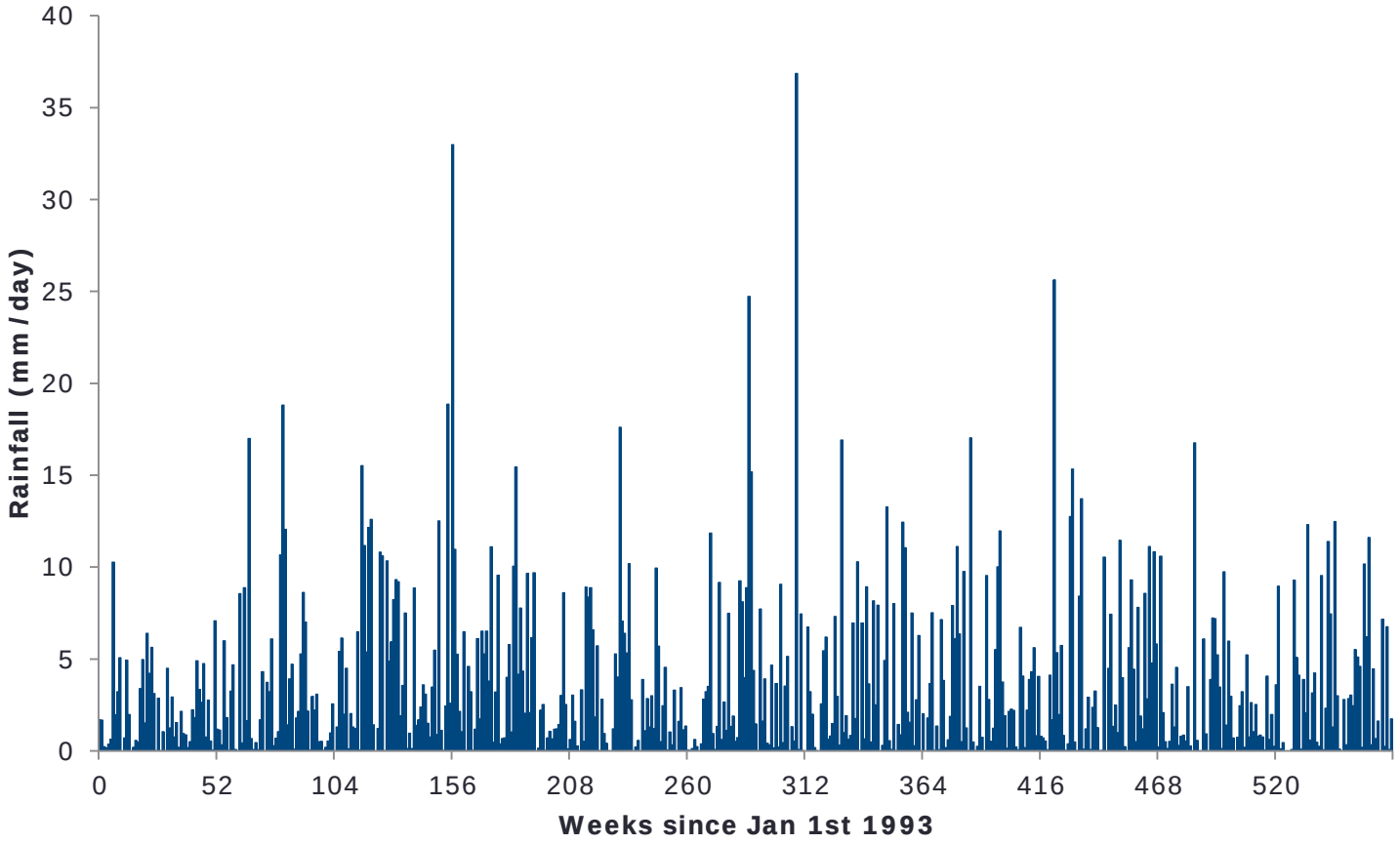
How does farmer behaviour change if they can use buy futures?

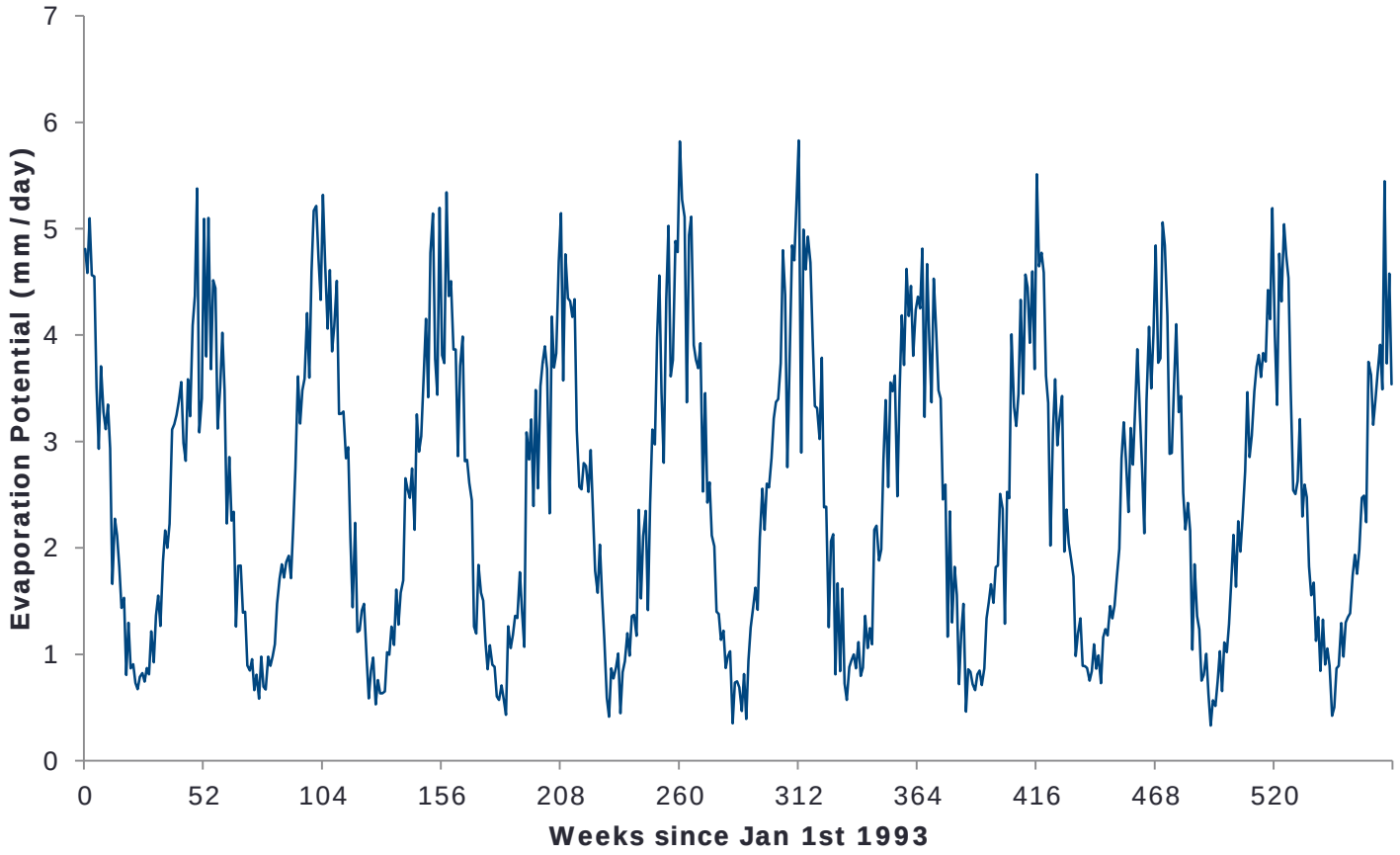
- Reduce economic risk -> allows them to manage environmental risk

What quantity and at what price should farmers be willing to trade at?

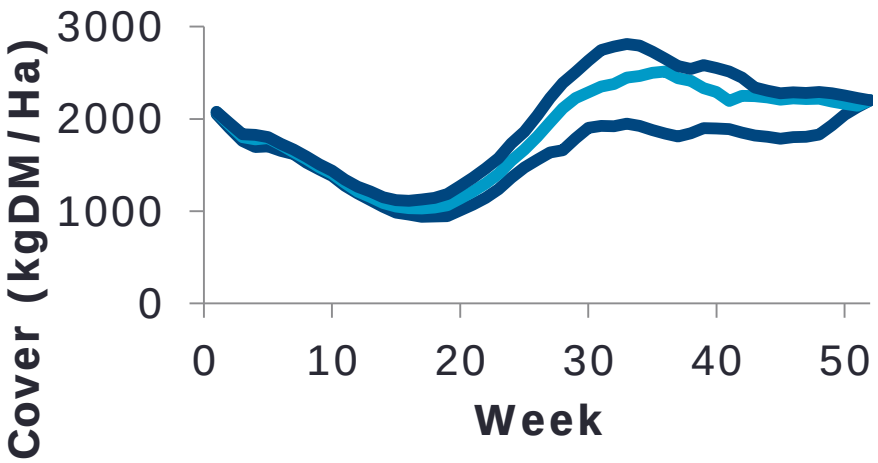
Questions

A Bay of Plenty Example

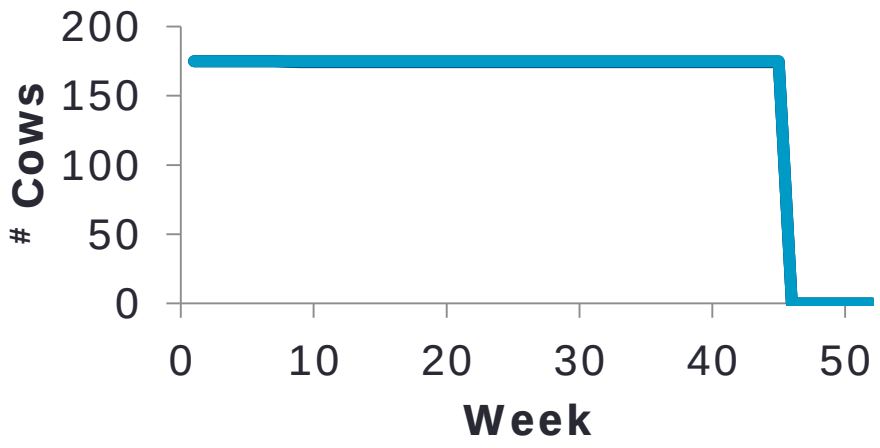

Rainfall (mm/day)
40
35
30
25
20
15
10
5
0
0
52
104
156
208
260
312
364
416
468
520
Weeks since Jan 1st 1993


Evaporation Potential (mm/day)
7
6
5
4
3
2
1
0
0
52
104
156
208
260
312
364
416
468
520
Weeks since Jan 1st 1993

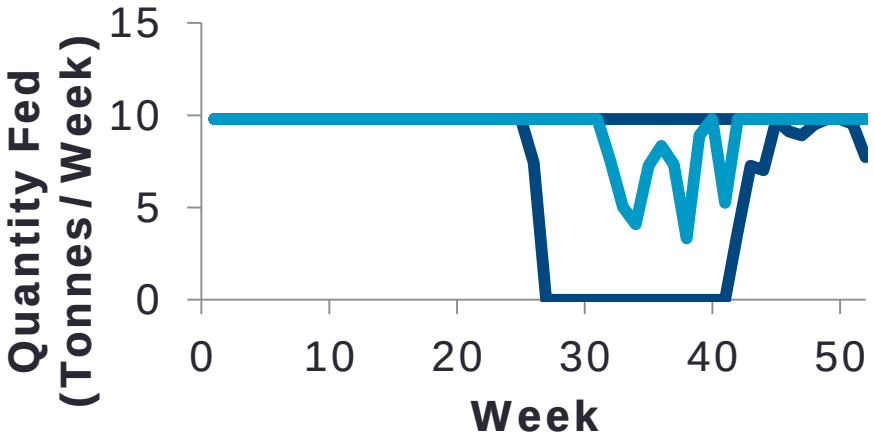
Pasture Cover



Cows milking



Supplement Fed



Feed Store