



St Peter's School/Lincoln University  
Demonstration Dairy Farm

## Recommendations Report: Stage 2 Farm System modelling



## **1. Introduction**

Owl Farm has been developed in conjunction with our partners with the intention of demonstrating to farmers and rural professionals what a sustainable profitable farm for the Waikato and Bay of Plenty could look like going forward.

Within a rapidly changing environment we are experiencing significant change which is causing the farming community a level of uncertainty and anxiety. We are facing unprecedented global volatility impacting milk price, changing environmental regulations which are questioning status quo, more stringent health and safety legislations and more focus on people through attracting and retaining a quality workforce. These factors now need to be considered holistically when determining what a future proof sustainable farm system looks like.

Owl Farms development has been undertaken via a staged process. Stage 1 (1-3 years) has a primary focus on optimising our existing position within the present farm system utilising current infrastructure. Stage 2 (3-5 years) is about testing and investigating in conjunction with partners which farm systems are best suited to achieve long term sustainable profits.

The intention of this report is to provide a broad overview of a range of farm systems and to demonstrate how they measure up in relation to sustainable profits. Based on this information, recommendations will be developed as to the most appropriate future farm systems for further consideration. Ideally, it is anticipated that the Farm Governance Committee will agree on the direction of the future farm system which is most appropriate in achieving Owl Farm's objectives.

The Farm Management Committee identified the following range of farm systems. We believe these reflect the variety of options currently available from system 1 through system 5 and everywhere in between. These include:

1. Status Quo – Basefile
2. Status Quo – Wintering off 100 late calving cows
3. Status Quo – In-shed Feed system
4. Status Quo - In-shed feed system with wintering off 100 late calving cows
5. 2.7 cow/ha stocking rate – No imported feeds
6. 2.7 cows/ha stocking rate - Production optimised with PKE
7. Seasonal (spring calving) Feed Pad – Stocking rate of 3
8. Split calving (40% autumn/60% spring calving) Feed Pad – Stocking rate of 3
9. Winter milking Feed Pad (100% autumn calving) – Stocking rate of 3
10. Seasonal (spring calving) Herd Home – Stocking rate of 3
11. Seasonal (spring calving) Feed Pad – Stocking rate of 4

## **2. Methodology**

For all intents and purposes this has been undertaken as a modelling exercise, with that it needs to be accepted that there will be a margin of error within the outputs. Regardless the numbers are deemed sufficient to warrant further robust discussion around the viability of farm system for Owl Farm.

As mentioned, sustainable profits have been identified as the key criteria in determining the most appropriate future farm system. The cash surplus of each modelled farm system along with the modelled nitrogen loss from overseer are therefore key metrics for comparison and

overall evaluation. Cash surplus has been chosen as the measure of profitability above operating profit as the impact of any additional debt servicing must ultimately be considered in regards to take home income. Additionally, the return on assets has been calculated along with a sensitivity analysis for each scenario which will also be taken into consideration. It is expected that criteria such as animal welfare, HR, health and safety, etc. are minimum practice within any implemented farm system and as such these aspects haven't been specifically considered within this report. In saying that, internal and external perception in some circumstances may be given consideration if it's believed pre-conceived ideas would be associated with particular models.

Above all else, Owl Farm must demonstrate leadership within the environmental space to ensure we operate within the regulations set out within the recently release Healthy Rivers: Plan for Change. As a minimum standard Owl Farm will be required to operate within a Nitrogen Reference Point which is likely to reflect the modelled nitrogen losses from either the 14/15 or 15/16 dairy seasons. Although not confirmed it is likely our nitrogen reference point will sit around 45kgN/ha. This is a crucial piece of information when considering which farm system is most appropriate for Owl Farm going forward.

As a side note, the constructed treatment wetland and any potential associated benefits regarding nitrogen losses have not been considered for the purpose of this report.

The farm system scenarios outlined above have been modelled through several programmes to measure key metrics such as profitability, productivity, nitrogen loss, return on assets and sensitivity of changes in production or payout. By plotting these metrics against one another we wish to identify the sweet spot for what is deemed both an acceptable profit and sustainable outcome. It is expected that the direction of travel will not necessarily be the most profitable or the most sustainable option but one which has an acceptable level of both.

Farmax has been used as the primary Farm system modelling tool which includes feed, production and financial budgeting. Redsky is also likely to be used to review/ground truth the scenarios which hold the most appeal. Overseer has been used to complete the environmental modelling which demonstrates the likely nitrogen losses expected under each system. Finally, Westpac's budget structure has been used to provide a sensitivity analysis on both the milk price and production levels.

In regards to the return on assets, two calculations have been completed. The first is the return on any additional investment. This represents the additional operating profit above the baseline operating profit through any modelled scenario with a capital requirement. The additional operating profit is then divided by the value of the capital requirement. The second calculation is a straight return on asset for the entire business, this is the operating profit divided by the total asset base.

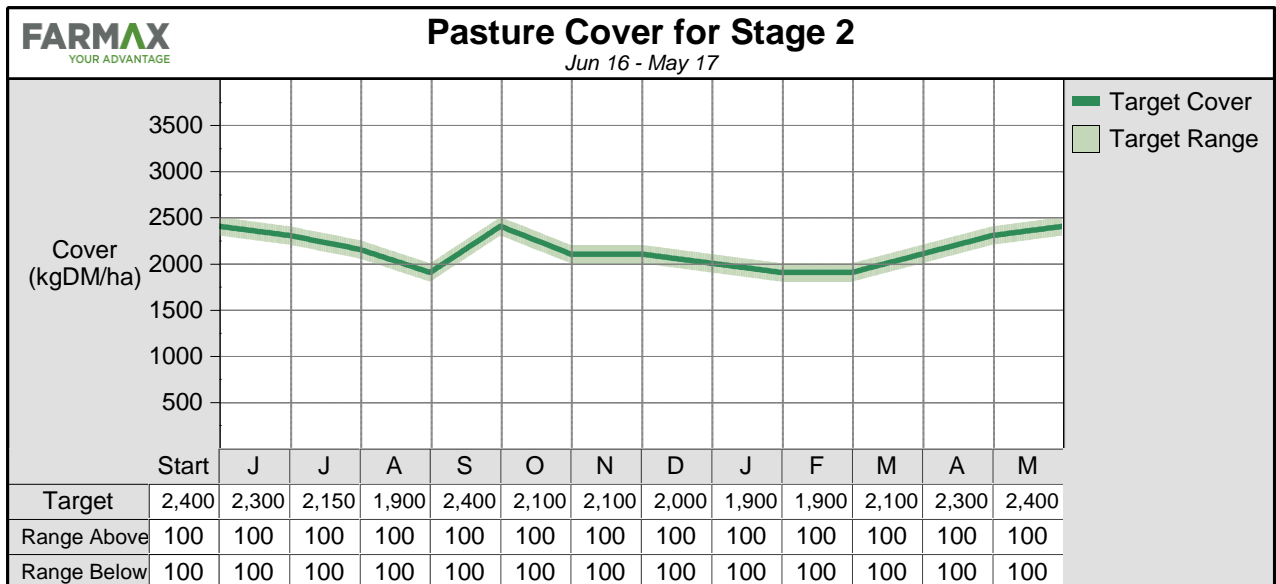
### **3. Assumptions made**

Given this is largely a modelling exercise there are a number of assumptions which have been used across all scenarios. This ensures consistency and allows accurate comparison between models. Assumptions include.

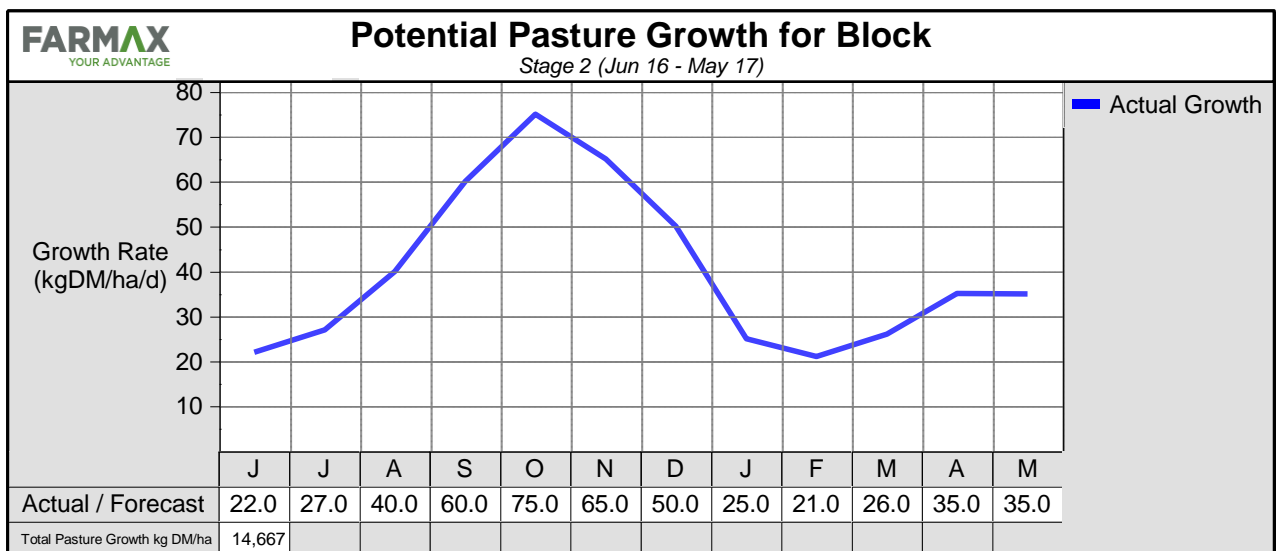
- Land: 154 hectares
- Capital:
  - Additional cows purchased @\$2000/cow
  - Additional shares purchased @\$6.00/kgMS
  - It has been assumed that a new effluent pond will be constructed irrespective of which farm system is selected however the feed pad scenarios have an additional cost relative to improvements in system and additional storage.



- Depreciation: existing depreciation of infrastructure is consistent across all models at \$53,000.00. Additional depreciation has been added above this value when additional capital investment is required. Depreciation on additional capital has been based on the following assumptions:
  - Mixer wagon depreciated over 5 years
  - In-shed feed system depreciated over 10 years
  - Feed-pads, herd homes, feed bunkers and effluent systems depreciated over 25 years
- Financials: The following costs are consistent across all modelled scenarios, those which aren't covered below differ within each scenario.
  - Milk Price – \$5.50/kgMS plus 30c dividend
  - Wages
  - Animal Health - \$90/cow
  - Breeding - \$70/cow
  - Farm dairy \$10,000
  - Feed Price
    - Chicory - \$1000/ha
    - PKE - \$230/tonne
    - Brought Maize - \$300/tonne
    - Brought pasture silage - \$300/tonne
    - Calf feed - \$800/tonne
  - Grazing - \$7/wk for heifer calves, \$9/wk for rising 2 year olds, \$22/wk for cows.
  - Fertiliser - \$65,000 (except for herd home scenario where additional effluent has reduced nitrogen requirement)
  - Regrassing - \$25,000
  - Repairs and Maintenance - \$25,000
  - Weed and pest
  - Admin, insurance, ACC and rates remain unchanged.
- Fertiliser: 150kgN/ha/yr is consistent across each scenario applied via five dressings. The only scenario which differs is the herd home where additional effluent has meant several blocks have dropped an application.
- Pasture
  - Target pasture covers for each month have been entered into Farmax as seen below. The target covers are what they would be at the end of the month. The light green either side indicates an allowance for 100kgDM/ha either side of the target. This graph has been used as guide when building the feed budget in regards to how much pasture vs. supplement can be feed without compromising average pasture covers.



- Growth rates (kgDM/day). This illustrates a potential growth of 14,667kgDM/ha. It is likely growth rates would be higher within feed pad/herd home scenarios as grazing pressure is reduced however no allowances have been made for this at this stage.



- Pasture utilisation %.

FARMAX

YOUR ADVANTAGE

Properties for Dairy Default

Jun 16 - May 17

Month	Utilisation %
Jan	90
Feb	90
Mar	90
Apr	90
May	90
Jun	80
Jul	80
Aug	85
Sep	90
Oct	90
Nov	90
Dec	90

NB. Pasture utilisation only applies to adult stock.

- Cow
  - Breed, BW/PW remain unchanged.
  - Liveweight has changed to 485kgLW based on weighing of a cross section which was undertaken in January.
- Feed
  - Feed will differ depending on scenario but characteristics of each feed (i.e. ME) remain unchanged. Utilisation of feed will differ depending on relevant infrastructure.
- Feeding levels
  - In all scenarios dry cows are offered 13-14kgDM to increase gut capacity and condition coming into calving. Once calved cows, feed offered is progressively increased to between 20-22kgDM (depending on model) during peak production months of September/October. This general philosophy has been followed in all models.

#### 4. Farm System Modelling Overview

NB: Operating profit for the purpose of this includes depreciation and debt servicing to demonstrate the impact of any associated infrastructure.

Scenario	1	2	3	4	5	6	7	8	9	10	11
<b>Total KgMS</b>	184,410	187,634	199,364	195,575	171,002	184,536	211,171	203,151	205,000	211,171	259,467
Change in kgMS	-	+3,224	+14,954	+11,165	-13,408	+126	+26,761	+18,741	+20,590	+26,761	+75,057
<b>kgMS/cow</b>	419	426	452	444	420	453	479	453	455	479	462
<b>Total Cows</b>	450	450	450	450	416	416	470	470	470	470	620
<b>Total Income</b>	\$1,111,343	\$1,130,632	\$1,198,485	\$1,176,185	\$1,027,537	\$1,103,201	\$1,275,637	\$1,276,242	\$1,299,735	\$1,275,637	\$1,560,676
Change from basefile	-	+\$19,289	+87,142	+\$64,842	-\$83,806	-\$8,142	+\$164,294	+\$164,899	+\$188,392	+\$164,294	+\$449,333
<b>Total Farm Expenses</b>	\$767,091	\$764,129	\$799,178	\$789,190	\$690,126	\$718,091	\$851,376	\$869,461	\$880,849	\$900,176	\$1,119,532
Change from basefile	-	-\$2,962	+\$32,087	+\$22,099	-\$76,965	-\$49,000	+\$84,285	+\$102,370	+\$113,758	+\$133,085	+\$352,441
<b>Operating Profit</b>	\$344,252	\$366,233	\$399,307	\$386,995	\$337,411	\$385,111	\$424,260	\$406,781	\$418,886	\$374,460	\$441,144
<b>Debt servicing and lease costs</b>	\$225,750	\$226,290	\$232,500	\$231,420	\$225,750	\$225,750	\$245,550	\$244,200	\$244,200	\$273,643	\$280,380
<b>Cash Surplus</b>	\$118,502	\$139,943	\$166,807	\$155,575	\$111,661	\$159,361	\$178,710	\$162,581	\$174,686	\$100,817	\$160,764
Change from basefile	-	+\$21,441	+\$48,305	+\$37,073	-\$6,841	+\$40,859	+\$60,208	+\$44,079	+\$56,184	-\$17,685	\$42,262
<b>Capital requirement</b>	-	\$12,000	\$150,000	\$126,000	-	-	\$440,000	\$410,000	\$410,000	\$1,086,500	\$1,214,000
Return on additional investment	N/A	55%	37%	34%	N/A	N/A	18%	15%	18%	3%	8%
<b>Return on asset</b>	2.8%	3%	3.2%	3.1%	2.8%	3.1%	3.3%	3.2%	3.3%	2.8%	3.3%
<b>Total imported supplement (tDM)</b>	273	216	388	278	-	122	538	462	632	538	1206
<b>kgN/ha leached</b>	46	44	48	45	43	44	50	53	57	42	57
<b>N conversion efficiency</b>	33%	34%	33%	34%	34%	34%	35%	37%	33%	33%	33%

**1** = Status Quo - basefile, **2** = Status Quo - wintering off 100 late calving cow, **3** = Status Quo - In-shed Feed system, **4** = Status Quo - In-shed feed system with wintering off 100 late calving cows, **5** = 2.7 cows/ha Stocking rate - No imported feeds, **6** = 2.7 cows/ha Stocking rate - Production optimised with PKE, **7** = Seasonal (spring calving) Feed Pad - Stocking rate of 3, **8** = Split calving (40% autumn/60% spring calving) Feed Pad - Stocking rate of 3, **9** = Winter milking Feed Pad (100% autumn calving) - Stocking rate of 3, **10** = Seasonal (spring calving) Herd Home - Stocking rate of 3, **11** = Seasonal (spring calving) Feed Pad - Stocking rate of 4

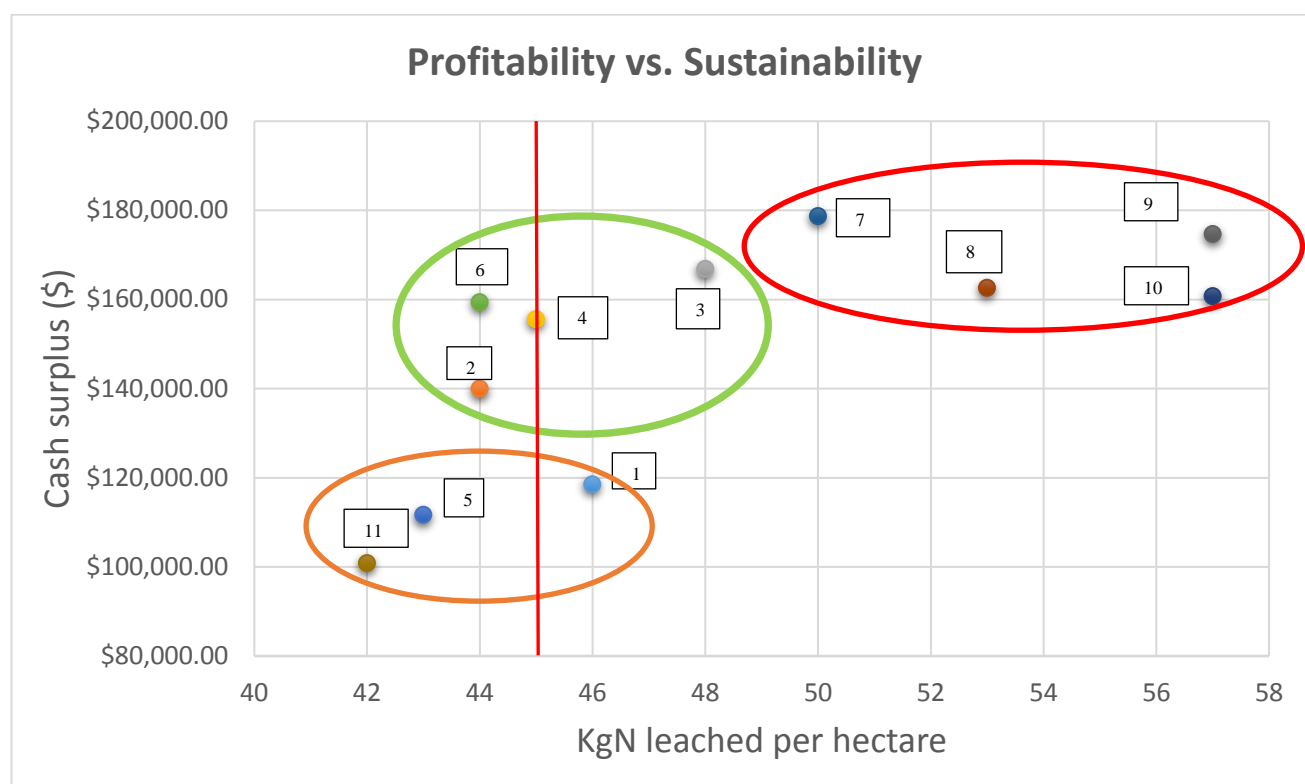
## 5. Farm System Modelling Summary

The table below summarises the key metrics which will largely influence the future direction of Owl Farm.

<b>Farm System</b>	<b>Cash surplus</b>	<b>Return on Asset</b>	<b>Nitrogen loss</b>
<b>1</b> = Status Quo – basefile	\$118,502.00	2.8%	46
<b>2</b> = Status Quo – wintering off 100 late calving cow	\$139,943.00	3%	44
<b>3</b> = Status Quo – In-shed Feed system	\$166,807.00	3.2%	48
<b>4</b> = Status Quo - In-shed feed system with wintering off 100 late calving cows	\$155,575.00	3.1%	45
<b>5</b> = 2.7 cows/ha Stocking rate – No imported feeds	\$111,661.00	2.8%	43
<b>6</b> = 2.7 cows/ha Stocking rate - Production optimised with PKE	\$159,361.00	3.1%	44
<b>7</b> = Seasonal (spring calving) Feed Pad – Stocking rate of 3	\$178,710.00	3.3%	50
<b>8</b> = Split calving (40% autumn/60% spring calving) Feed Pad – Stocking rate of 3	\$162,581.00	3.2%	53
<b>9</b> = Winter milking Feed Pad (100% autumn calving) – Stocking rate of 3	\$174,686.00	3.3%	57
<b>10</b> = Seasonal (spring calving) Herd Home – Stocking rate of 3	\$100,817.00	2.8%	42
<b>11</b> = Seasonal (spring calving) Feed Pad – Stocking rate of 4	\$160,764.00	3.3%	57



Modelled profitability (via the cash surplus figure) and nitrogen leaching have been plotted against one another in the graph below. This allows us to identify which scenarios achieve both an acceptable level of profit and nitrogen loss.



### Red circle = high profit/low environmental – not recommended

The red circle illustrates the farms systems which would not likely be considered due to their associated environmental footprint. Although profitable, these have all been modelled with nitrogen losses in excess of 50kgN/ha which is likely to be in excess of our nitrogen reference point by 10% or more.

These four points reflect the feed pad scenarios at various stocking rates and calving alignments. The silver and blue on the far side represent the complete winter milking scenario and feed pad with a stocking rate of 4 cows per hectare. At a modelled 57kgN loss per hectare it is suggested these options are eliminated from stage 2's thinking.

The orange dot in the middle is the split calving scenario which is promising in terms of profit but also high in terms of modelled nitrogen loss. Alterations to this system such as stocking rate could reduce the modelled nitrogen loss but such changes would also impact profit for those reasons it is recommended that this option is not explored further.

The blue dot in the top left of the red circle represents the spring calving feed pad with a stocking rate of 3 cows per hectare. Of all the models this is the most profitable largely as a result of higher feed inputs and high utilisation leading to a more productive and ultimately more profitable outcome. Alterations could be made to the model to reduce nitrogen losses but to trim as much as 5kgN it would influence profitability.

### Orange circle = high environmental/low profit – not recommended

The orange circle represents those farm systems which have a low environmental footprint but also low profitability.

The worst of these is the brown dot which represents the herd home at a stocking rate of 3cows/ha. The low operating profit here is largely driven by the high debt servicing and

depreciation costs while the imported feed bill is also very high. For this system to work we would need the ability to grow cheap feed either on or off farm.

The 2.7 cows/ha scenario is represented by the blue dot, as expected the nitrogen footprint is low, this relates to the lower stocking rate and no purchased feed. This option is not recommended on the basis there are other options which for marginally higher nitrogen losses have a substantially higher cash surplus. The same can be said for the status quo – basefile which rounds out the orange circle.

### **Green circle – The “Sweet Spot” - Recommended**

The green circle houses the farm systems with the most potential to be considered as part of stage 2’s development.

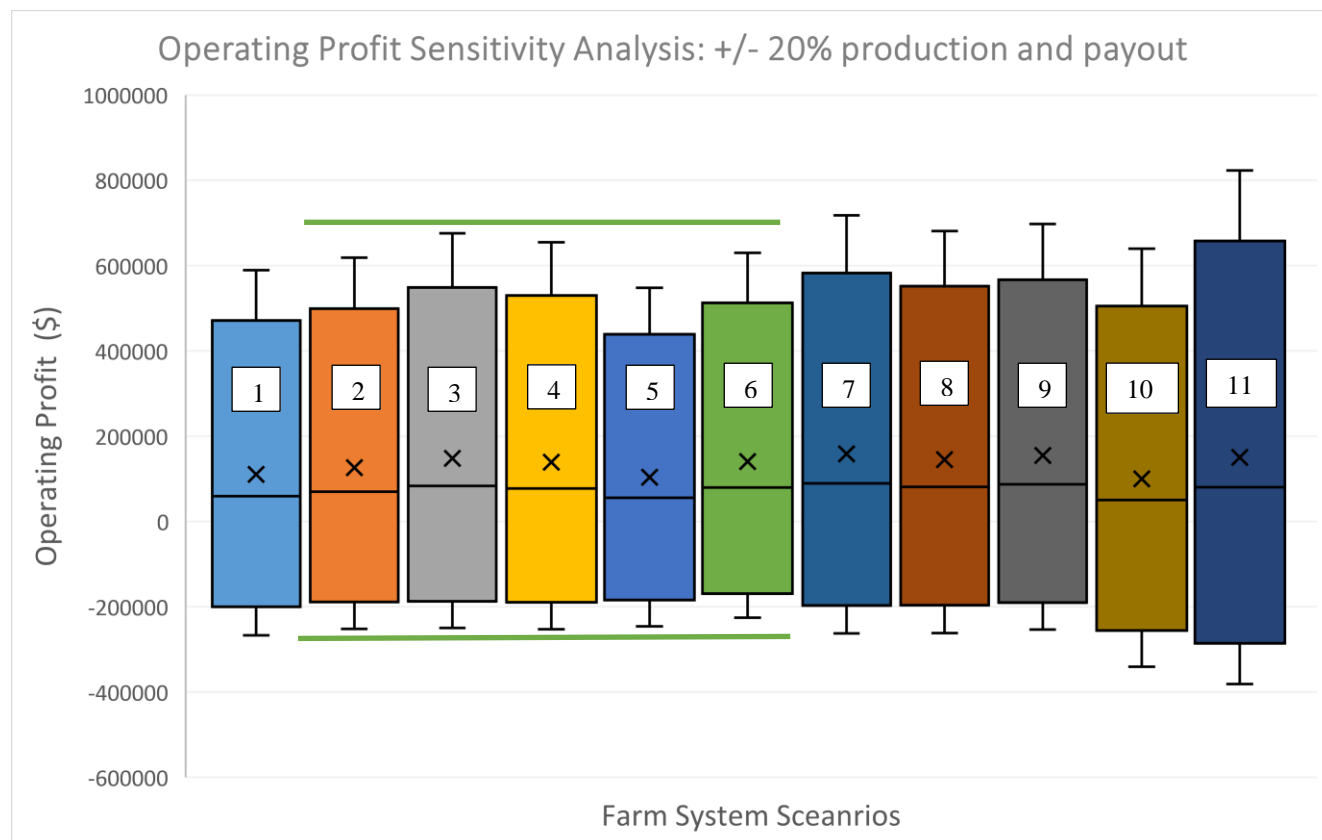
Of these the most profitable is the grey dot which represents in-shed feeding. Unfortunately, this is slightly higher in its modelled nitrogen loss. Slight alterations could however be made to reduce this back to within our nitrogen reference point. One of those options is the combination of wintering off late calving cows which is represented by the yellow dot. In reality, this option would be the most profitable for us as we already land available which we could use for wintering off late calving cows at a much lower cost than \$22/cow. There are also additional benefits with an in-shed feed system such as feed utilisation, mineral distribution and labour efficiency among others.

The green dot represents the scenario for 2.7 cows per hectare with purchased PKE to optimise production. At a modelled loss of 44kgN/ha and an operating profit which is almost \$160,000.00 this could be seen as one of the more favourable options. One of the limitations of this system remains the necessity to feed PKE in trailers in the paddock. During spring this season, our biggest challenge was undoubtedly being able to provide the cows with high quality feed when pasture utilisation was low. Given the saturation of the paddocks feeding PKE in the paddocks was not always an option meaning production went begging. In terms of developing a more resilient business we need to mitigate the risk of not being able to fully feed cows when conditions don’t suit. Outside of a feed pad an in-shed feed system remains our best option to achieve that.

The orange dot represents status quo with wintering off 100 late calving cows. Although reasonably profitable in its own right profitability could be optimised with the additional investment of infrastructure such as an in shed feed system.

## Sensitivity analysis overview

The graph below represents the sensitivity analysis data which was calculated for each scenario within the report. The series in the legend reflect the farm system numbering structure outlined in the introduction. The X represents the current cash surplus whereas the highest and lowest points reflect what the cash surplus would be with both plus or minus 20% of production and payout i.e. the upper and lower extremes.



This suggests that series 5 (2.7 cows/ha stocking rate – no imported feed) is the most resilient as the extremes are closest together, the cash surplus of this scenario however isn't favourable. At the other end of scale series 11 (feed pad with a stocking rate of 4) illustrates a significant range and therefore shows it is more sensitive to changes in production and payout.

Of the four recommended farm systems within the green circle above (series 2, 3, 4 and 6), all are nearly identical in regards to the bottom range for price and production sensitivity. As expected, both the in-shed feed systems (series 3 and 4) appear to be most profitable with increases to production and price.

## Return on asset



The inclusion of feed pads have a slightly better return on asset as indicated in the red circle above. However the associated environmental footprint likely rules these systems out for Owl Farm.

Of the recommended farm system models (green circle in first graph) the in-shed feed system alone (3 – red arrow) had the best return on asset at 3.2% per annum. Not far below at 3.1% was both the in-shed feed system with wintering 100 late calving cows off farm (4) and 2.7 cows per hectare with PKE (6).

## Summary

Although more profitable the feed pad scenarios were unlikely to stack up environmentally, this was always going to be challenging given the farm system Owl Farm has historically operated. Although environmentally sound, the operating profit of a herd home given the significant capital investment also means this option for incorporating infrastructure isn't feasible. Similarly, the low input scenario of 2.7 cows per hectare scored well environmentally but lower productivity meant profitability is compromised.

This essentially leaves us with four options. Although wintering off 100 late calving cows scored well environmentally there is still more that can be done to improve profitability without compromising environmental performance. Similarly, the in-shed system alone scored well profitability but with a higher environmental footprint. For that reason, wintering some late calving cows off with a combination of in-shed feeding to optimise productivity is a strong contender for stage 2. The other strong candidate is very similar to the existing farm system just with a slightly lower stocking rate of 2.7 cows/ha. Although certainly promising this farm system does still leave us vulnerable to extended periods on rainfall, with the potential impact on productivity likely to negatively influence profitability. In-shed feeding

isn't without risk either, there is a risk that the cost of PKE increases or that feeding PKE becomes socially irresponsible in years to come. Although there are plenty of alternatives the cost of feed would likely increase causing the operating profit and cash surplus to decrease. Feed utilisation during prolonged wet weather and cost of feed for in-shed feeding are expected to be strong discussion points at the Farm Governance Committee meeting.

## 6. Specific Farm System Overview

### 6.1 Status Quo – Basefile

#### Farm System Overview – Key Figures

Total kgMS	184,410
KgMS per cow	419
Total cows	450
Total Income	\$1,111,343
Total farm expenses	\$767,091
Operating Profit	\$344,252
Debt servicing and lease costs	\$225,750
Cash Surplus	\$118,502
Capital requirement	-
Return on additional investment	N/A
Return on assets (%)	2.8%
Kg nitrogen leached per hectare	46
Nitrogen conversion efficiency	33%

This model essentially reflects our existing farm system with optimised production and profit based on ideal feed inputs, weather conditions and growth rates throughout the year. The existing farm system is essentially a system 3, with a stocking rate of 2.9cows/ha there is strategic use of PKE to reduce pressure on pasture and optimise production.

For the purpose of this report, all other modelled farm system scenarios will be compared against this as a basefile.

### 6.2 Status Quo – Wintering off 100 late calving cows

#### Farm System Overview – Key Figures

Total kgMS	187,634
KgMS per cow	426
Total cows	450
Total Income	\$1,130,632
Total farm expenses	\$764,129
Operating Profit	\$366,233
Debt servicing and lease costs	\$226,920
Cash Surplus	\$139,943
Capital requirement	\$12,000
Return on additional investment	55%
Return on assets (%)	3%
Kg nitrogen leached per hectare	44
Nitrogen conversion efficiency	34%



The same stocking rate and general feeding strategy has been employed here with a very similar overall production being achieved. This model differs in the wintering off 100 late calving cows of farm from the 1<sup>st</sup> of June until the 20<sup>th</sup> of July. The cash surplus is slightly higher as a result of slightly higher production and less demand on supplementary feed over winter given there is less feeding pressure. Although there are slightly higher grazing costs this still doesn't outweigh the cost of importing supplements to hit feeding targets.

There is a slight capital cost in the purchasing of 2000 additional Fonterra shares at \$6.00/kgMS.

As expected, this scenario has slightly dropped the nitrogen leaching from 46kgN/ha at the basefile to 44kgN/ha. This reflects taking stock off farm during winter as well as less imported supplements.

### 6.3 Status Quo – In-shed feed system

#### Farm System Overview – Key Figures

Total kgMS	199,364
KgMS per cow	452
Total cows	450
Total Income	\$1,198,485
Total farm expenses	\$799,178
Operating Profit	\$399,307
Debt servicing and lease costs	\$232,500
Cash Surplus	\$166,807
Capital requirement	\$150,000
Return on additional investment	37%
Return on assets (%)	3.2
Kg nitrogen leached per hectare	48
Nitrogen conversion efficiency	34%

This scenario sees the introduction of an in-shed feed system. PKE has been assumed as the feed source, different feeds at different prices would obviously impact the profitability. The rationale for this scenario is better feed utilisation, distribution of minerals and time efficiency.

Per cow production has increased significantly given PKE is feed in the shed throughout the season. This in turn has significantly increased the overall production and therefore total farm income which is \$87,142.00 more than the baseline at \$1,198,485.00. Expenses are higher given the increase in purchased supplement. The cash surplus is \$166,807.00 which is almost \$50,000.00 more than the basefile.

The \$150,000 capital requirement reflects the following:

- In-shed feed system @ \$60,000.00
- 15,000 additional Fonterra shares @ \$6.00/kgMS

There has been a slight increase in modelled nitrogen leaching with an additional 2kgN/ha from the basefile. This reflects the additional supplement being brought in the farm gate.

## 6.4 Status Quo - In-shed feed system with wintering off 100 late calving cows

### Farm System Overview – Key Figures

Total kgMS	195,575
KgMS per cow	444
Total cows	450
Total Income	\$1,176,185
Total farm expenses	\$789,190
Operating Profit	\$386,995
Debt servicing and lease costs	\$231,420
Cash Surplus	\$155,575
Capital requirement	\$126,000
Return on additional investment	34%
Return on assets (%)	3.1%
Kg nitrogen leached per hectare	45
Nitrogen conversion efficiency	34%

This scenario is similar to 6.3 above with the addition of wintering 100 late calving cows off farm from the 1<sup>st</sup> of June until the 20<sup>th</sup> of July. Throughout the milking season the feed budget looks very similar to the in-shed feed system scenario however the major difference comes through the reduction of imported supplements through the winter and reduced grazing pressure.

Once again per cow production has increased given PKE is feed in the shed throughout the season. This has increased the overall production and therefore total farm income which is \$64,842.00 more than the baseline at \$1,176,185.00. The cash surplus is 155,575.00 which is almost \$40,000.00 more than the basefile.

The \$126,000 capital requirement reflects the following:

- In-shed feed system @ \$60,000
- 11,000 additional Fonterra shares @ \$6.00kgMS

There has been a slight decrease of modelled nitrogen leaching of 1kgN/ha from the basefile which is the result of taking 100 late calving cows off farm for 50 days through winter. This is in line with what our Nitrogen Reference Point is likely to be.

## 6.5 2.7 cow/ha stocking rate – No imported feeds

### Farm System Overview – Key Figures

Total kgMS	171,002
KgMS per cow	420
Total cows	416
Total Income	\$1,027,537
Total farm expenses	\$690,126
Operating Profit	\$337,411
Debt servicing and lease costs	\$225,750
Cash Surplus	\$111,661
Capital requirement	-
Return on additional investment	N/A
Return on assets (%)	2.8%
Kg nitrogen leached per hectare	43
Nitrogen conversion efficiency	34%

This scenario is models on an all pasture system 1 farm milking 2.7 cows per hectare with no imported supplements. Production is significantly lower than the basefile due to lower stock numbers and not optimising production with purchased feed, this has led to a decrease of total income of \$81,010.00 from the basefile.

Understandably, of all the scenarios this is one of the most environmentally sustainable given the lower stocking rate and no purchased feed. This has a modelled reduction 3kgN/ha from the basefile.

## 6.6 2.7 cows/ha stocking rate - Production optimised with PKE

### Farm System Overview – Key Figures

Total kgMS	184,536
KgMS per cow	453
Total cows	416
Total Income	\$1,103,201
Total farm expenses	\$718,091
Operating Profit	\$385,111
Debt servicing and lease costs	\$225,750
Cash Surplus	\$159,361
Capital requirement	-
Return on additional investment	N/A
Return on assets (%)	3.1%
Kg nitrogen leached per hectare	44
Nitrogen conversion efficiency	34%

This farm system scenario is also based on a stocking rate of 2.7 cows per hectare with the strategic inclusion of PKE to optimise production. Within this model PKE is feed with troughs in the paddock. The additional PKE has lifted this modelled production almost 15,000kgMS over the previous model and essentially puts production on par with the base file.

The total income between this scenario and the basefile is very similar given the similar production totals. However given the expenses are less as a result of both per cow costs and lower imported PKE the cash surplus for this system is \$40,859.00 higher than the base file at \$159,361.00.

This is also favourable from an environmental perspective as the model demonstrates a 2kg decrease in nitrogen leaching from the basefile to 44kgN/ha. This is a result of the lower stocking rate throughout the season.

## 6.7 Seasonal (spring calving) Feed Pad – Stocking rate of 3

### Farm System Overview – Key Figures

Total kgMS	211,171
KgMS per cow	479
Total cows	470
Total Income	\$1,275,637
Total farm expenses	\$851,376
Operating Profit	\$424,260
Debt servicing and lease costs	\$245,550
Cash Surplus	\$178,710
Capital requirement	\$440,000
Return on additional investment	18%
Return on assets (%)	3.3%
Kg nitrogen leached per hectare	50
Nitrogen conversion efficiency	35%

This farm system scenario incorporates a feed pad to better utilise supplement. The stocking rate has also been slightly increased to 3 cows per hectare. Production has increased significantly as a result of high input system associated with the use of the feedpad.

As expected the increase in production has led to a significant increase in total income which is \$164,294.00 more than the basefile. Given the higher reliance on supplementary feeds the farm expenses have also increased by \$84,285.00 from the basefile. With an cash surplus of \$178,710.00 this option is \$60,208.00 more profitable than the basefile.

The \$440,000.00 capital requirement reflects the construction of the feedpad and additional effluent infrastructure along with the purchasing of additional Fonterra shares. The feed pad has only been sized for 300 cows given the farm currently operates a split herd, this will also save money on additional concrete. The feedpad has been designed with the most efficient concrete to feed face ratio. Pricing for all pads has also been provided through Archway, a company who specialises in agricultural concrete construction. The capital cost is outlined below.

- \$144,000.00 for feedpad incl. concrete, mesh steel, etc. nib walls and 130m of feed bins.
- \$16,000.00 for pipe work, gates and water troughs/system.
- \$100,000 for effluent system – scrapper, wedge with weeping wall, additional effluent storage, improvements to pump and pipes.
- 180,000.00 for additional Fonterra shares (30,000 @\$6.00kgMS)
  - \$440,000.00

Although more profitable this farm system is not more sustainable, with 50% more imported supplement than the basefile as well 20 additional cows nitrogen leaching has increased by 4kgN/ha from the basefile to sit at a modelled 50kgN/ha.

## 6.8 Split calving (40% autumn/60% spring calving) Feed Pad – Stocking rate of 3

### Farm System Overview – Key Figures

Total kgMS	203,151
KgMS per cow	453
Total cows	470
Total Income	\$1,276,242
Total farm expenses	\$869,461
Operating Profit	\$406,781
Debt servicing and lease costs	\$244,200
Cash Surplus	\$162,581
Capital requirement	\$410,000
Return on additional investment	15%
Return on assets (%)	3.2
Kg nitrogen leached per hectare	53
Nitrogen conversion efficiency	37%

This farm system scenario also incorporates a feed pad to better utilise supplement. This models a split calving system whereby 40% of the herd calve in autumn and the remaining 60% calve in spring. The purpose of this model is to reflect the additional value derived from Fonterra's winter milk premium.

Farmax is a seasonal model. One imitation is therefore that it does not model winter milk particularly well in terms of the conversion of feed into milk. Actual milk production would likely be marginally higher than modelled during the winter months, though at a modelled 453kgMS/cow it is still quite high. Although not ideal, this model is more likely to be governed by nitrogen leaching than profitability. With a modelled nitrogen leaching of 53kgN/ha this model is unlikely to be seriously considered.

Regardless, this model does have a significantly higher total income than the basefile and a slightly higher total income than the seasonal feedpad from the previous model, this reflects the winter premium. Total farm expenses are higher than the previous model on the basis additional supplementary feed needs to be purchased to satisfy demand during winter. With an cash surplus of \$162,581.00 this scenario is \$44,079.00 more profitable than the base file.

In terms of capital investment the sizing and cost of feed pad is the same as the previous model. The \$30,000.00 difference reflects the lower production and therefore lower number of shared required.



## 6.9 Winter milking Feed Pad (100% autumn calving) – Stocking rate of 3

### Farm System Overview – Key Figures

Total kgMS	205,000
KgMS per cow	455
Total cows	470
Total Income	\$1,299,735
Total farm expenses	\$880,849
Operating Profit	\$418,886
Debt servicing and lease costs	\$244,200
Cash Surplus	\$174,686
Capital requirement	\$410,000
Return on additional investment	18%
Return on assets (%)	3.3%
Kg nitrogen leached per hectare	57
Nitrogen conversion efficiency	33%

A purely winter milking scenario has also been developed to demonstrate both the financial impact of the winter milk premium as well as the additional environmental challenges associated with transitioning to these systems.

At \$1,299,735.00, the total income is significantly higher (\$188,392.00) than the base file largely reflecting the higher per cow performance. The total income is also \$24,098.00 higher than the seasonal feed pad scenario put forward earlier which largely reflects the winter milk premium. Regardless of the higher total income the cash surplus for this model is slightly lower than the traditional feed pad scenario given the higher demand on purchased feed for the winter months.

The capital requirement for this scenario is the same as the previous split milking scenario. At an cash surplus of \$174,686.00, this scenario is one of the most profitable farm systems, however with a modelled 57kg of nitrogen leaching per hectare this is also one of the most environmentally challenged scenarios. It is unlikely to be considered on those grounds alone.

## 6.10 Seasonal (spring calving) Herd Home – Stocking rate of 3

### Farm System Overview – Key Figures

Total kgMS	211,171
KgMS per cow	479
Total cows	470
Total Income	\$1,275,637
Total farm expenses	\$900,176
Operating Profit	\$374,460
Debt servicing and lease costs	\$273,643
Cash Surplus	\$100,817
Capital requirement	\$1,086,500
Return on additional investment	3%
Return on assets (%)	2.8%
Kg nitrogen leached per hectare	42
Nitrogen conversion efficiency	33%

This scenario has been modelled to essentially demonstrate the profitability of animal housing as well as illustrating the potential environmental benefits. Although it is acknowledged that herd homes are not necessarily classified as wintering barns this still provides a high-level indication of where they would stack up on both scales.

The capital requirement is the biggest cost associated with this farm system with the cost of the herd home has been calculated at \$1875/cow. This is based on recommendations from a similar farm system we visited. At \$1875/cow the herd home alone would cost \$862,500.00, above this an additional \$50,000.00 feed bunker along with 29,000 Fonterra shares (\$174,000.00) means this system would require a \$1,086,000 capital injection.

In regards to total income, this system is no different from the feed pad scenario as the feed budget remains identical. It could be argued that cows produce more milk within these systems due to a reduction in heat stress. One such extrapolated assumption suggesting it could be within the vicinity of \$10,000/year. Heat stress cannot be modelled within Farmax and even with a potential \$10,000/year increase it would remain the least profitable.

There are less nitrogen costs given the redistribution of effluent from the bunkers but the cost of contractors to do this work has made it cost neutral. The high expenses driven by significant purchased feed and high depreciation has led to a low cash surplus of \$100,817.00 which is \$17,685.00 less than the basefile and \$77,893.00 less than the seasonal feed pad option.

Environmentally this system has been modelled with a nitrogen loss of 42kgN/ha. This is made possible through taking stock off pastures for 4-6 hours per day during the season, as well redistributing nutrients from effluent at a time and rate which soils can fully utilise.

Although these systems are clearly more sustainable their profitability remains questionable at a \$5.50kgMS payout, for that reason it is not a farm system that would likely be recommended.

## 6.11 Seasonal (spring calving) Feed Pad – Stocking rate of 4

### Farm System Overview – Key Figures

Total kgMS	259,467
KgMS per cow	462
Total cows	620
Total Income	\$1,560,676
Total farm expenses	\$1,119,532
Operating Profit	\$441,144
Debt servicing and lease costs	\$280,380
Cash Surplus	\$160,764
Capital requirement	\$1,214,000
Return on additional investment	8%
Return on assets (%)	3.3%
Kg nitrogen leached per hectare	57
Nitrogen conversion efficiency	33%

In reality this farm system has only been modelled to ensure a complete package of scenarios have been considered. Although not an option Owl Farm would likely consider it is important to model by means of demonstrating the environmental impact for other farmers considering what impact different options may have on their businesses.

With a modelled stocking rate of 4 cows per hectare this scenario has 620 cows, 150 more than the stocking rate of 3 which has been used for many other scenarios. The higher stocking rate has meant a significant increase in purchased supplements with 933 tonnes DM more purchased than the basefile. Total income is significantly higher than the basefile (+\$449,333.00) resulting from the higher total milksolid production. However, with expenses also being \$352,411.00 more than the basefile the cash surplus is the lowest of all the feed pad scenarios at \$160,764.00.

Once again it has been assumed that a feedpad wouldn't be scoped to hold the entire herd given the split herd requirement, a 450 cow feedpad has therefore been priced. The capital requirement for this scenario is outlined below:

- \$180,000.00 for feedpad incl. concrete, mesh steel etc., nib walls and 240m of feed bins
- \$20,000.00 for pipe work, gates and water troughs/system
- \$100,000.00 effluent system – flood wash, wedge with weeping wall, additional storage
- \$50,000.00 for feed storage bins
- \$50,000.00 mixer wagon
- Additional stock 170 cows @\$2000 = \$340,000.00
- Additional Fonterra Shares required ~ 79,000 @\$6.00 = \$474,000.00

If this system was to be implemented it would likely require a bigger cowshed would need to be considered with the current only a 36 aside bale. For the purpose of this scenario its just been assumed that milking will be longer.

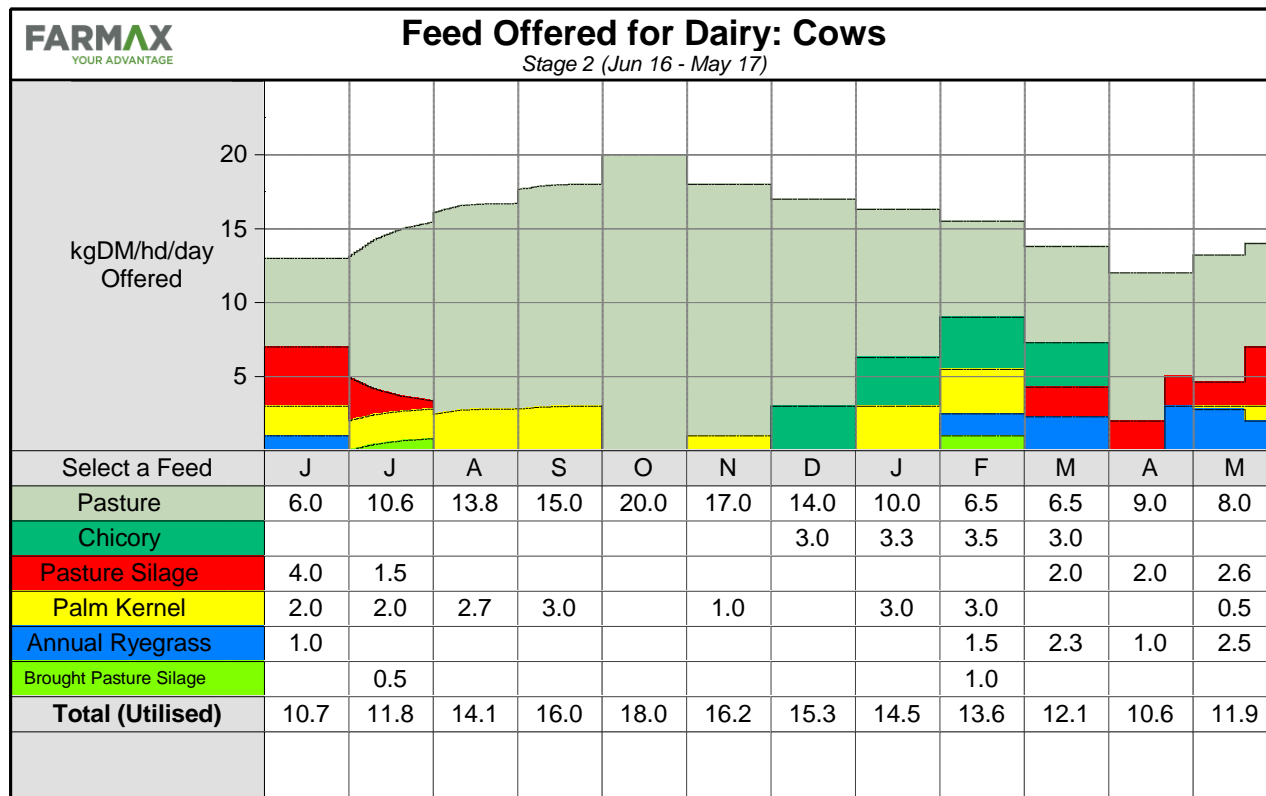
Environmentally, the additional cows and significant increase in purchased feed has illustrated the additional impact this system would put on water quality with nitrogen leaching increasing to 57kgN/ha/yr, for this reason alone it is likely this option would not be considered.

## 7. Appendix – Additional modelling detail – Farmax, Overseer, Sensitivity analysis

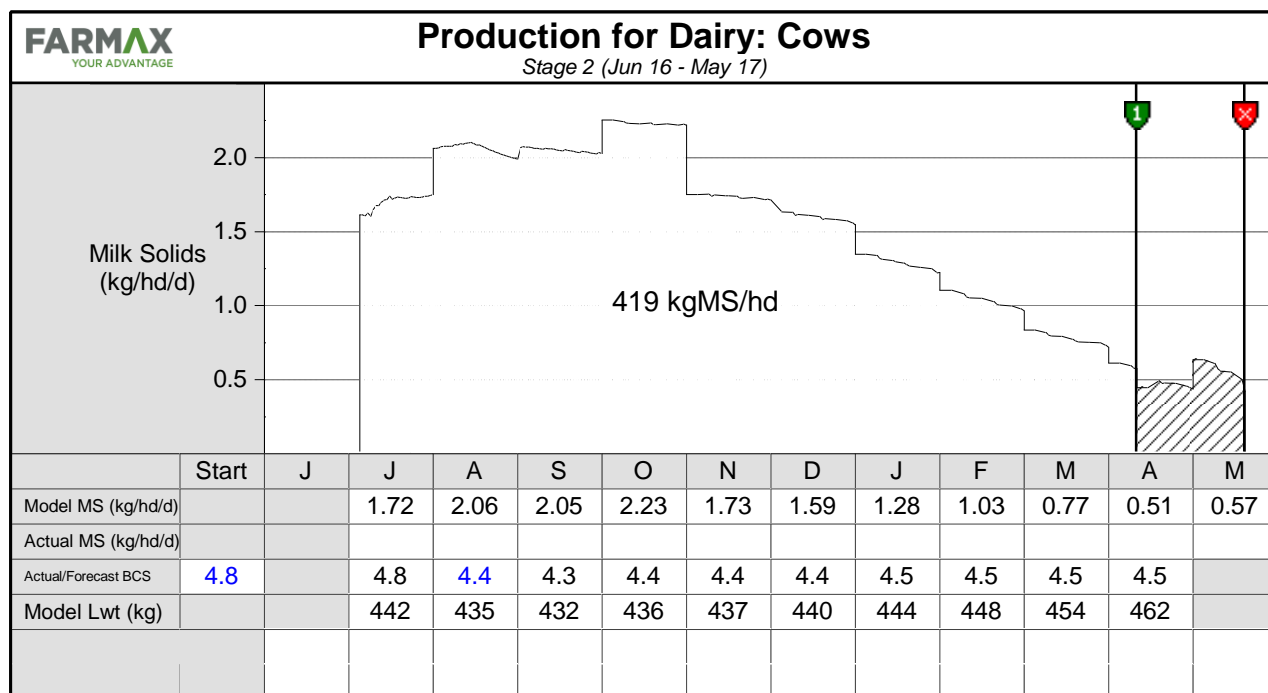
### 7.1 Status Quo – Basefile

#### Farmax system modelling

The graph below illustrates the feed budget for both the dries and milkers. This remains very similar to what the current 16/17 season feed budget reflects.



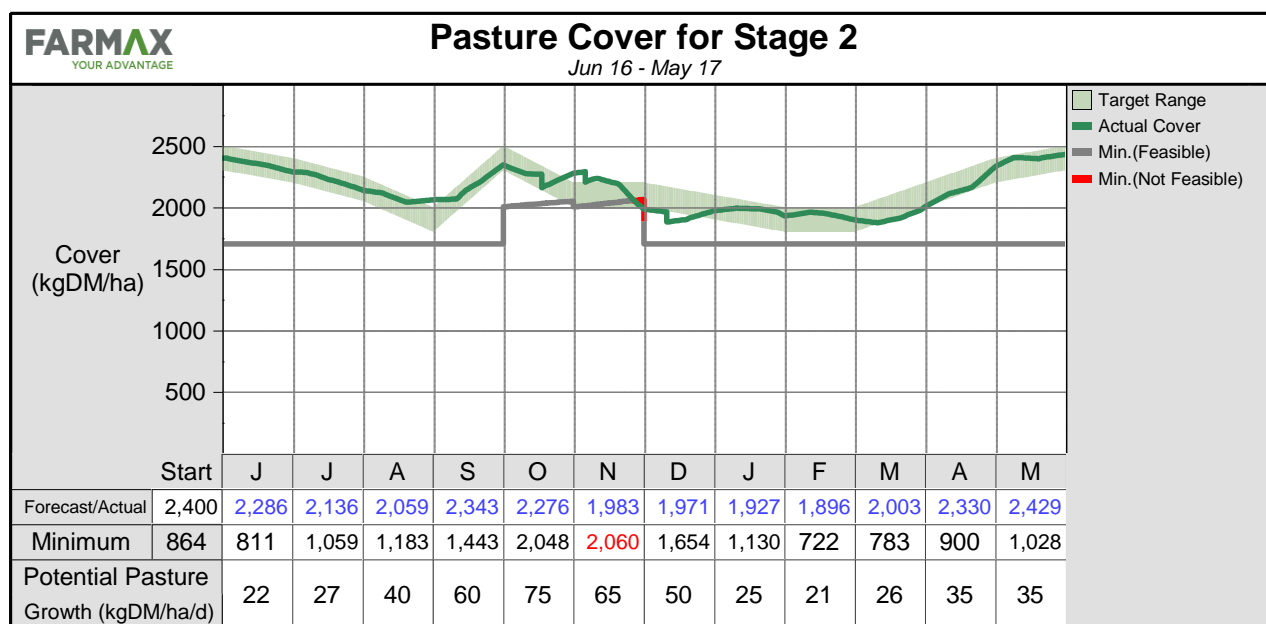
The graph below illustrates the production curve, among other things this reflects the feed budget in terms of feed offered and relative milk produced. At peak offering of 20kgDM/cow the model suggests the cows will achieve an average 2.23kgMS/day/cow for the month. This also demonstrates the total average per cow production target of 419kgMS/cow.





The graph below represents the modelled pasture cover throughout the season based on the pasture offered through the feed budget and predicted growth rates. There is faint green line surrounding the prominent green line which reflects the range of the pasture targets each month. This does suggest we get a little tight in November as growth rates and energy levels of pasture drop and 15ha of chicory is out.

The infeasibility that is shown below is in relation to the issue of intake vs the animals potential within the model. Minimum cover isn't directly related to demand; rather the minimum cover increases as the cow's intake gets close to their potential. The general idea is that in order to eat right up to potential, the animals need lots of easily accessed feed. We are not concerned by the slightly higher minimum cover compared to the forecast as we went through November this season at an average cover of 1950kgDM/ha without any issues.



## Environmental Modelling: Overseer

The table below is the summary from the Overseer file. This shows modelled nitrogen leaching at 46kgN/ha and nitrogen conversion efficiency at 33%.

(Whole farm)	Units	Value	Benchmark
<b>Nutrient loss indices</b>			
Loss to water	kg N/ha/yr	46	24-42
	kg P/ha/yr	1.2	
includes loss from effluent pond of:	kg N/ha/yr	0	
	kg P/ha/yr	0.0	
<b>Production efficiency indices</b>			
Farm N surplus (pastoral)	kg N/ha/yr	172	123-191
N conversion efficiency (pastoral)	%	33	27-35
<b>Effluent: area of pastoral farm</b>			
Currently receiving effluent	ha	39	
Required to achieve application rate of 150 kg N/ha/yr	ha	23	
<b>Greenhouse gas emissions</b>			
Total greenhouse gas emissions	eCO <sub>2</sub> ha/year	16,593	

## Sensitivity analysis:

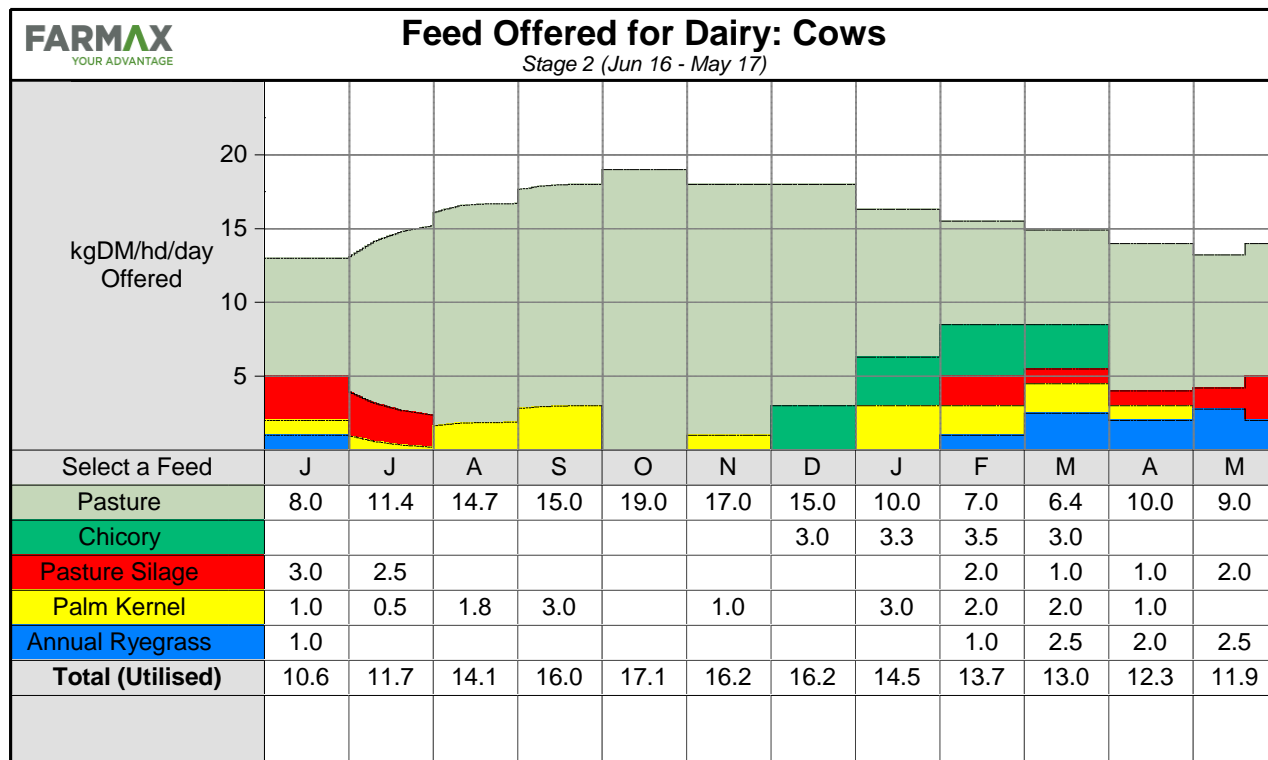
Both production and price sensitivity is shown below going up or down at 10% increments.

<b>PRODUCTION/PRICE SENSITIVITY</b>					
PRICE VARIANCE					\$0.58
PRODUCTION VARIANCE (KG's)					18441
	\$4.64	\$5.22	<b>\$5.80</b>	\$6.38	\$6.96
147528	-\$266,546	-\$180,980	-\$95,414	-\$9,847	\$75,719
165969	-\$180,980	-\$84,718	\$11,544	\$107,806	\$204,068
<b>184410</b>	-\$95,414	\$11,544	<b>\$118,502</b>	\$225,460	\$332,418
202851	-\$9,847	\$107,806	\$225,460	\$343,113	\$460,767
221292	\$75,719	\$204,068	\$332,418	\$460,767	\$589,116

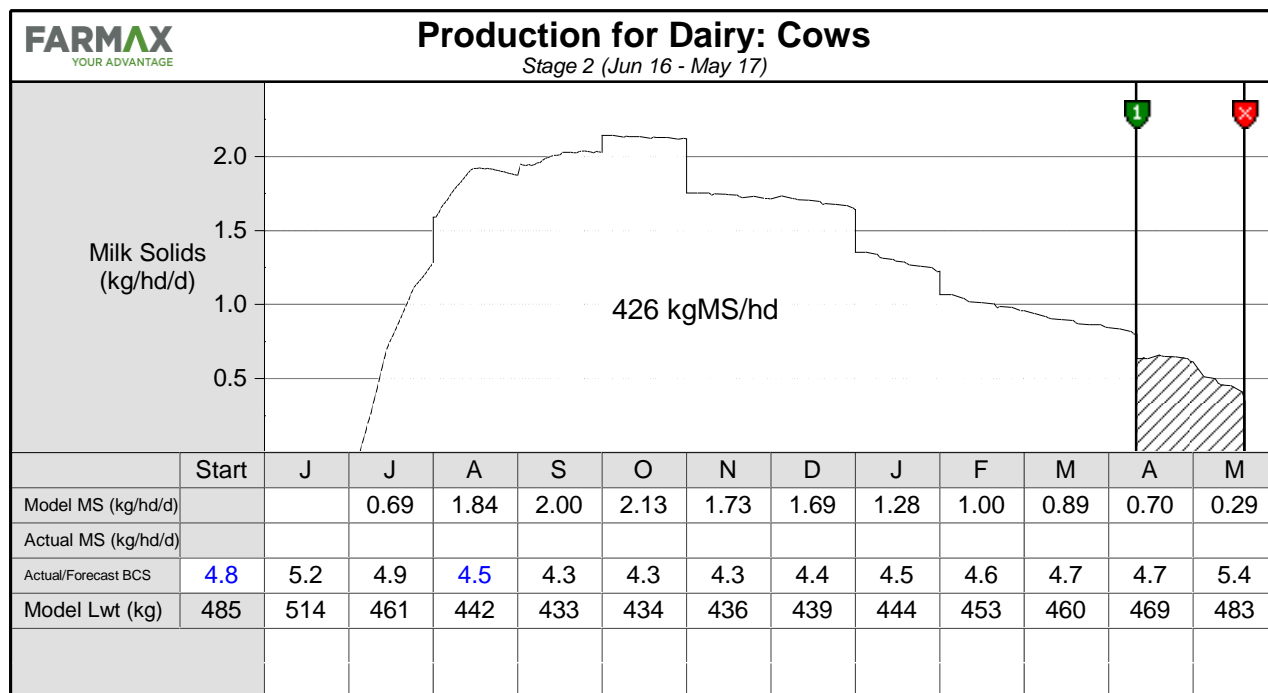
## 7.2 Status Quo – Wintering off 100 late calving cows

### Farmax system modelling

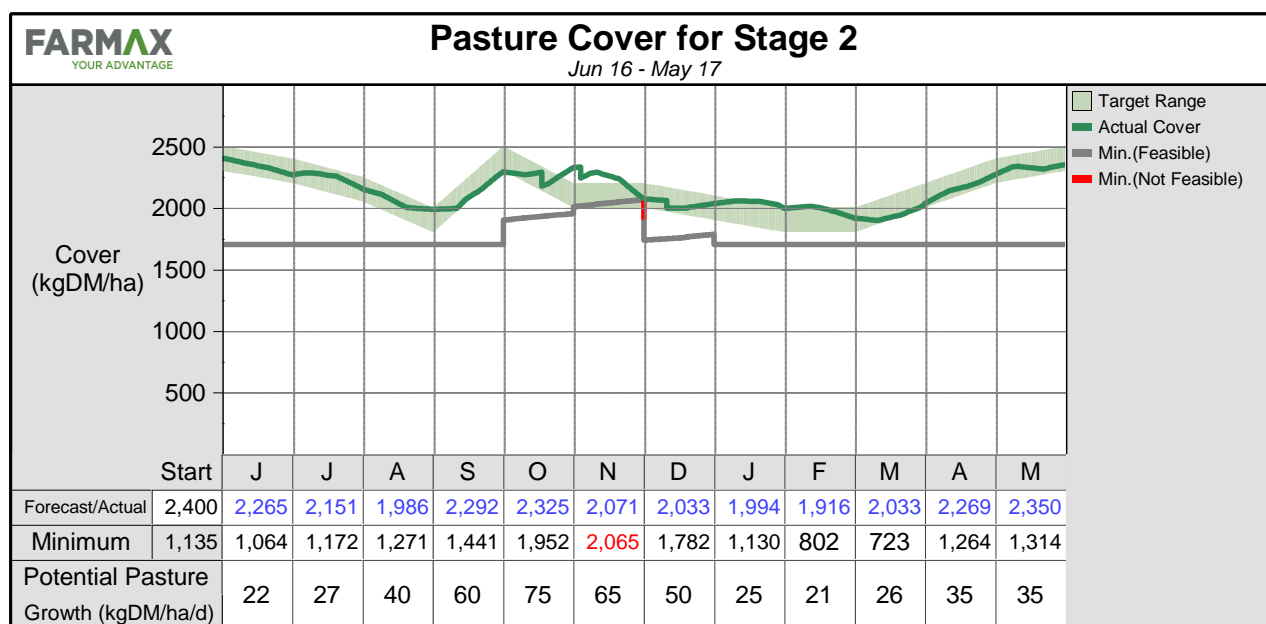
Similar feed objectives have been targeted for this scenario as the base file, only there is slightly more pasture feed and less supplement through the winter months as demand is less. Otherwise the feed budget reflects a very similar pattern to the base file.



The graph below illustrates the production curve; at 426kgMS/cow the modelled production is slightly higher than the basefile.



The graph below represents the modelled pasture cover throughout the season based on the pasture offered within the feed budget and predicted growth rates. Once again we would get slightly short in November.



## Environmental Modelling: Overseer

The table below is the summary from the Overseer file. This shows modelled nitrogen leaching at 44kgN/ha and nitrogen conversion efficiency at 34%.

(Whole farm)	Units	Value	Benchmark
<b>Nutrient loss indices</b>			
Loss to water	kg N/ha/yr	44	24-42
	kg P/ha/yr	1.2	
includes loss from effluent pond of:	kg N/ha/yr	0	
	kg P/ha/yr	0.0	
<b>Production efficiency indices</b>			
Farm N surplus (pastoral)	kg N/ha/yr	166	123-191
N conversion efficiency (pastoral)	%	34	27-35
<b>Effluent: area of pastoral farm</b>			
Currently receiving effluent	ha	39	
Required to achieve application rate of 150 kg N/ha/yr	ha	23	
<b>Greenhouse gas emissions</b>			
Total greenhouse gas emissions	eCO <sub>2</sub> ha/year	16,104	

### Sensitivity analysis:

Both production and price sensitivity is shown below going up or down at 10% increments.

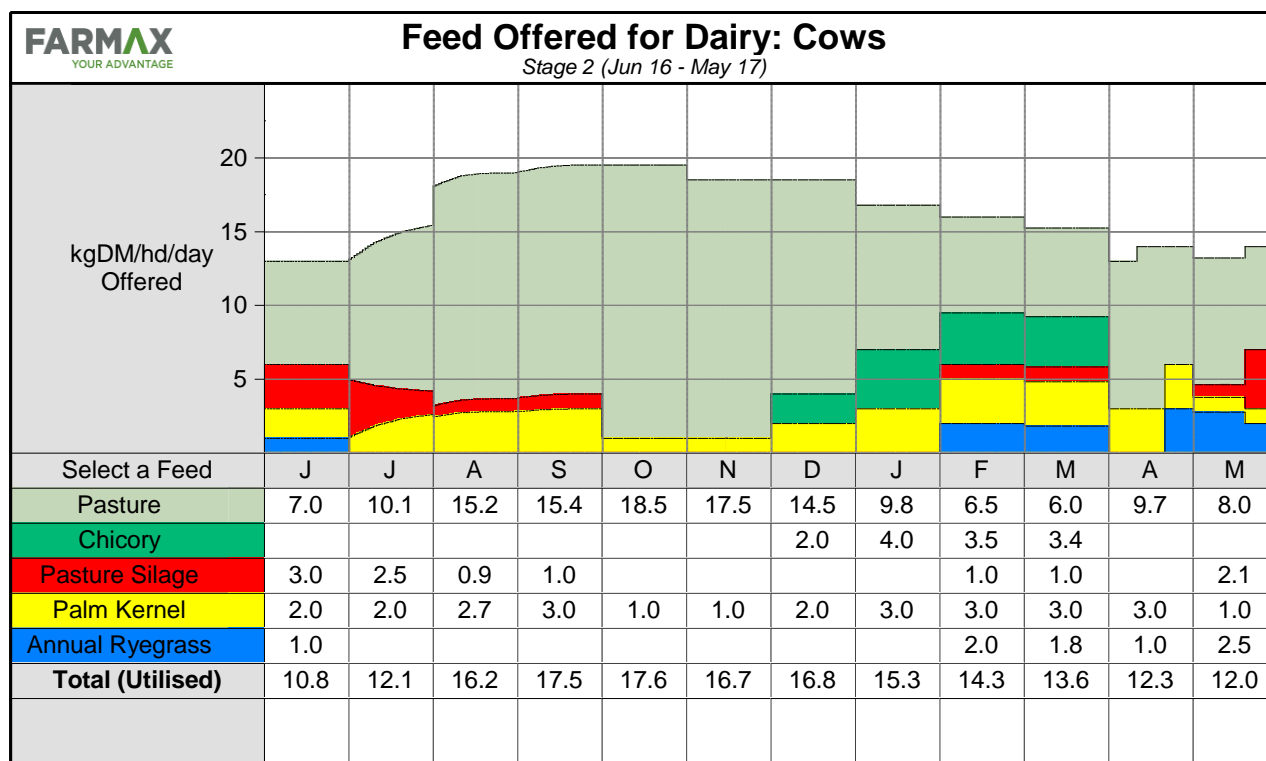
<b>PRODUCTION/PRICE SENSITIVITY</b>					
PRICE VARIANCE					\$0.58
PRODUCTION VARIANCE (KG's)					18763.4
	\$4.64	\$5.22	<b>\$5.80</b>	\$6.38	\$6.96
150107.2	-\$251,837	-\$164,775	-\$77,712	\$9,350	\$96,412
168870.6	-\$164,775	-\$66,830	\$31,115	\$129,060	\$227,005
<b>187634</b>	-\$77,712	\$31,115	<b>\$139,943</b>	\$248,771	\$357,598
206397.4	\$9,350	\$129,060	\$248,771	\$368,481	\$488,192
225160.8	\$96,412	\$227,005	\$357,598	\$488,192	\$618,785



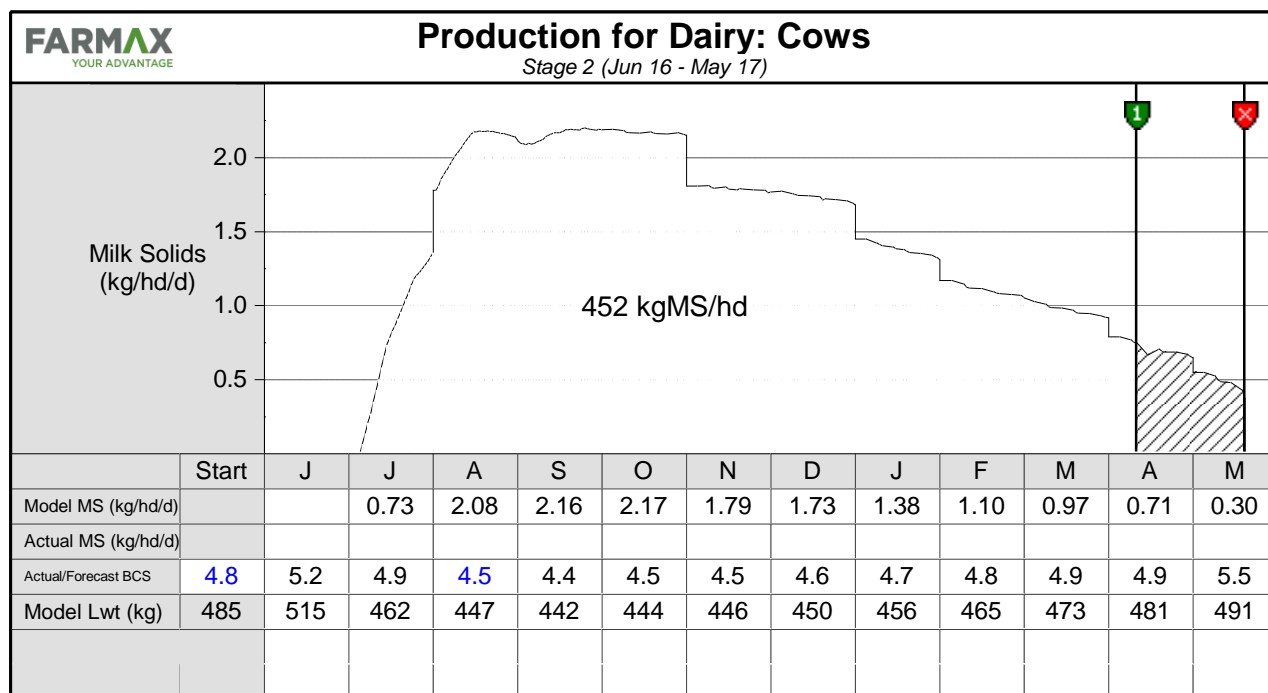
### 7.3 Status Quo – In-shed feed system

#### Farmax system modelling

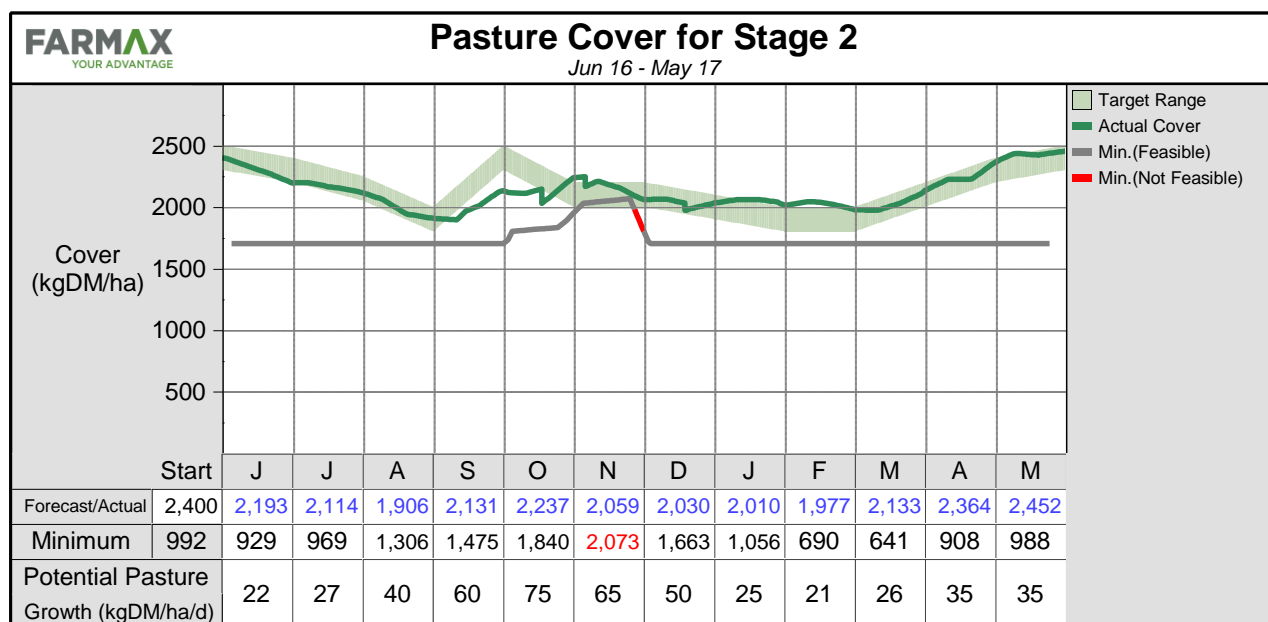
The major difference within this feed budget is the inclusion of PKE through the entire season. This reflects the use of the in-shed feed-system. One frequently discussed limitation of in shed feed systems is having to feed throughout the season even at small amounts to ensure cow flow isn't impacted.



The graph below illustrates the production curve with the cows peaking at an average of 2.17kgMS in October. With production modelled at over 2kgMS/cow for 3 months (a reflection of the feed offered) its unsurprising that average per cow production sits at 452kgMS/cow.



The graph below represents the modelled pasture cover throughout the season based on the pasture offered within the feed budget and predicted growth rates.



## Environmental Modelling: Overseer

The table below is the summary from the Overseer file. This shows modelled nitrogen leaching at 48kgN/ha and nitrogen conversion efficiency at 33%.

(Whole farm)	Units	Value	Benchmark
<b>Nutrient loss indices</b>			
Loss to water	kg N/ha/yr	48	24-42
	kg P/ha/yr	1.2	
includes loss from effluent pond of:	kg N/ha/yr	0	
	kg P/ha/yr	0.0	
<b>Production efficiency indices</b>			
Farm N surplus (pastoral)	kg N/ha/yr	181	123-191
N conversion efficiency (pastoral)	%	33	27-35
<b>Effluent: area of pastoral farm</b>			
Currently receiving effluent	ha	39	
Required to achieve application rate of 150 kg N/ha/yr	ha	28	
<b>Greenhouse gas emissions</b>			
Total greenhouse gas emissions	eCO <sub>2</sub> ha/year	17,237	

## Sensitivity analysis:

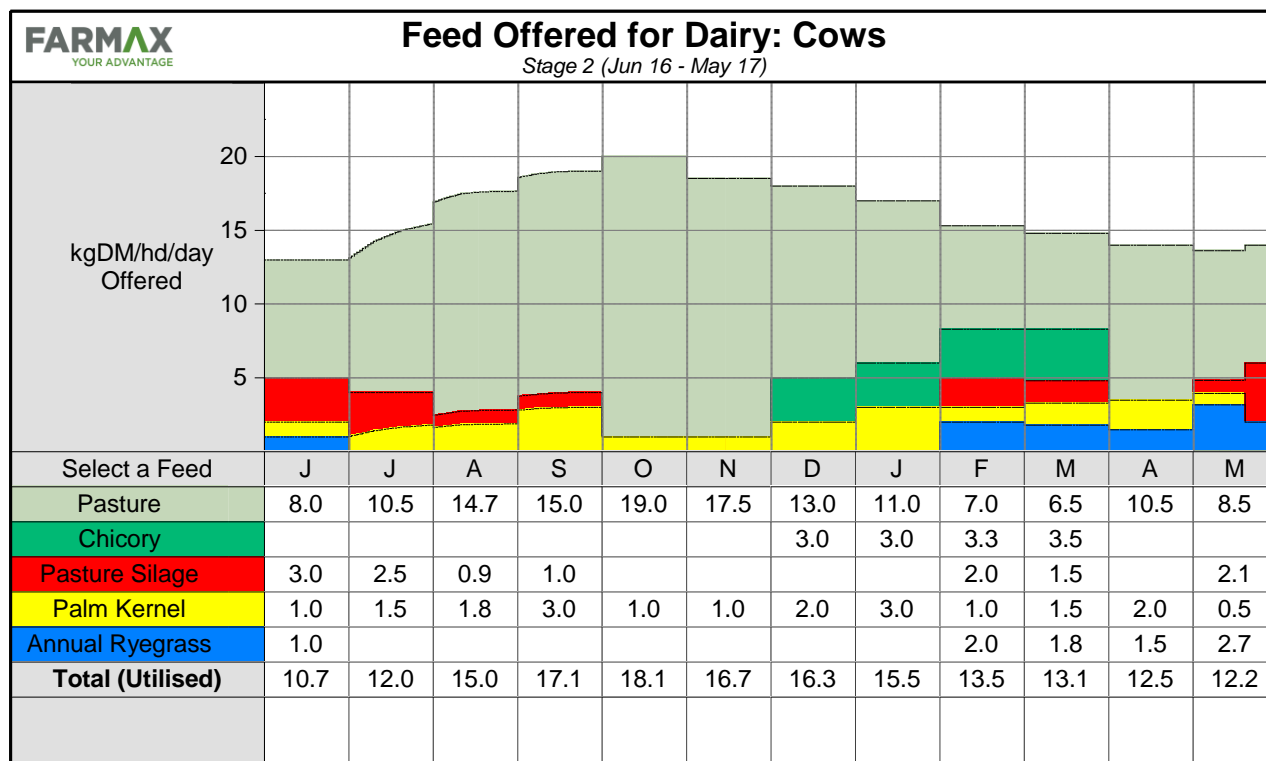
Both production and price sensitivity is shown below going up or down at 10% increments.

<b>PRODUCTION/PRICE SENSITIVITY</b>					
PRICE VARIANCE					\$0.58
PRODUCTION VARIANCE (KG's)					19936.4
	\$4.64	\$5.22	<b>\$5.80</b>	\$6.38	\$6.96
159491.2	-\$249,464	-\$156,959	-\$64,454	\$28,051	\$120,556
179427.6	-\$156,959	-\$52,891	\$51,177	\$155,245	\$259,313
<b>199364</b>	-\$64,454	\$51,177	<b>\$166,808</b>	\$282,439	\$398,070
219300.4	\$28,051	\$155,245	\$282,439	\$409,633	\$536,828
239236.8	\$120,556	\$259,313	\$398,070	\$536,828	\$675,585

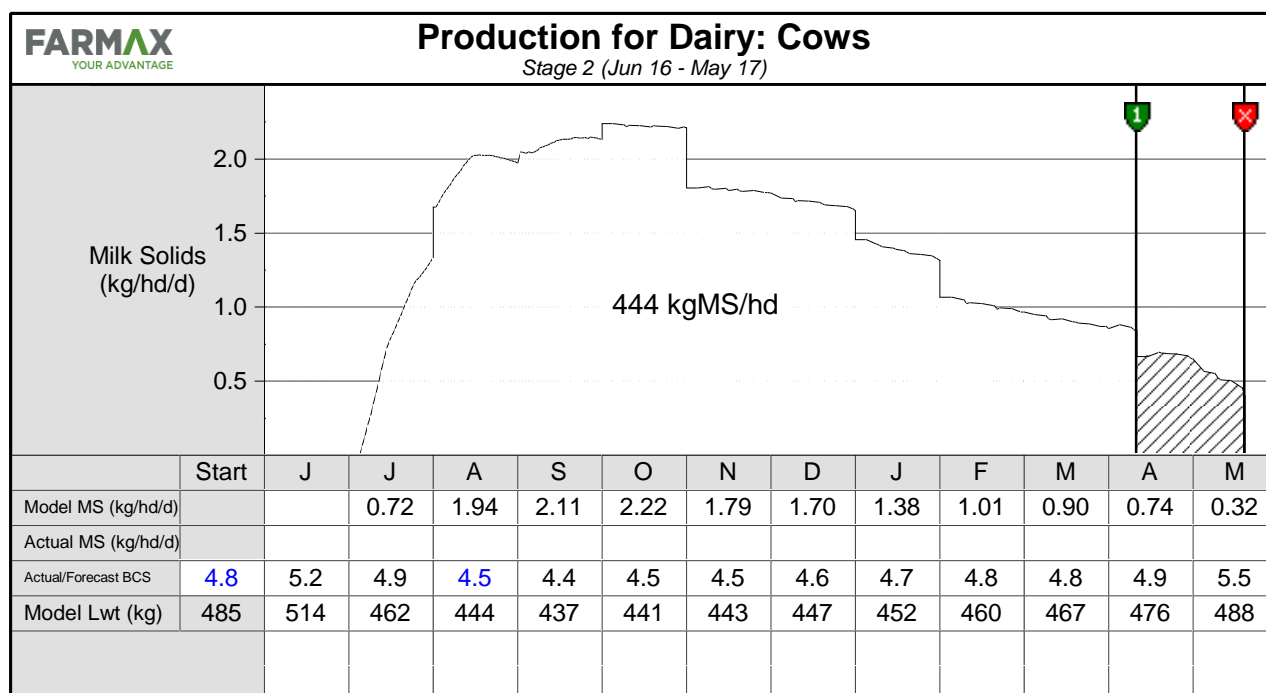
## 7.4 Status Quo - In-shed feed system with wintering off 100 late calving cows

### Farmax system modelling

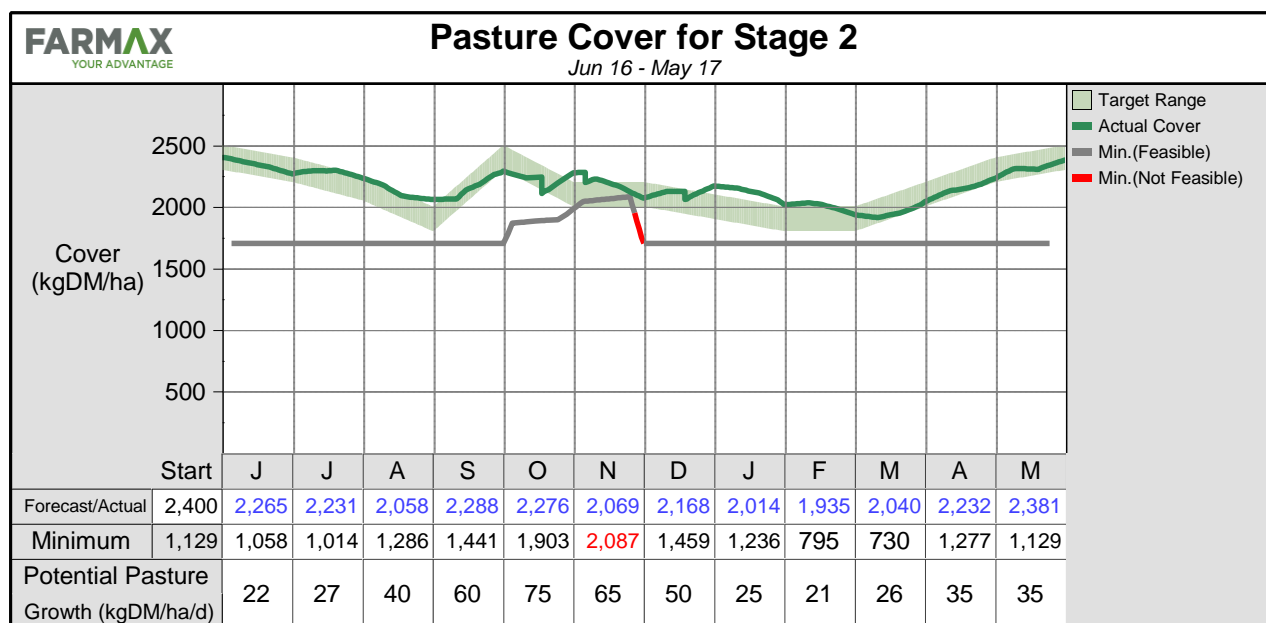
A similar feeding regime has once again been developed for this scenario only there is less demand over winter so more of the diet can consist of pasture and not purchased supplements.



The graph below illustrates the production curve with the cows peaking at an average of 2.22kgMS in October with an average production of 444kgMS/cow.



The graph below represents the modelled pasture cover throughout the season based on the pasture offered within the feed budget and predicted growth rates.



## Environmental Modelling: Overseer

The table below is the summary from the Overseer file. This shows modelled nitrogen leaching at 45kgN/ha and nitrogen conversion efficiency at 34%.

(Whole farm)	Units	Value	Benchmark
<b>Nutrient loss indices</b>			
Loss to water	kg N/ha/yr	45	24-42
	kg P/ha/yr	1.2	
includes loss from effluent pond of:	kg N/ha/yr	0	
	kg P/ha/yr	0.0	
<b>Production efficiency indices</b>			
Farm N surplus (pastoral)	kg N/ha/yr	172	123-191
N conversion efficiency (pastoral)	%	34	27-35
<b>Effluent: area of pastoral farm</b>			
Currently receiving effluent	ha	39	
Required to achieve application rate of 150 kg N/ha/yr	ha	26	
<b>Greenhouse gas emissions</b>			
Total greenhouse gas emissions	eCO <sub>2</sub> ha/year	16,568	

### Sensitivity analysis:

Both production and price sensitivity is shown below going up or down at 10% increments.

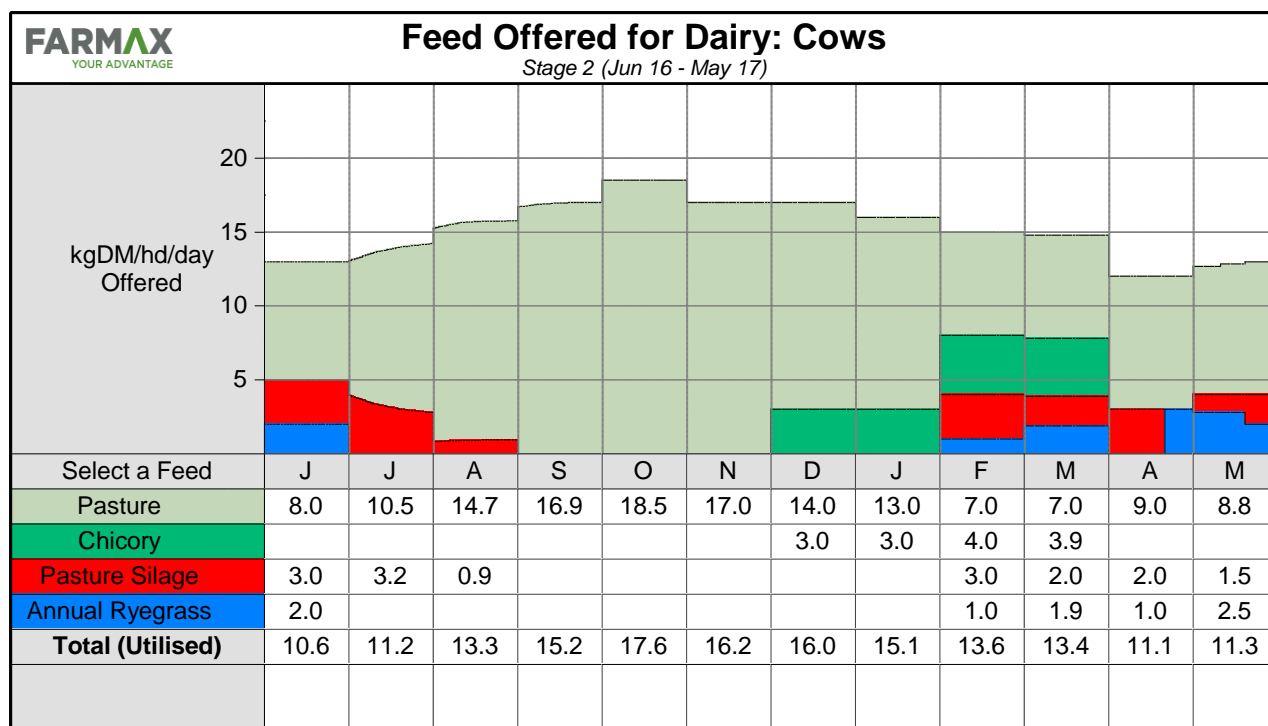
<b>PRODUCTION/PRICE SENSITIVITY</b>					
PRICE VARIANCE					\$0.58
PRODUCTION VARIANCE (KG's)					19557.5
	\$4.64	\$5.22	<b>\$5.80</b>	\$6.38	\$6.96
156460	-\$252,786	-\$162,039	-\$71,292	\$19,455	\$110,202
176017.5	-\$162,039	-\$59,949	\$42,142	\$144,232	\$246,322
<b>195575</b>	-\$71,292	\$42,142	<b>\$155,575</b>	\$269,009	\$382,442
215132.5	\$19,455	\$144,232	\$269,009	\$393,785	\$518,562
234690	\$110,202	\$246,322	\$382,442	\$518,562	\$654,682



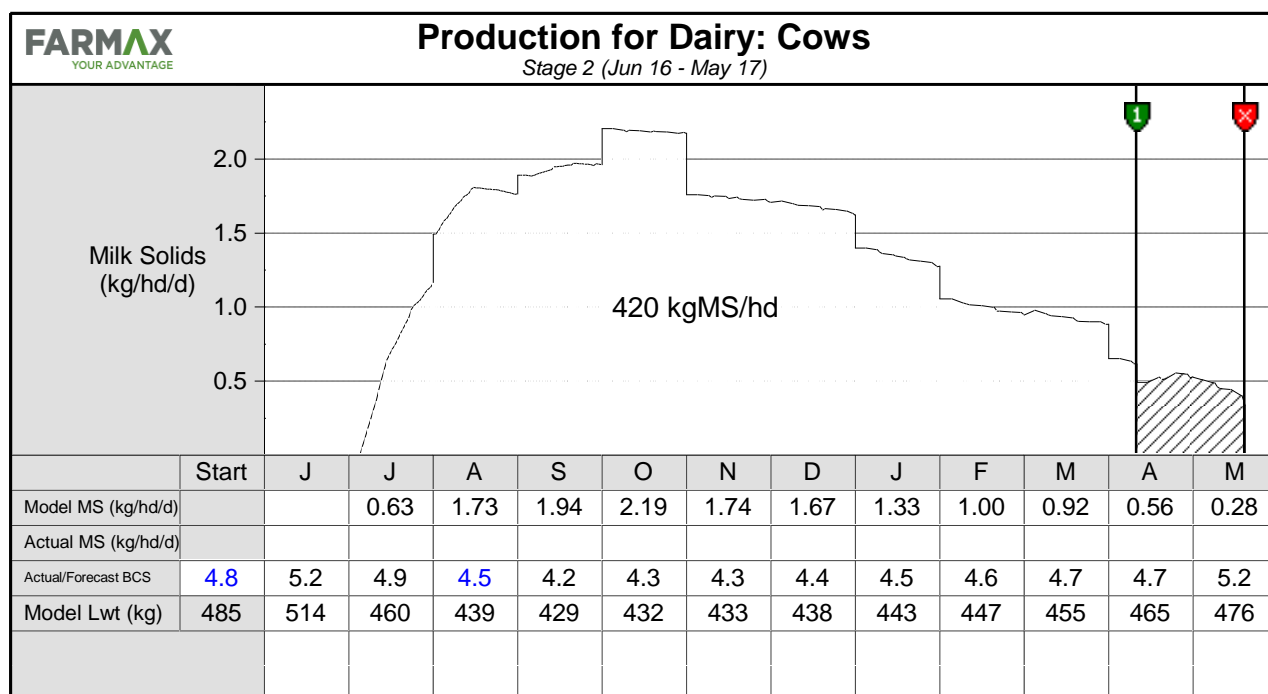
## 7.5 2.7 cow/ha stocking rate – No imported feeds

### Farmax system modelling

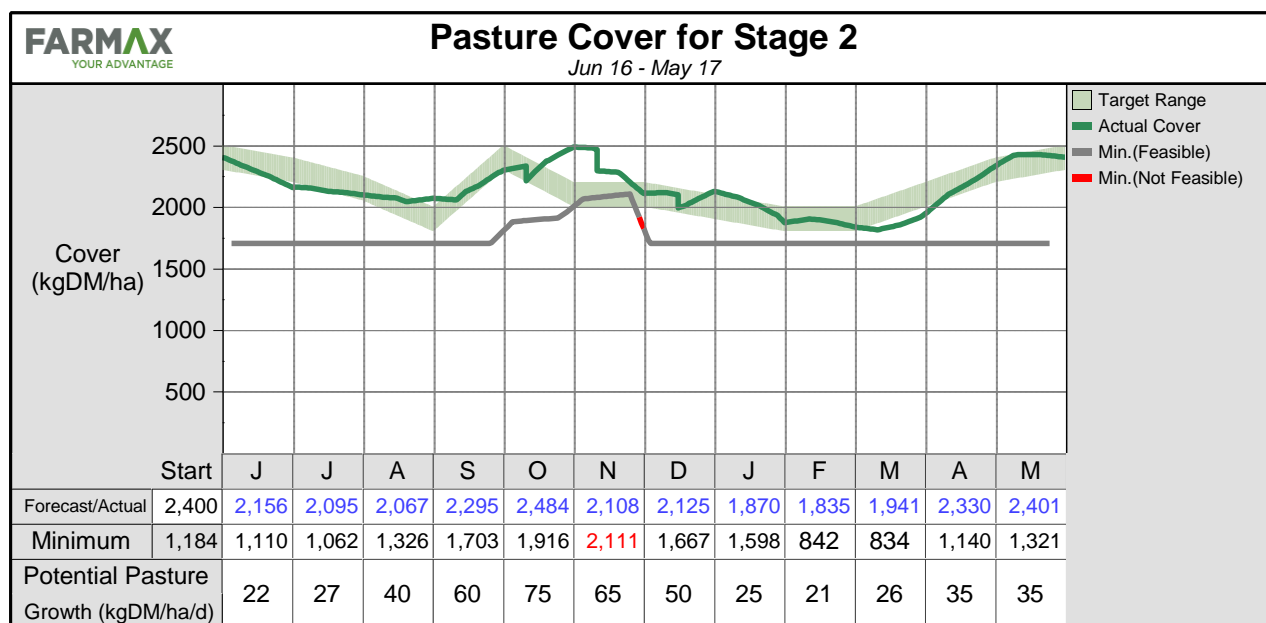
The below feed budget includes only home grown feed with no imported supplements. Peak intakes are therefore not as high as they have been within previous scenarios.



The graph below illustrates the production curve with the cows peaking at an average of 2.19kgMS in October with an average annual production of 420kgMS/cow.



The graph below represents the modelled pasture cover throughout the season based on the pasture offered within the feed budget and predicted growth rates.



## Environmental Modelling: Overseer

The table below is the summary from the Overseer file. This shows modelled nitrogen leaching at 43kgN/ha which reflects the lower stocking.

(Whole farm)	Units	Value	Benchmark
<b>Nutrient loss indices</b>			
Loss to water	kg N/ha/yr	43	24-42
	kg P/ha/yr	1.1	
includes loss from effluent pond of:	kg N/ha/yr	0	
	kg P/ha/yr	0.0	
<b>Production efficiency indices</b>			
Farm N surplus (pastoral)	kg N/ha/yr	155	123-191
N conversion efficiency (pastoral)	%	34	27-35
<b>Effluent: area of pastoral farm</b>			
Currently receiving effluent	ha	39	
Required to achieve application rate of 150 kg N/ha/yr	ha	22	
<b>Greenhouse gas emissions</b>			
Total greenhouse gas emissions	eCO <sub>2</sub> ha/year	15,323	

### Sensitivity analysis:

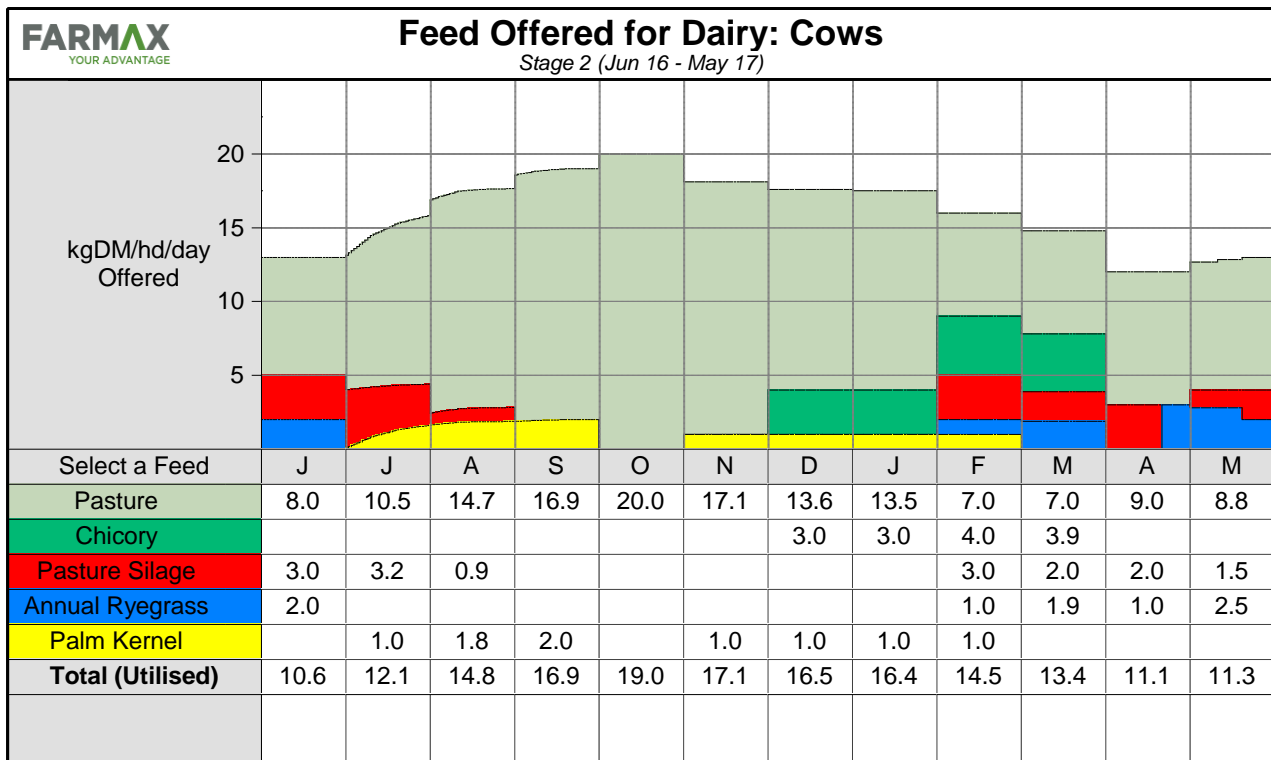
Both production and price sensitivity is shown below going up or down at 10% increments.

<b>PRODUCTION/PRICE SENSITIVITY</b>					
PRICE VARIANCE					\$0.58
PRODUCTION VARIANCE (KG's)					17100.2
	\$4.64	\$5.22	<b>\$5.80</b>	\$6.38	\$6.96
136801.6	-\$245,392	-\$166,047	-\$86,702	-\$7,357	\$71,988
153901.8	-\$166,047	-\$76,784	\$12,479	\$101,742	\$191,005
<b>171002</b>	-\$86,702	\$12,479	<b>\$111,660</b>	\$210,841	\$310,022
188102.2	-\$7,357	\$101,742	\$210,841	\$319,940	\$429,040
205202.4	\$71,988	\$191,005	\$310,022	\$429,040	\$548,057

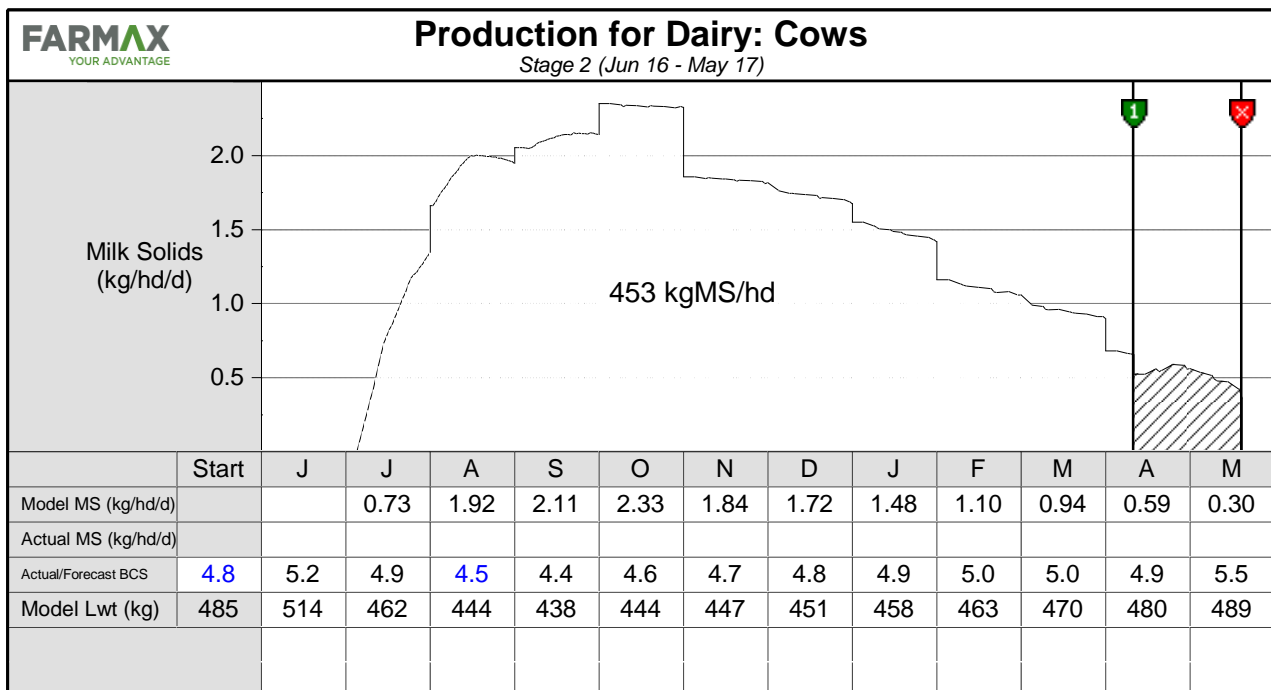
## 7.6 2.7 cows/ha stocking rate - Production optimised with PKE

### Farmax system modelling

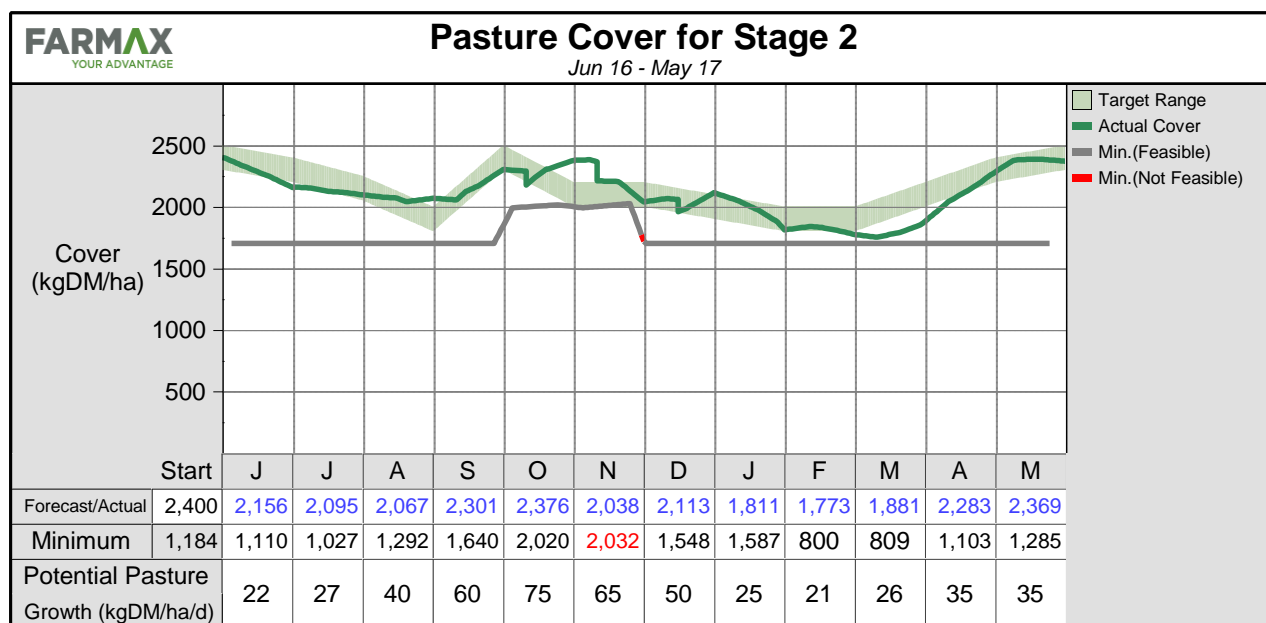
This is essentially the same feed budget that was used for the previous model, the difference being this model optimises production based on including imported supplements.



The graph below illustrates the production curve with the cows peaking at an average of 2.33kgMS in October with an average production of 453kgMS/cow.



The graph below represents the modelled pasture cover throughout the season based on the pasture offered within the feed budget and predicted growth rates.



## Environmental Modelling: Overseer

The table below is the summary from the Overseer file. This shows modelled nitrogen leaching at 44kgN/ha which reflects the lower stocking rate.

(Whole farm)	Units	Value	Benchmark
<b>Nutrient loss indices</b>			
Loss to water	kg N/ha/yr	44	24-42
	kg P/ha/yr	1.1	
includes loss from effluent pond of:	kg N/ha/yr	0	
	kg P/ha/yr	0.0	
<b>Production efficiency indices</b>			
Farm N surplus (pastoral)	kg N/ha/yr	163	123-191
N conversion efficiency (pastoral)	%	34	27-35
<b>Effluent: area of pastoral farm</b>			
Currently receiving effluent	ha	39	
Required to achieve application rate of 150 kg N/ha/yr	ha	22	
<b>Greenhouse gas emissions</b>			
Total greenhouse gas emissions	eCO <sub>2</sub> ha/year	15,845	

### Sensitivity analysis:

Both production and price sensitivity is shown below going up or down at 10% increments.

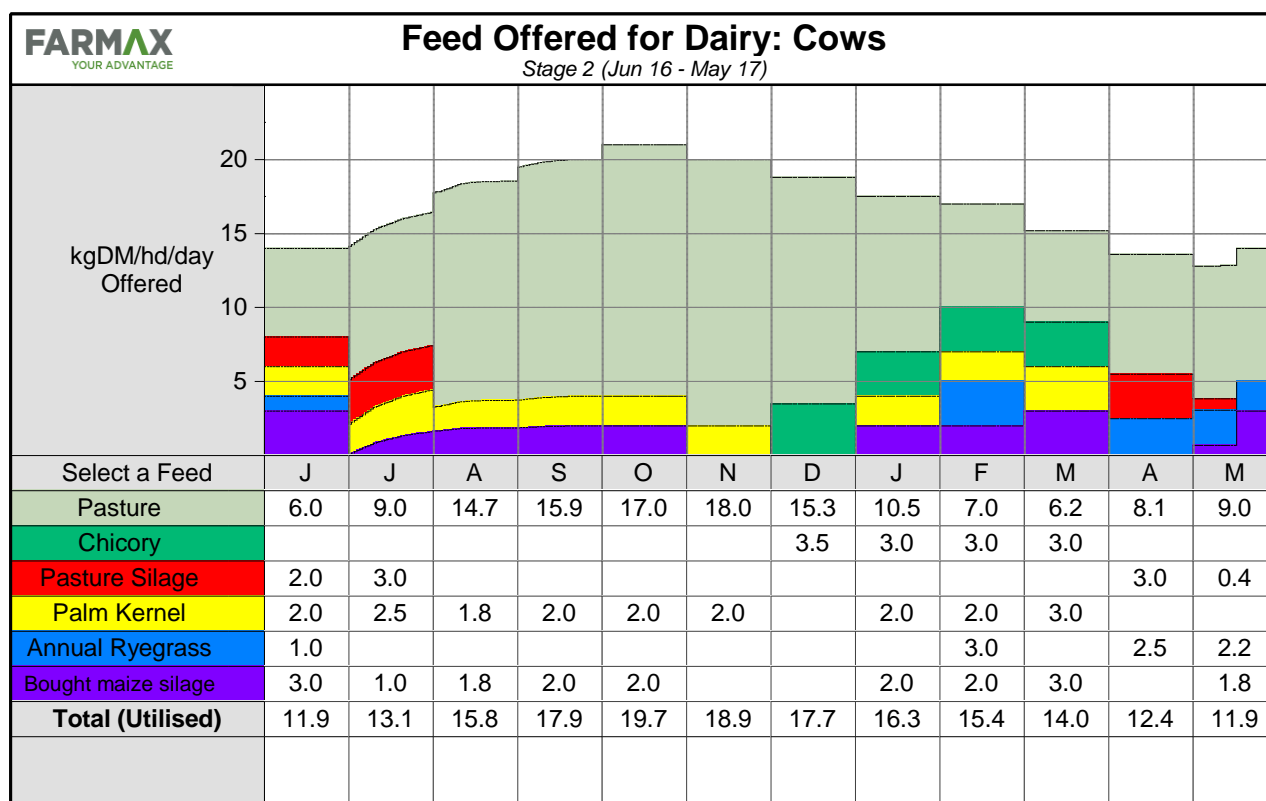
<b>PRODUCTION/PRICE SENSITIVITY</b>					
PRICE VARIANCE					\$0.58
PRODUCTION VARIANCE (KG's)					18444
	\$4.64	\$5.22	<b>\$5.80</b>	\$6.38	\$6.96
147552	-\$225,750	-\$140,170	-\$54,589	\$30,991	\$116,571
165996	-\$140,170	-\$43,892	\$52,386	\$148,663	\$244,941
<b>184440</b>	-\$54,589	\$52,386	<b>\$159,361</b>	\$266,336	\$373,311
202884	\$30,991	\$148,663	\$266,336	\$384,009	\$501,682
221328	\$116,571	\$244,941	\$373,311	\$501,682	\$630,052



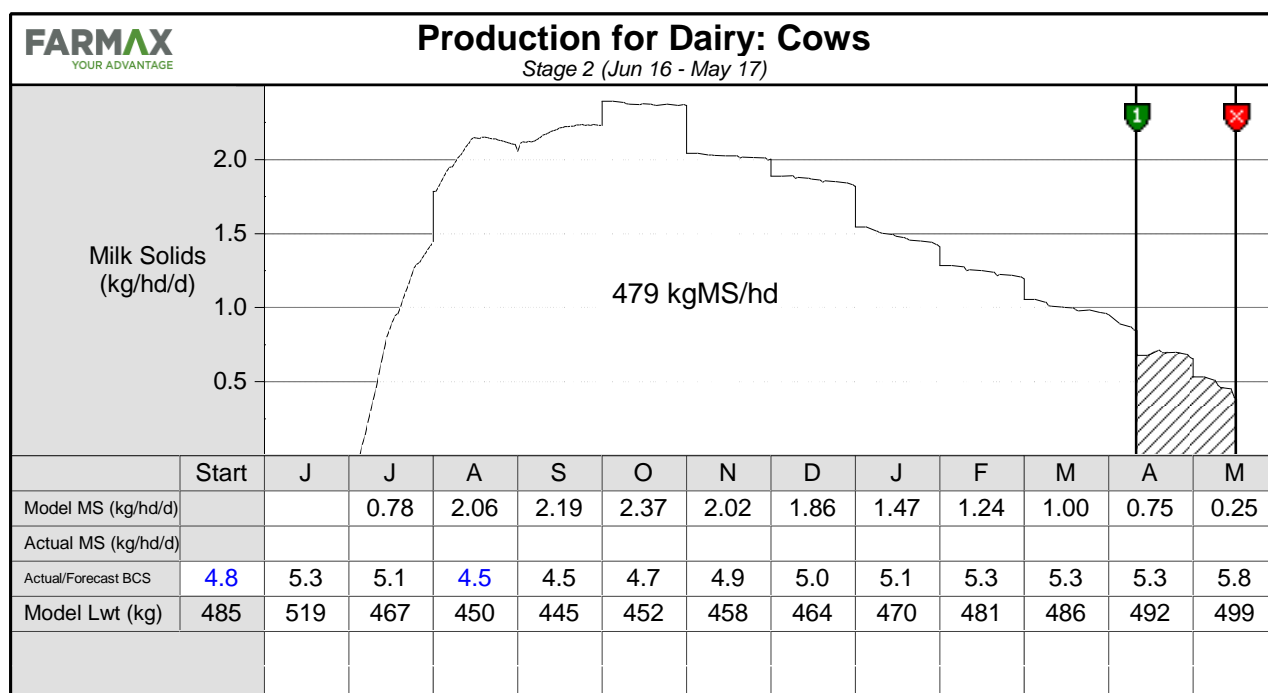
## 7.7 Seasonal (spring calving) Feed Pad – Stocking rate of 3

### Farmax system modelling

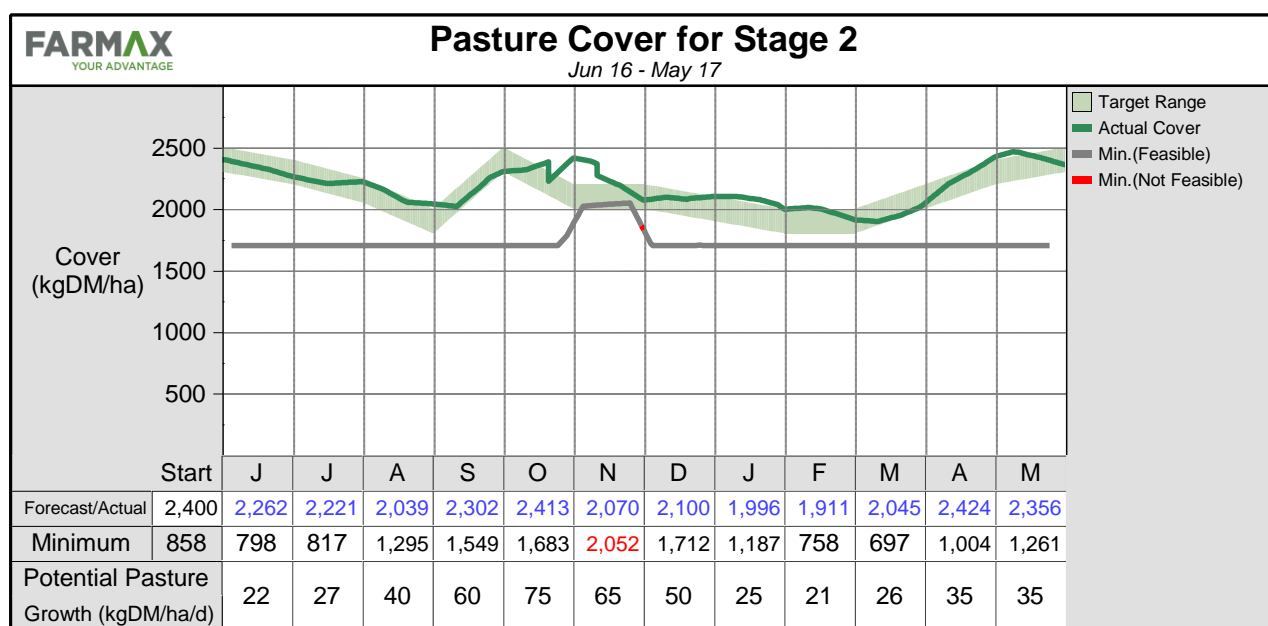
The feed budget shown below reflects a much higher input than those outlined previously. At peak over 20kgDM/cow is being offered. Both maize and PKE have been purchased with the intention of being feed on the pad, this has also significantly improved the feed utilisation. Chicory remains part of the equation for the seasonal milking scenario.



At an average production of 479kgMS/cow this model reflects the higher feed inputs as well as improved utilisation of feed offered. Modelled production remains over 2kgMS/cow for 4 months with a potential average peak as high as 2.37kgMS/cow in October.



The graph below represents the modelled pasture cover throughout the season based on the pasture offered within the feed budget and predicted growth rates.



## Environmental Modelling: Overseer

The table below is the summary from the Overseer file. This shows modelled nitrogen leaching at 50kgN/ha which reflects an increase in imported supplement and higher stocking rate.

(Whole farm)	Units	Value	Benchmark
<b>Nutrient loss indices</b>			
Loss to water	kg N/ha/yr	50	24-42
	kg P/ha/yr	1.2	
includes loss from effluent pond of:	kg N/ha/yr	0	
	kg P/ha/yr	0.0	
<b>Production efficiency indices</b>			
Farm N surplus (pastoral)	kg N/ha/yr	176	123-191
N conversion efficiency (pastoral)	%	35	27-35
<b>Effluent: area of pastoral farm</b>			
Currently receiving effluent	ha	39	
Required to achieve application rate of 150 kg N/ha/yr	ha	41	
<b>Greenhouse gas emissions</b>			
Total greenhouse gas emissions	eCO <sub>2</sub> ha/year	17,178	

## Sensitivity analysis:

Both production and price sensitivity is shown below going up or down at 10% increments.

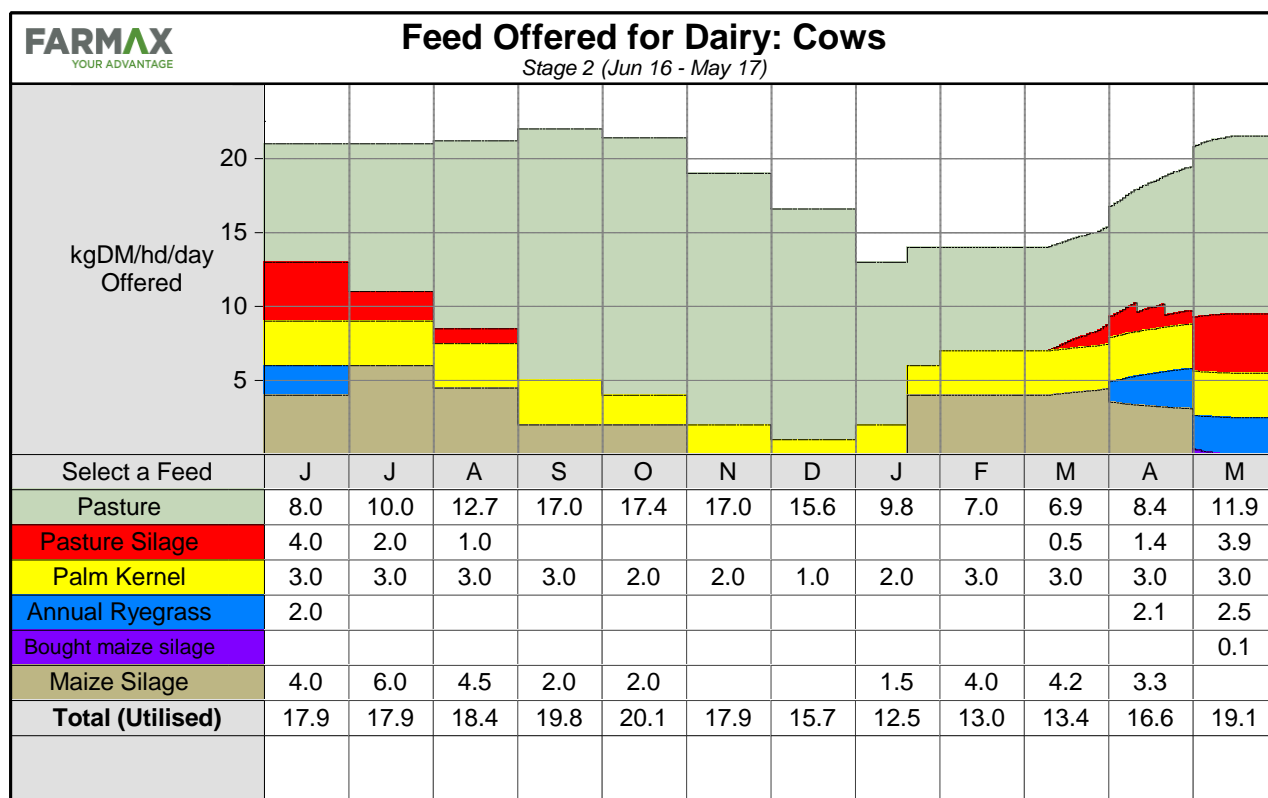
<b>PRODUCTION/PRICE SENSITIVITY</b>					
PRICE VARIANCE					\$0.58
PRODUCTION VARIANCE (KG's)					21117.1
	\$4.64	\$5.22	<b>\$5.80</b>	\$6.38	\$6.96
168936.8	-\$262,215	-\$164,232	-\$66,248	\$31,735	\$129,718
190053.9	-\$164,232	-\$54,000	\$56,231	\$166,462	\$276,693
<b>211171</b>	-\$66,248	\$56,231	<b>\$178,710</b>	\$301,189	\$423,668
232288.1	\$31,735	\$166,462	\$301,189	\$435,916	\$570,643
253405.2	\$129,718	\$276,693	\$423,668	\$570,643	\$717,618

## 7.8 Split calving (40% autumn/60% spring calving) Feed Pad – Stocking rate of 3

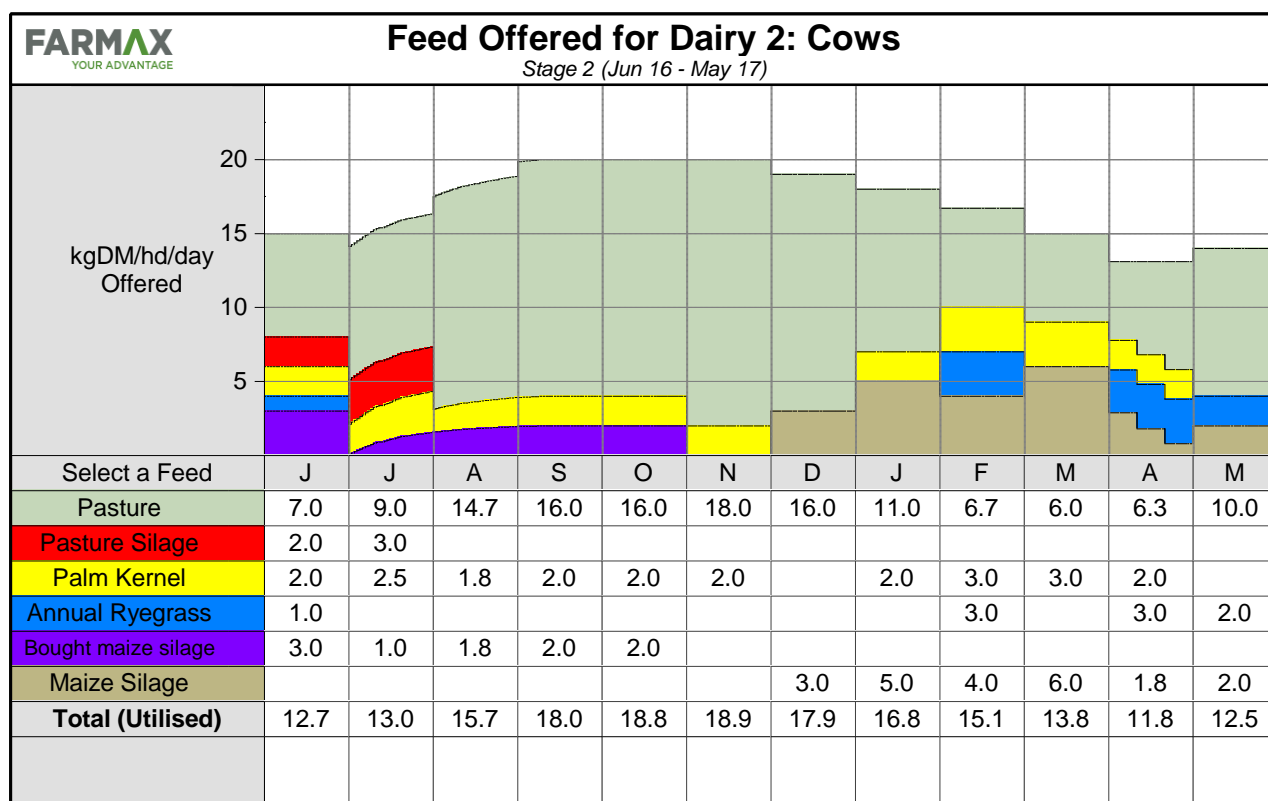
### Farmax system modelling

To model this system within Farmax there must be two separate herds meaning there are two separate feed budgets and production curves, the pasture curve however still works off both herds as it reflects the farm's overall pasture position.

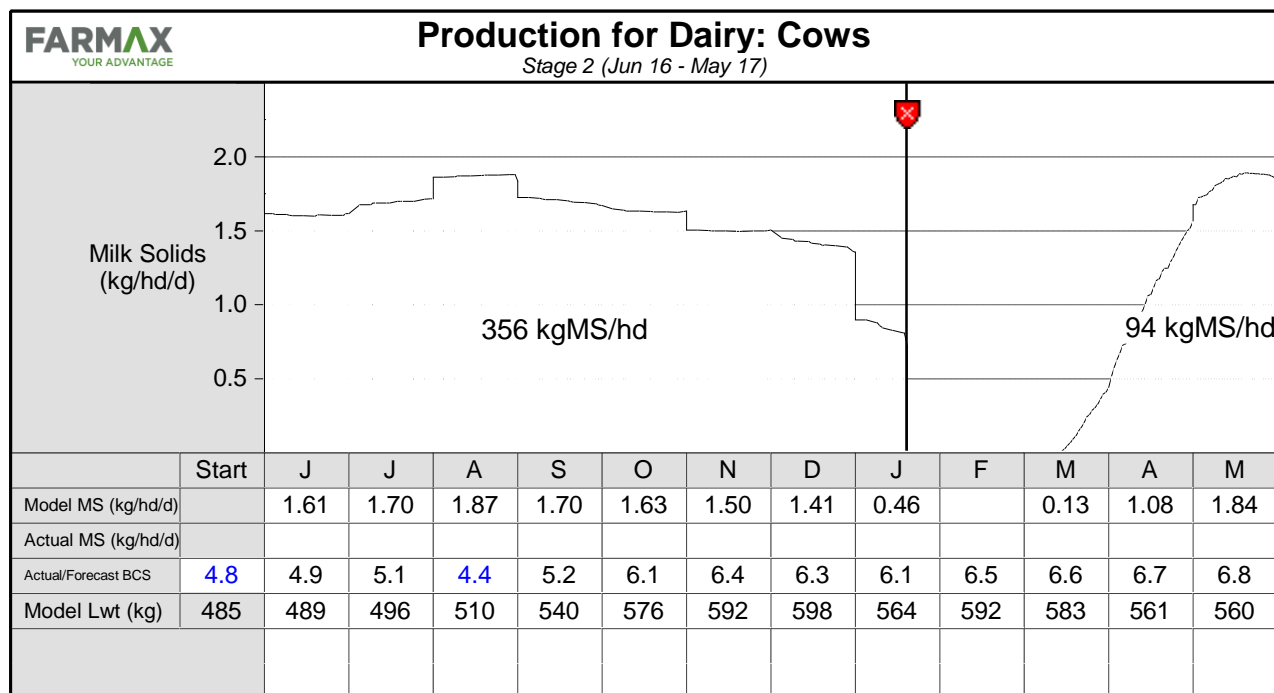
The feed budget shown below reflects the autumn calving herd (winter milking) only. This demonstrates a heavy reliance on purchased feed in winter as demand is higher. For this scenario the home grown chicory has been replaced by home grown maize due to the higher per hectare yield and ability to keep supplement costs low.



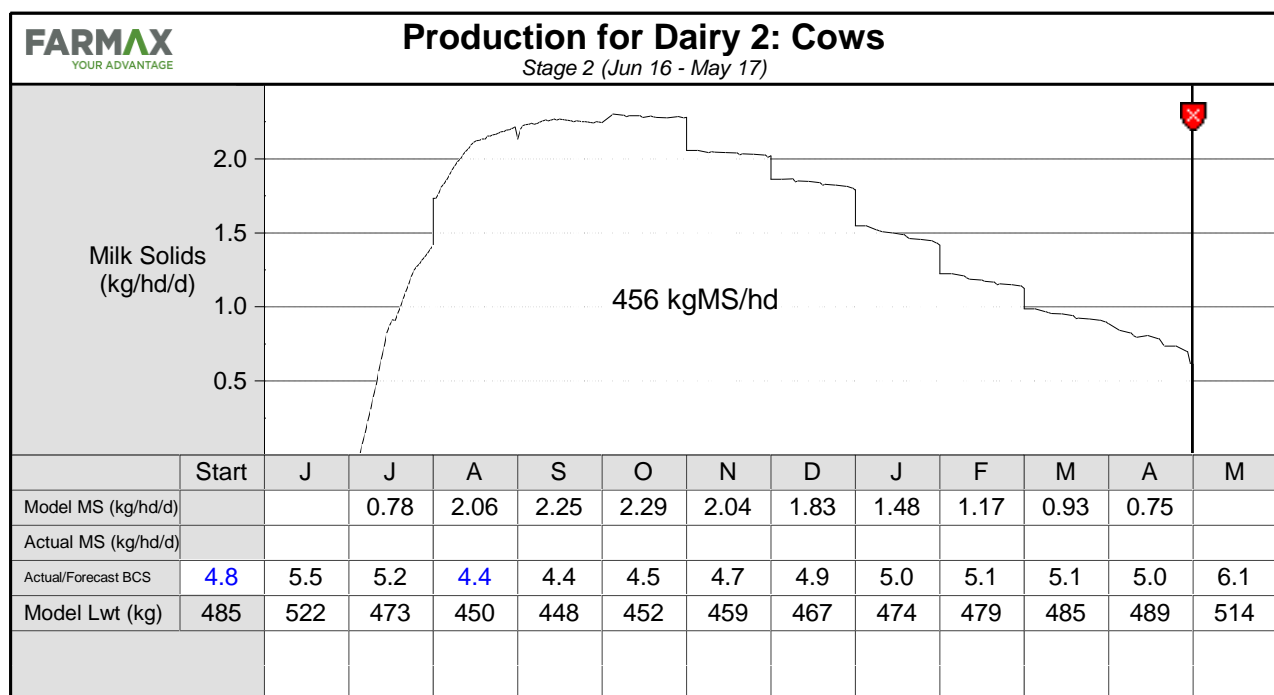
The feed budget below reflects the spring calving mob. This is reflective of the previous feed budget scenario where the entire herd was spring calving.



The production curve below reflects the winter milking herd. This is where the results can be somewhat questionable. With intakes over 20kgDM in June and July you would expect per cow production to be in excess of 1.6-1.7kgMS/cow. By the time the cows reach August/September given theoretically they would have passed peak production the modelled production is more realistic. This still reflects a seasonal production of 450kgMS/cow, which could potentially be closer to 470-480kgMS which in turn could increase operating profit by approximated 5%.

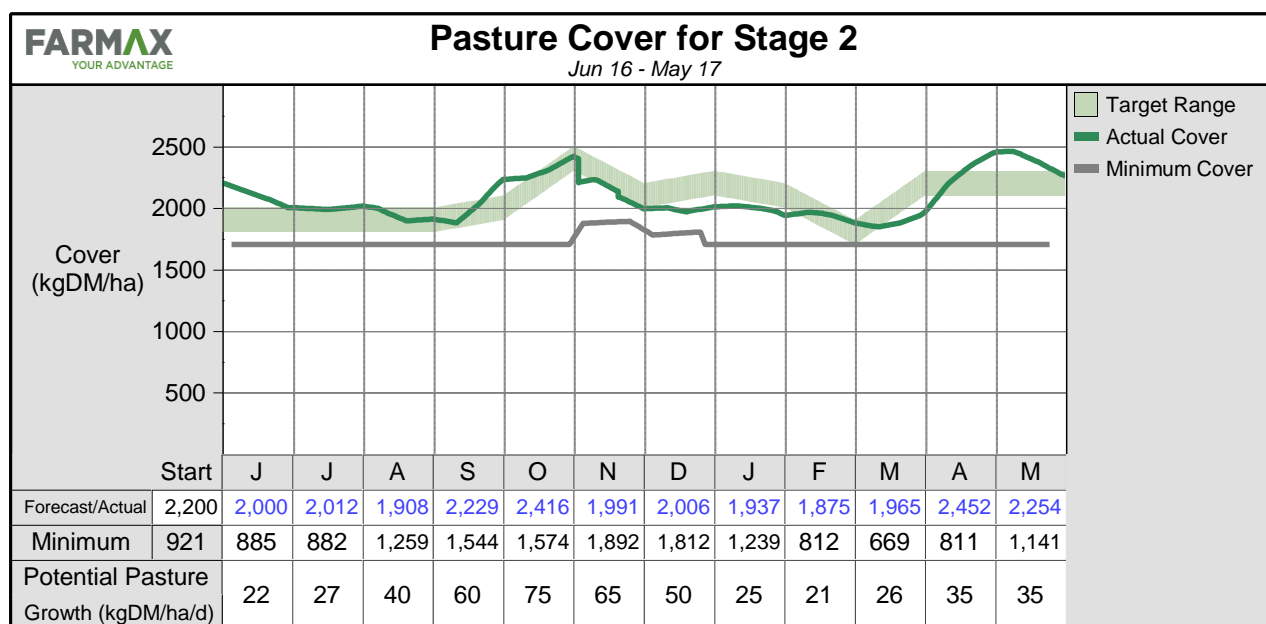


The production curve below reflects the more common seasonal milk production curve from the spring calving herd.





The graph below represents the modelled pasture cover throughout the season based on the pasture offered within the feed budget and predicted growth rates.



## Environmental Modelling: Overseer

The table below is the summary from the Overseer file built to model this farm system. This shows modelled nitrogen leaching at 53kgN/ha which reflects an increase in purchased supplement as well as milk one herd through winter. At 53kgN/ha this farm system looks to be significantly higher than our predicted nitrogen reference point.

(Whole farm)	Units	Value	Benchmark
<b>Nutrient loss indices</b>			
Loss to water	kg N/ha/yr	53	24-42
	kg P/ha/yr	1.2	
includes loss from effluent pond of:	kg N/ha/yr	0	
	kg P/ha/yr	0.0	
<b>Production efficiency indices</b>			
Farm N surplus (pastoral)	kg N/ha/yr	159	123-191
N conversion efficiency (pastoral)	%	37	27-35
<b>Effluent: area of pastoral farm</b>			
Currently receiving effluent	ha	39	
Required to achieve application rate of 150 kg N/ha/yr	ha	42	
<b>Greenhouse gas emissions</b>			
Total greenhouse gas emissions	eCO <sub>2</sub> ha/year	16,629	

### Sensitivity analysis:

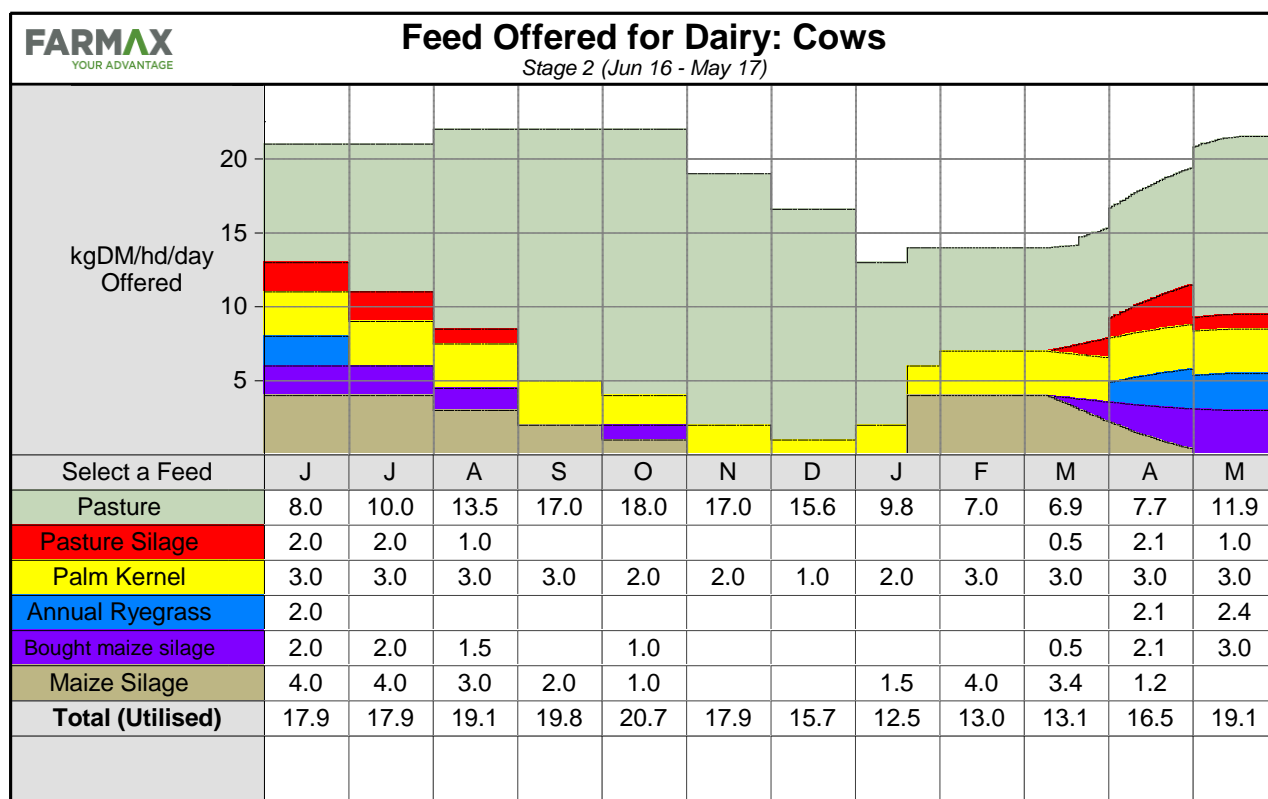
Both production and price sensitivity is shown below going up or down at 10% increments.

<b>PRODUCTION/PRICE SENSITIVITY</b>					
PRICE VARIANCE					\$0.58
PRODUCTION VARIANCE (KG's)					20315.1
	\$4.64	\$5.22	<b>\$5.80</b>	\$6.38	\$6.96
162520.8	-\$261,598	-\$167,336	-\$73,074	\$21,188	\$115,450
182835.9	-\$167,336	-\$61,291	\$44,753	\$150,798	\$256,843
<b>203151</b>	-\$73,074	\$44,753	<b>\$162,581</b>	\$280,409	\$398,236
223466.1	\$21,188	\$150,798	\$280,409	\$410,019	\$539,629
243781.2	\$115,450	\$256,843	\$398,236	\$539,629	\$681,022

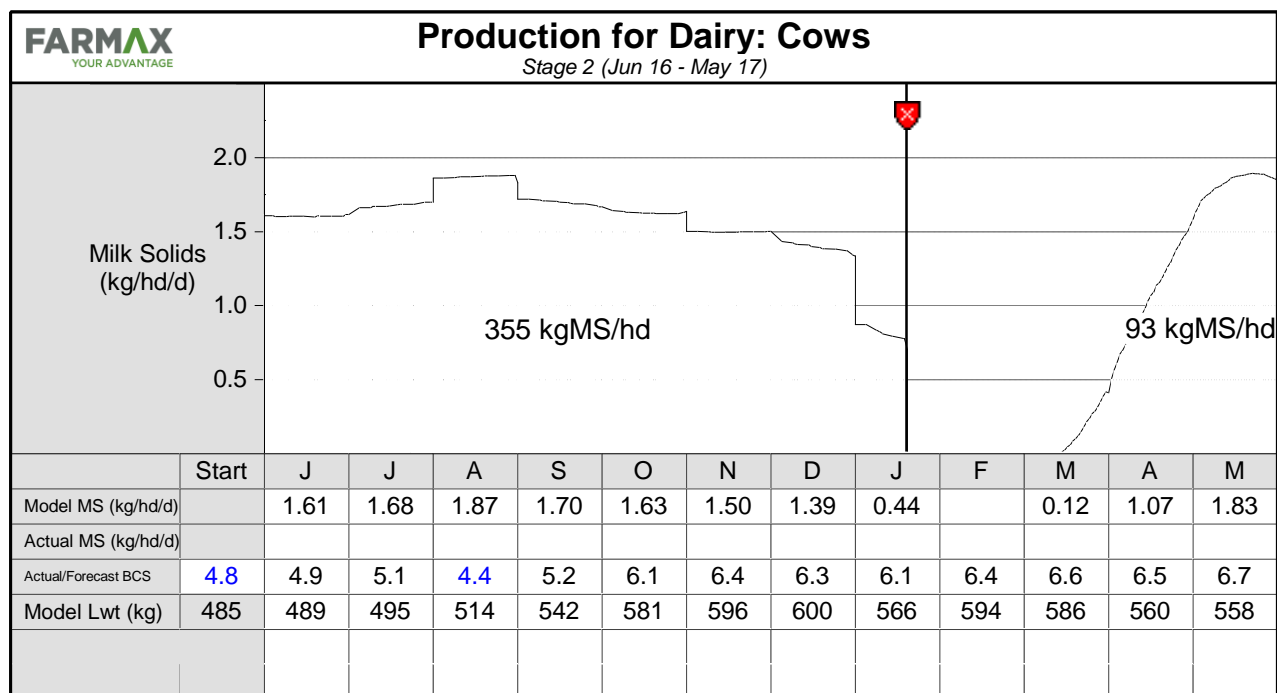
## 7.9 Winter milking Feed Pad (100% autumn calving) – Stocking rate of 3

### Farmax system modelling

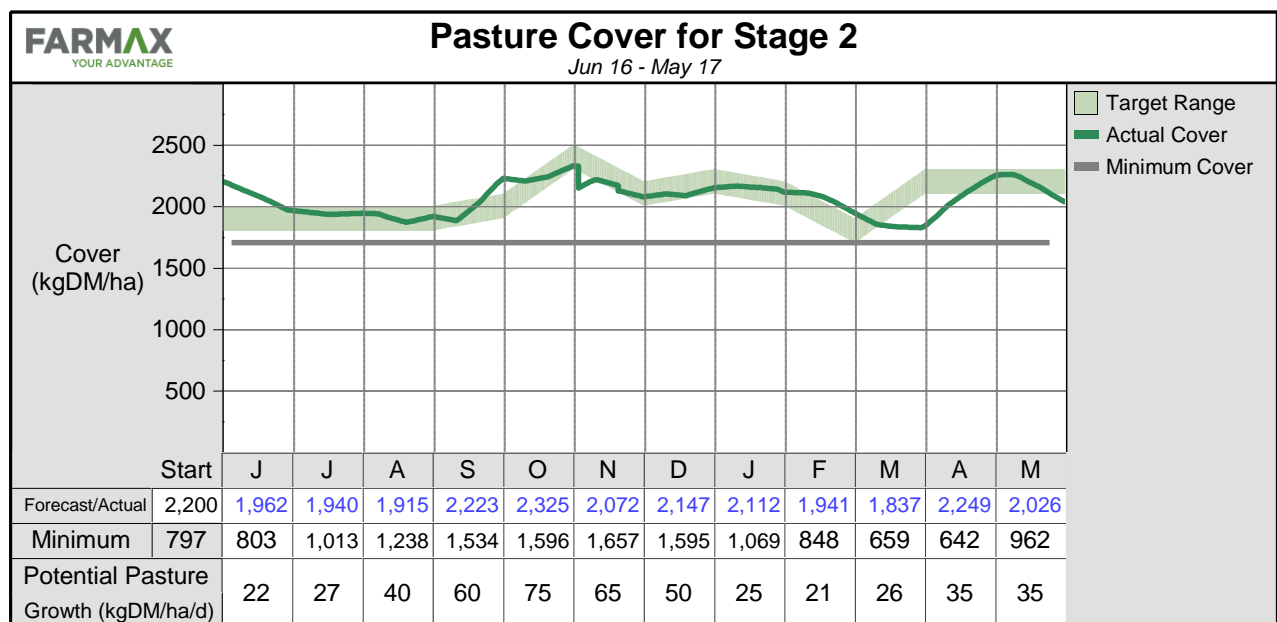
The feed budget shown below reflects the winter milk diet with a heavy use of supplements over the winter months.



The production curve below represents a total milk production of 453kgMS/cow. Once again there are limitations in modelling the winter milk production. Given the nitrogen leaching is so high its unlikely this is a viable option so further consideration to that hasn't occurred at this stage.



The graph below represents the modelled pasture cover throughout the season based on the pasture offered within the feed budget and predicted growth rates.



## Environmental Modelling: Overseer

The table below is the summary from the Overseer file built to model this farm system. This shows modelled nitrogen leaching at 57kgN/ha which reflects an increase in purchased supplement as well as winter milking. At 57kgN/ha this farm system looks to be significantly higher than our predicted nitrogen reference point.

(Whole farm)	Units	Value	Benchmark
<b>Nutrient loss indices</b>			
Loss to water	kg N/ha/yr	57	24-42
	kg P/ha/yr	1.2	
includes loss from effluent pond of:	kg N/ha/yr	0	
	kg P/ha/yr	0.0	
<b>Production efficiency indices</b>			
Farm N surplus (pastoral)	kg N/ha/yr	183	123-191
N conversion efficiency (pastoral)	%	34	27-35
<b>Effluent: area of pastoral farm</b>			
Currently receiving effluent	ha	56	
Required to achieve application rate of 150 kg N/ha/yr	ha	39	
<b>Greenhouse gas emissions</b>			
Total greenhouse gas emissions	eCO <sub>2</sub> ha/year	18,267	

## Sensitivity analysis:

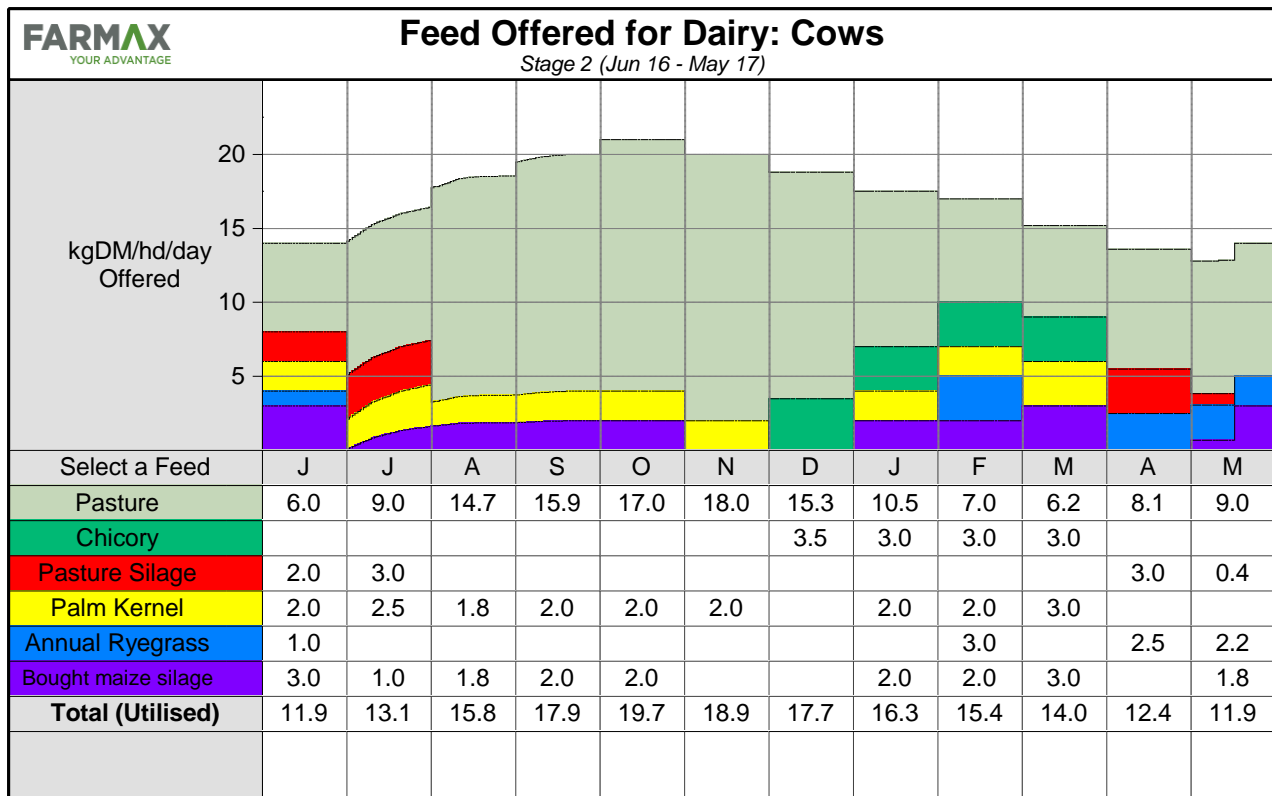
Both production and price sensitivity is illustrated below going up or down at 10% increments.

<b>PRODUCTION/PRICE SENSITIVITY</b>					
<b>PRICE VARIANCE</b>					<b>\$0.58</b>
<b>PRODUCTION VARIANCE (KG's)</b>					<b>20500</b>
	<b>\$4.64</b>	<b>\$5.22</b>	<b>\$5.80</b>	<b>\$6.38</b>	<b>\$6.96</b>
164000	-\$253,353	-\$158,233	-\$63,113	\$32,007	\$127,127
184500	-\$158,233	-\$51,223	\$55,787	\$162,797	\$269,807
<b>205000</b>	-\$63,113	\$55,787	<b>\$174,687</b>	\$293,587	\$412,487
225500	\$32,007	\$162,797	\$293,587	\$424,377	\$555,167
246000	\$127,127	\$269,807	\$412,487	\$555,167	\$697,847

## 7.10 Seasonal (spring calving) Herd Home – Stocking rate of 3

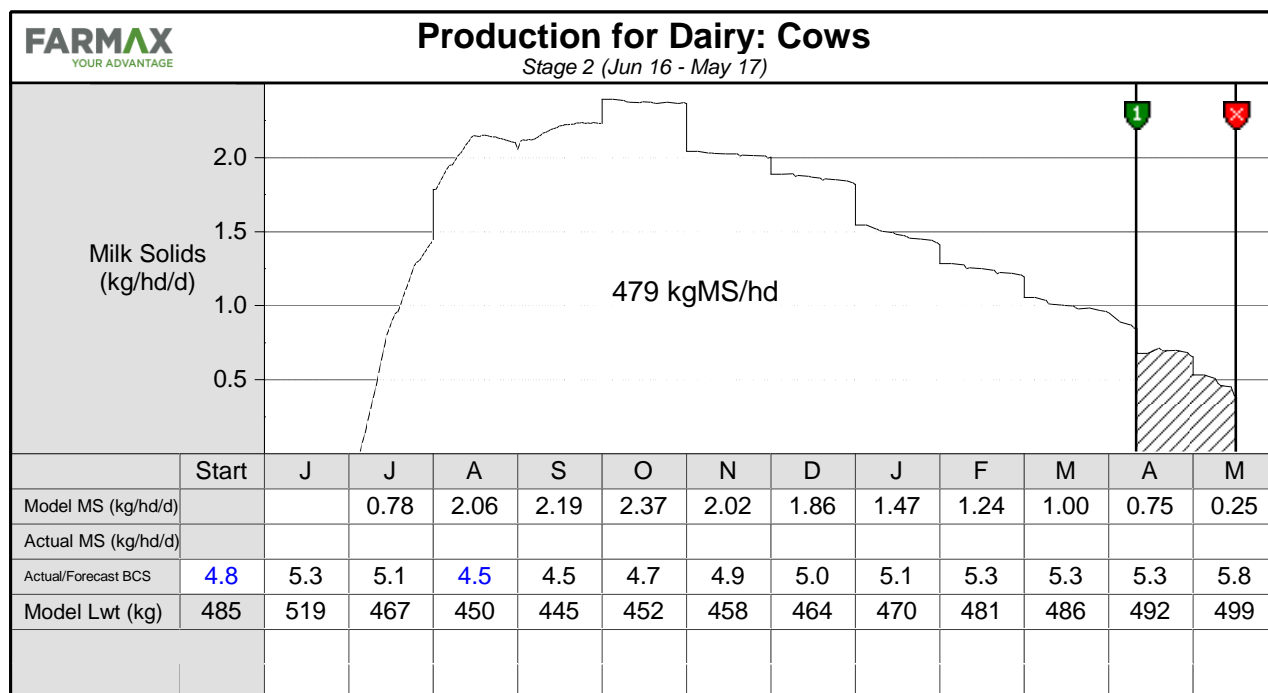
### Farmax system modelling

As mentioned the feed budget for the herd home mirrors that of the seasonal feed pad with a stocking rate of 3 cows per hectare.

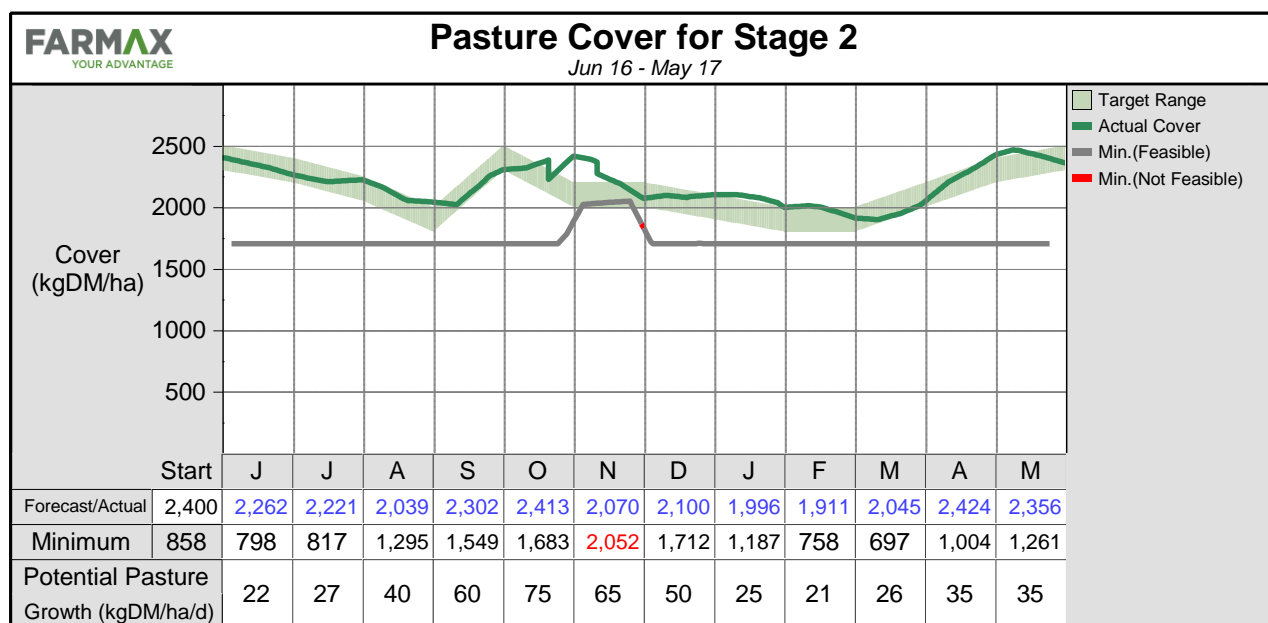




The production curve below also represents a mirror of the seasonal feed pads production curve. The respective feed budget demonstrates a modelled peak production of 2.37kgMS/cow lending towards a per cow average of 479kgMS/cow – this is close to 100% of liveweight production.



The graph below represents the modelled pasture cover throughout the season based on the pasture offered within the feed budget and predicted growth rates. The strategic use of a herd home in standing cows off when pastures are wet would likely increase the total pasture yield. In terms of the modelling exercise this assumption hasn't been included.



## Environmental Modelling: Overseer

The table below is the summary from the Overseer file built to model this farm system. This is significantly lower than the similarly stocked feed pads and reflects having cows off pasture for longer durations and redistributing that nutrient more evenly.

(Whole farm)	Units	Value	Benchmark
<b>Nutrient loss indices</b>			
Loss to water	kg N/ha/yr	42	24-42
	kg P/ha/yr	1.2	
includes loss from effluent pond of:	kg N/ha/yr	0	
	kg P/ha/yr	0.0	
<b>Production efficiency indices</b>			
Farm N surplus (pastoral)	kg N/ha/yr	188	123-191
N conversion efficiency (pastoral)	%	34	27-35
<b>Effluent: area of pastoral farm</b>			
Currently receiving effluent	ha	110	
Required to achieve application rate of 150 kg N/ha/yr	ha	152	
<b>Greenhouse gas emissions</b>			
Total greenhouse gas emissions	eCO <sub>2</sub> ha/year	17,422	

## Sensitivity analysis:

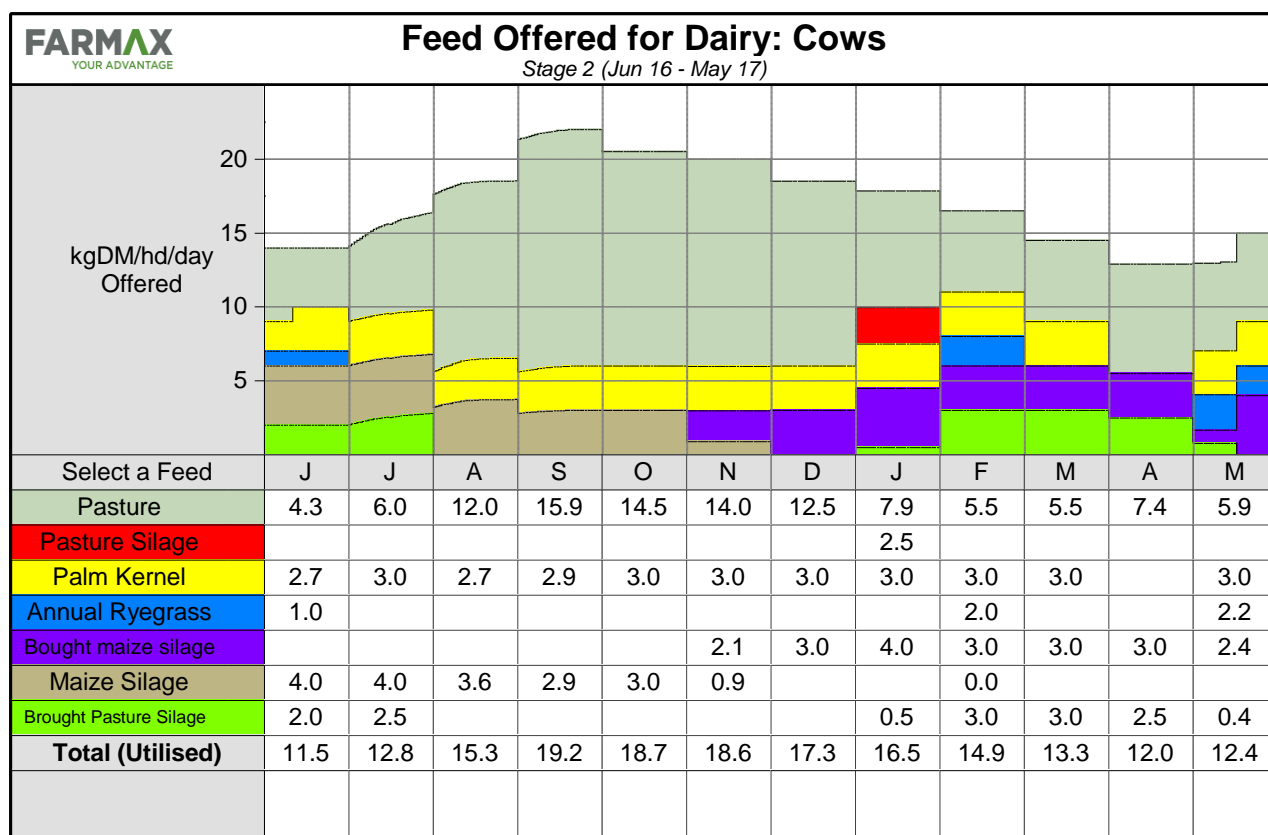
Both production and price sensitivity is shown below going up or down at 10% increments.

<b>PRODUCTION/PRICE SENSITIVITY</b>					
PRICE VARIANCE					\$0.58
PRODUCTION VARIANCE (KG's)					21117.1
	\$4.64	\$5.22	<b>\$5.80</b>	\$6.38	\$6.96
168936.8	-\$340,108	-\$242,125	-\$144,141	-\$46,158	\$51,825
190053.9	-\$242,125	-\$131,893	-\$21,662	\$88,569	\$198,800
<b>211171</b>	-\$144,141	-\$21,662	<b>\$100,817</b>	\$223,296	\$345,775
232288.1	-\$46,158	\$88,569	\$223,296	\$358,023	\$492,750
253405.2	\$51,825	\$198,800	\$345,775	\$492,750	\$639,725

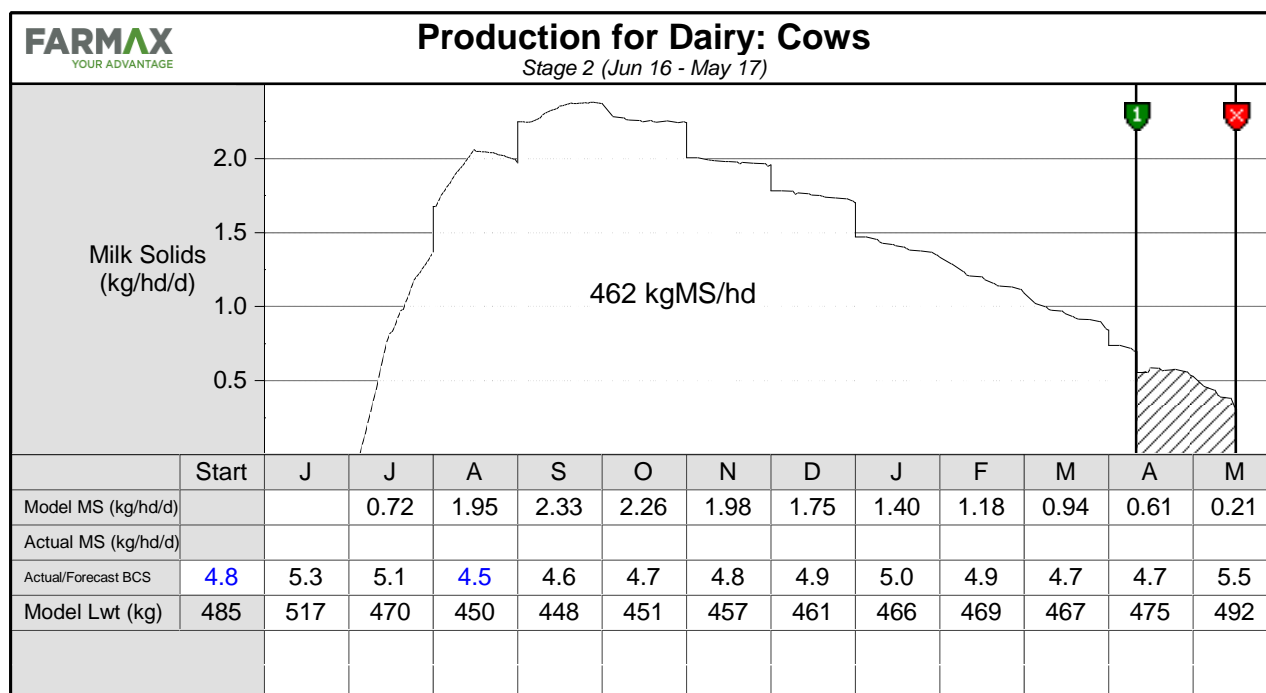
## 7.11 Seasonal (spring calving) Feed Pad – Stocking rate of 4

### Farmax system modelling

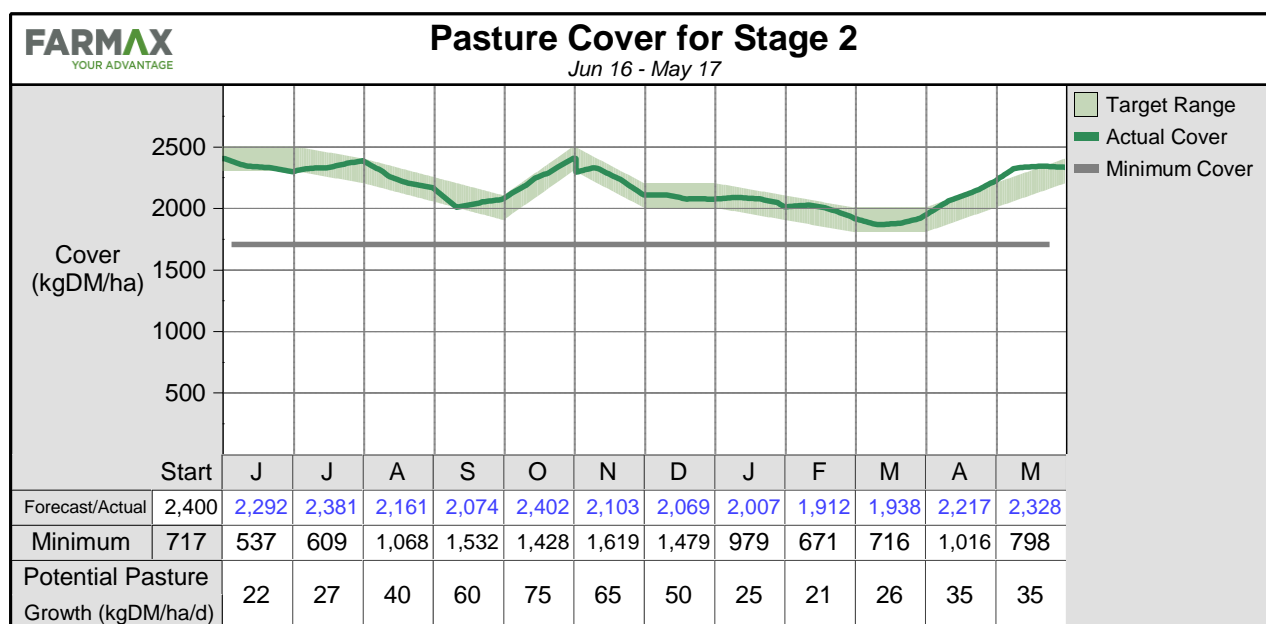
Once again the chicory has been substituted for home grown maize to increase home grown yield and decrease brought in maize. Irrespective with over 1200 tonnes of DM imported this feed budget is very heavily weighted with supplement.



The high input diet does lend to a higher modelled per cow production with the production curve below representing a total milk production of 462kgMS/cow.



The graph below represents the modelled pasture cover throughout the season based on the pasture offered within the feed budget and predicted growth rates.



## Environmental Modelling: Overseer

The table below is the summary from the Overseer file built to model this farm system. This shows modelled nitrogen leaching at 57kgN/ha which reflects the significant increase in purchased feed and increase in stocking rate. At 57kgN/ha this farm system looks to be significantly higher than our predicted nitrogen reference point.

(Whole farm)	Units	Value	Benchmark
<b>Nutrient loss indices</b>			
Loss to water	kg N/ha/yr	57	24-42
	kg P/ha/yr	1.2	
includes loss from effluent pond of:	kg N/ha/yr	0	
	kg P/ha/yr	0.0	
<b>Production efficiency indices</b>			
Farm N surplus (pastoral)	kg N/ha/yr	206	123-191
N conversion efficiency (pastoral)	%	33	27-35
<b>Effluent: area of pastoral farm</b>			
Currently receiving effluent	ha	39	
Required to achieve application rate of 150 kg N/ha/yr	ha	51	
<b>Greenhouse gas emissions</b>			
Total greenhouse gas emissions	eCO <sub>2</sub> ha/year	20,370	

## Sensitivity analysis:

Both production and price sensitivity is shown below going up or down at 10% increments.

<b>PRODUCTION/PRICE SENSITIVITY</b>					
PRICE VARIANCE					\$0.58
PRODUCTION VARIANCE (KG's)					25946.7
	\$4.64	\$5.22	<b>\$5.80</b>	\$6.38	\$6.96
207573.6	-\$381,013	-\$260,620	-\$140,228	-\$19,835	\$100,558
233520.3	-\$260,620	-\$125,179	\$10,263	\$145,705	\$281,147
<b>259467</b>	-\$140,228	\$10,263	<b>\$160,754</b>	\$311,245	\$461,736
285413.7	-\$19,835	\$145,705	\$311,245	\$476,785	\$642,325
311360.4	\$100,558	\$281,147	\$461,736	\$642,325	\$822,914