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MANUHERIKIA ENTERPRISE MODEL METHODOLOGY

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Background

Otago Regional Council (ORC) is evaluating the implementation of minimum flow policies within the Manuherkia River, a major irrigation watercourse in Central Otago. These minimum flow policies are intended to retain a greater volume of water within the river to better cater to environmental, social and cultural objectives.

The Manuherikia supports a wide range of irrigated agricultural and pastoral landuses that rely on reliable access to irrigation water to underpin their farm operations.

ORC has engaged AbacusBio to evaluate the impact on representative farm businesses of a range of 5 minimum flow scenarios (900 L/s, 1500 L/s, 2000 L/s, 2500 L/s and 3000 L/s) on representative farm businesses at different locations within the Manuherikia catchment. This assessment will inform the ORC of the on-farm economic impacts associated with different flow scenarios, enabling these impacts to be balanced against the environmental, social and cultural benefits.

To undertake this assessment, AbacusBio has developed case study models of three livestock enterprises (a dairy farm, a dairy support farm and a sheep-beef farm) that are based on real farms located within the Manuherikia. These case studies have been evaluated within a whole-farm economic model to understand the impact of the flow scenarios on farm profitability.

Methodology & model design

Livestock Model Description

The enterprise model is a fully dynamic farm systems model. The model is driven off monthly pasture growth data which flows through a livestock schedule and feed budget to determine the monthly feed surplus or deficit. A set of rules that govern key farm management decisions such as livestock sales and purchases, supplement feeding and supplement purchases subsequently balance monthly feed demand with feed supply, and projects revenue and expenditure. The model generates a multitude of physical and financial outputs that align with key farming metrics. These include earnings before interest and tax (EBIT), net profit before tax (NPBT), return on assets (ROA), average price per head for livestock, kg of dry matter per hectare, and net saleable product per hectare.

Farm production parameters have been moderated to reflect the average performance for the area. An example is the lambing percentage which is set to 135% to align with industry benchmarks and what would be expected from average efficient operators in this area. The dairy platform also reflects a level of production and stocking rate we believe to be typical of the area and in line with industry benchmarks. Milk payout has been set at $6.25 which is a 5 year average price at the time of modelling.

For each farm type modelled, a level of debt has been assigned in line with industry averages.

The model is set up to run for a single year with the impact of inventory (livestock, stored supplement and pasture cover) depletion and repletion realised in the year modelled rather than subsequent years as would occur in practice. Farm costs and product prices are fixed across the years for each iteration and within each farm system type. In this way, the impact on farm financial performance is not masked by factors other than pasture growth.

How the model works

Farm system models representing real sheep and beef farms, Dairy support and beef farms, and dairy platforms have been modelled. Activities including basic strategies of buying in feed during periods of shortfall as well as selling trading stock have been modelled to mimic basic management strategies run in the area. Decisions are triggered by feed supply and animal demand. Feed supply is dictated by historical monthly pasture growth from 1973 to 2020, this was derived from a pasture growth model that analysed historical climate data and irrigation availability to estimate soil moisture and subsequent pasture growth. Where more extreme seasons are experienced and significantly more feed is required to meet animal demand, feed is purchased at an incrementally increasing price. The range of price reflects the range of value from easily acquired surplus feed to more difficult to access feed or more expensive options such as cereal grains. Where feed deficit is extreme, a high value is placed on the purchased feed reflecting costly impacts difficult to model such as resowing pasture and selling and buying capital stock.

Model components

The model consists of four key components; a pasture budget, stock and feed reconciliation and a profit and loss and balance sheet. These components work dynamically together which allows pasture growth inputs to be dynamically converted into financial and physical output. The model utilises a macro function to dynamically produce a P&L simulation for each year over 1973 to 2020 based on the pasture growth inputs. As a consequence, over 2250 annual farm system scenarios have been run to represent both the farm system and flow scenarios of interest. Utilising 47 years of calibrated pasture growth data gives us confidence that the approach adequately represents the farm systems and the realistic range of likely outcomes for each flow scenario.

A schematic of the model is provided in Appendix 1.

Pasture budget

Pasture growth has been estimated for the different areas of the farms modelled including efficient spray, flood and dryland. The estimations have been supplied and take into account the annual climatic and hydrological information available for the past 47 years. For the purposes of the model,

the daily growth estimates of production have been collated into monthly totals to facilitate the modelling of the farm system in each of the 47 years and also in those same 47 years under the altered hydrology scenarios.

Where the farming system has been used to represent a different location in the catchment, the base farm system is altered to ensure the feed supply and animal demand is reasonably matched. The simplest way to achieve this is to adjust the farmed area to account for lower production in dryer zones or where restrictions are different such as tributary takes.

The key advantage of this methodology is the ability to model farm performance over a long and variable time series, this enables:

- Accurate assessment of mean farm performance.
- Consideration of risk and changes in the variability of farm performance.

- Ability to quantify and compare impacts in specific years.

Reconciliations

Stock numbers are tracked each month so that feed requirements can also be estimated from livestock classes and numbers on hand, bodyweight and metabolic state (pregnant or lactating). Where feed demand is not met by pasture supply, stored supplements are fed. Where demand is lower than supply, pasture covers build and surplus is assumed to be harvested and stored.

Feed supply and animal demand are well matched in our farms over what we see as an average year. While supplements are fed, they are also able to be stored so that the drystock farms are largely self contained normally. The Dairy model differs in this case as there is a support block where supplements can be imported from. In this case, an amount of supplement is always purchased. At the end of each year the surplus or deficit of feed is valued so that the subsequent year is separated.

Profit and Loss

Income varies where stock are sold as stores in response to feed pressure. The direct costs incurred by the farm are also dynamic and reduce where stock are sold prior to key events. Where surplus feed is available (pasture supply exceeds animal demand and average covers are above a threshold for the system) then additional cost is incurred to harvest feed at 13c/KgDM.

A standard set of costs run across each of the farm systems, reflecting normal sets of operating costs required to run the operation. These operating costs have been checked against actual costs and also published local and regional data sets. As the amount of feed grown has changed due to irrigation availability across the years modelled for each system. More cost is incurred in feeds purchased during shortfall and also more cost is incurred to make additional feed when there is surplus. At year end, surplus feed is accounted for on the balance sheet.

Balance sheet

The balance sheet is largely stable across the models but does account for a reduction in stock on hand if insufficient feed is available and store cattle are not purchased. At the end of each financial period, the value of a feed surplus or shortfall is calculated. In seasons where soil moisture is well above normal and additional feed is generated, a value that reflects the margin that could reasonably be made by consuming the feed is assigned to the surplus. The impact this has on the model is to limit the upside of surplus which reflects the limited option to convert surplus to revenue. Where soil moisture is lower than normal and there are restrictions to irrigation, feed that is purchased in is given a value to reflect the cost to buy that feed. In seasons where shortfall is significant, the cost to purchase feed is expected to increase as availability locally declines. The value of feed purchased is tiered to reflect the increasing cost of options in extreme dry. The impact this has on the model is to significantly penalise the poorest soil moisture seasons. We believe this methodology best represents the actual situation where changes to irrigation allocation are incurred. As the dryland is impacted independently, regardless of changes to irrigation reliability, the farms systems with significant dryland area remain variable. We are able to plot the variation to EBIT and give a fair representation of the impact of each season and scenario modelled.

Depreciation is captured and utilises standard rates for the farm systems modelled. It has no bearing on the impact to the business as it is the same across the various flow scenarios.

Balance sheet impacts also account for the impact of annual cash surplus/deficit on farm working account balances.

Value of feed

Across all farm system models, the feed demand of livestock on hand varies to meet the productive needs of livestock. As pasture growth varies depending on soil moisture between the scenarios, more feed is required to be purchased to fill the increased deficit. The value of feed can vary between years and within seasons as product values fluctuate and the availability of supplements change. The models have fixed product prices and most inputs have fixed cost as well based on long term (last 5 year average).

Farmers look to reduce their cost of feed by taking options to fill known shortfalls. Winter is a good example where cool temperatures restrict pasture growth necessitating a fairly consistent period of feed supplementation (with the obvious exception of Dairy where off farm grazing is paid for). Summer dry is more variable ranging from non-existent to catastrophic. Farmers tend to carry an amount of supplement to cover the extreme dry years in the knowledge that the value of feed in these seasons is likely to be very high.

We have utilised a base feed price for purchased forage at 35c/Kg DM. The base price broadly reflects the first series of options that farmers may take when meeting a slight to moderate shortfall. A combination of Nitrogen use, off farm grazing, hay/balage purchase or silage purchase may be considered and taken depending on availability or practicality. As supplement requirements escalate during dry conditions, we consider the price of available supplement will be more restricted and as a result the financial implication of increased supplementation will be increasingly greater. Purchased feeds will become more expensive and where options are taken to reduce capital stock and buy back in at a later date, we have assumed that these options have a greater cost. We have capped the value of feed at 50c/KgDM which is broadly equivalent to the cost to buy cereal grain as a supplement. Baleage purchased in would be of a similar price when sourced from outside the area.

Where there is a feed surplus, in the seasons where pasture growth is more favourable, additional supplements are made and stored. In the models, the additional supplement and pasture on hand is given a value at the year end. The additional forage on hand is valued at 35c/KgDM which is equivalent to the value to purchase in the supplement at the start of a dry period. The cost to make the additional forage into supplement has been set at 13c/KgDM giving a net value of 17c/KgDM for the stored feed. However, where a large amount of surplus is available, the value is reduced for two main reasons. With a cost to make the surplus, the cashflow implications can be a significant barrier and while the feed can be stored for many years, the holding cost is also significant. A secondary factor is the reduced quality of silage able to be made in a season of significant surplus. The quality is usually inferior due to delays as contractors struggle to deal with the backlog. To reflect these considerations, a reduction in feed value over 585t (approx. 70Kg/su) is applied. Surplus supplement on hand at balance date over 585t is given a value of 20c/KgDM or 7c/Kg DM above the cost to make.

The impact of the variable value of feed applied is to better reflect the on farm reality of feed value during periods of surplus or deficit. The alternative of applying a fixed pricing to surplus and purchased supplements would undervalue to impact of restricted water.

Farm systems models

Farm Types & Locations

As previously described, models were developed for representative livestock farms from the Manuherikia catchment. These farms comprised:

- 300 ha dairy platform
- 720 ha sheep-beef farm
- 359 ha dairy support farm

These farms represent the primary pastoral land uses within the Manuherikia catchment.

In accordance with the descriptions below, models for each farm were configured to reflect location of the farm at Omakau (upper Manuherikia), Lauder (Manuherikia tributary) and Alexandra (Lower Manuherkia) to demonstrate impacts across different catchment and climatic zones[1].

In addition to the livestock enterprises, impacts on a cherry enterprise at Alexandra were also estimated using a different modelling approach. Cherry production, along with Viticulture represent the primary horticultural land use in the lower Manuherikia.

Descriptions of each farm system are provided below.

Sheep and Beef

The sheep and beef system is modelled based on a real farm entity using crossbred sheep and a relatively small component of trading cattle. The farm is 720Ha effective with 500Ha of dryland, 180Ha of flood irrigatino and 40Ha of spray irrigation. Production has been set to 135% lambing to reflect a typical operation with a policy of selling a large portion as finished lambs. Trading cattle are purchased annually at the weaner sales with the intention to sell as forward stores the following year. Both lambs and trading cattle offer flexibility in the system if dry conditions prevail. Capital ewe numbers are retained along with replacements, supplement is used to support these during periods of deficit.

Where this model is shifted to an area where pasture production is different, the farm area is uniformly increased across all pasture production zones to provide an equivalent feed production as the original base model. By doing this we were able to retain the stock numbers in the model. In the case of the sheep and beef model farm being applied to the Alexandra feed production, the dryland area is increased from 500 to 576Ha and irrigated from 220 to 253Ha . The increase of 15% is applied to both land types to keep the ratio constant across locations.

Dairy Support

The dairy support system is based primarily around 700 dairy replacements being taken as calves and returning to the platform as first calving heifers. A second enterprise is included in this farm system in response to summer dry risk. 400 2yo cattle are purchased in Spring, grown fast and killed prior to summer dry and potential water restriction impacts on pasture production. The system is an example of adapting a mix of enterprises to fit feed supply and expected variation.

[1] Note that the dairy farm was only modelled at Omakau and Lauder due to the limited extent of dairy production in the lower Manuherikia.

The basic farm parameters comprise:

- Farm area – 359 Ha
- Irrigated area (spray irrigation) – 235 Ha
- Dryland area – 124 Ha

As per the sheep and beef farm, the areas of each land type are increased when the farm is shifted to Alexandra to reflect the lower level of pasture production (246 Ha irrigated and 130 Ha dryland).

Dairy

The dairy system is a milking platform where supplements are brought to fill periodic shortfall so that the intake and utilisation of pasture is maximised. Grain is fed in the system as this was the practice on the farm that the model is based on. Under the base scenario approximately 22% of cow energy intake is derived from grain and supplements.

Although the farm is mostly irrigated, there is sufficient variation between seasons and through restrictions, that having the ability to supplement with a high quality feed is a reasonable assumption. In any case the amount of grain fed is fixed irrespective of flow scenarios with only the forage based supplements changing.

The amount of feed supplied by supplement is capped at 50% of the required energy intake (ME). Beyond this point the cow's ME intake is restricted and milk production falls – this reflects potential mitigation of extreme seasonal conditions via once-a-day milking, or a similar low-input approach.

The base system is a 300Ha platform with 280 effective Ha of efficiently irrigated area running 3 cows per Ha. Calving % is set to 85% with 6 week in calf rate at 70% and replacement rate at 20%.

Horticulture

Consultation with a prominent local cherry producer identified that horticultural producers would not absorb a reduction in irrigation reliability as per a livestock enterprise. The significant capital investment in establishing horticultural landuse, and the significant impacts of water shortages on crop revenue/value, necessitate that horticulturalists either mitigate a reduction in reliability via increased storage capacity, or increase their irrigation water entitlement.

To model the impacts on a horticultural enterprise (cherries) AbacusBio elected to estimate the increase in water storage capacity that is required to achieve full irrigation reliability at each minimum flow setting. This was undertaken using monthly water harvesting forecasts from the catchment hydrology model.

The increased storage capacity was modelled as a one-off capital expenditure impact using indicative storage construction costs.

Results

Impact on Dairy Farm

As the dairy system makes a greater revenue per Kg of feed eaten, the effect of purchasing additional supplements is not as great. At the same time, a reduced stocking rate is not able to utilise feed as efficiently when feed conditions are good. Should restrictions be imposed across all farms as expected, there will be a greater variability in generated feed and the price is likely to reflect this. As some of the farm costs are fixed (don't vary as stock numbers are reduced), the beneficial impact of stock number reduction in poor years is partly offset by reduced profitability in good years. We have modelled dairy platform at the tributary and upper mainstem sites and retained base cow numbers.

The Figure below displays the distribution of annual EBIT across four scenarios for the Lauder Dairy farm for the 47 years of historical pasture growth data. This figure visually demonstrates both the shift in mean performance, and the increase in variability of performance across a sample of the scenarios. The frequency of years where EBIT is negative is also reflected below.

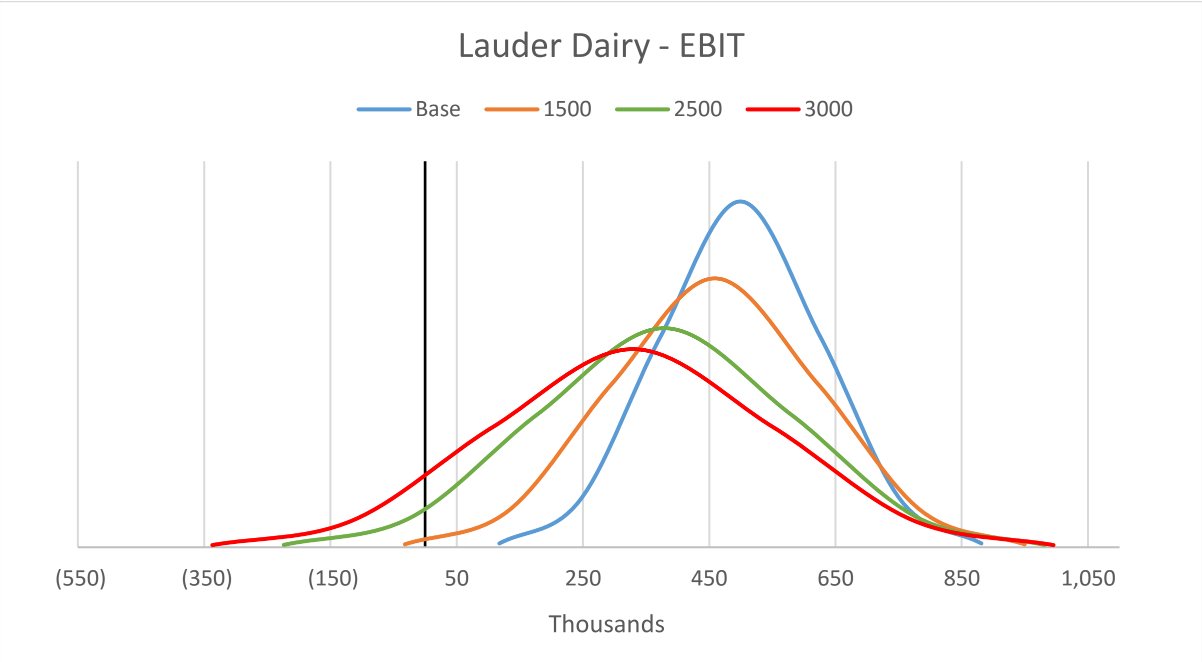


Figure 1 Distribution of EBIT for Lauder Dairy Farm Across 4 Flow Scenarions[2]

At EBIT level, the status quo flow scenario shows relatively low variance and no year with negative EBIT. The impact on EBIT is evident as the reliability for irrigation drops and while average EBIT drops the number of years of negative EBIT increase to 8 years out of 47. Given the higher level of debt carried on dairy farms, this has a significant impact on the ability to service debt. The potential for

[2] Note that these distribution graphs are produced using a predictive formula in excel that fits a normal distribution to a sample of data (eg mean, standard deviation etc). The graphs imply that maximum profitability is higher under the restricted scenarios. This is not the case and is a result of the fitting of a predicted curve that increases the overall range of the restricted scenarios due to an increased standard deviation.

high returns still exists under restrictions as good years still occur where soil moisture is less restricted. The main difference is the increasing frequency of poor EBIT years where growth is impacted as irrigation is not available.

As displayed in Figure 1 there is a significant increase in the variability of returns that arises from increased variability of pasture production. The coefficient of variation values presented below, display the relative increase in variability of farm EBIT.

Table 1 EBIT Results - Dairy Farm

Mean Dairy EBIT (CoV)		
Scenario	**Omakau**	**Lauder**
Base	$569,340 (16%)	$499,401 (25%)
900	$544,869 (22%)	$498,912 (26%)
1500	$522,610 (26%)	$458,913 (36%)
2000	$484,151 (33%)	$419,334 (44%)
2500	$437,576 (44%)	$378,617 (53%)
3000	$387,744 (55%)	$329,151 (67%)

Omakau represents the most reliable water availability at base and each subsequent reduction in reliability affects mean EBIT when considered over the 47 years of the model. Dairy at Lauder shows very little impact between base and 900 as the reliability is very similar. As the restrictions increase the relative EBIT impacts increase as supplementation costs increase in response to more variable feed availability. Milk production is also impacted in more extreme seasons.

The increase in variability of returns is significant (more than tripling base variability at the 3000 scenario). This has significant implications for risk, particularly in relation to balance sheet management.

Impact on Dairy Support Farm

The base model (representing status quo) for each modelled flow restriction has been adapted to reflect a realistic average situation where supplements are made on the property and fed on the property. To achieve this, the farm model generated at Omakau was adapted in the following way. Land area for each land type (dryland, flood and spray) were scaled up so that, in an average year, the same amount of feed was available. Due to the lower reliability of water at each scenario at Lauder and the more variable growth at Alexandra, the profitability of the base models representing status quo availability are lower. The impact of each reliability modelled is relative to the status quo file for each location.

The Figure below displays the distribution of annual EBIT across four scenarios for the Lauder Dairy Support farm for the 47 years of historical pasture growth data. This figure visually demonstrates both the shift in mean performance, and the increase in variability of performance across a sample of the scenarios. The frequency of years where EBIT is negative is also reflected below.

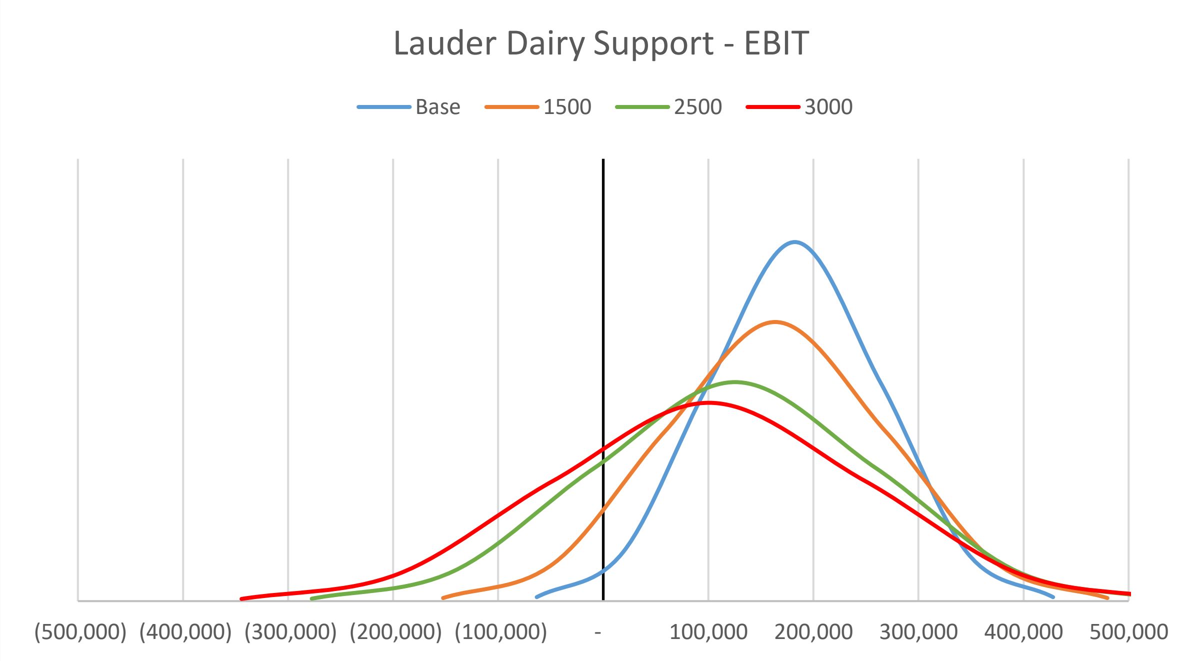


Figure 2 Distribution of EBIT for Lauder Dairy Support Farm Across 4 Scenarios

At Lauder, the dairy support model is less profitable at status quo than at Omakau due to the lower base reliability on the tributary. As the water becomes more restricted or less reliable for irrigation, the system becomes much more variable which is reflected in the flatter distribution curve and increase in years where negative EBIT is experienced (15/47 years or nearly 1 in 3 in the 3000l/s scenario).

Table 2 EBIT Results - Dairy Support Farm

Mean Dairy Support EBIT (CoV)			
Scenario	**Omakau**	**Lauder**	**Alexandra**
Base	217,677 (25%)	182,393 (45%)	213,433 (22%)
900	204,411 (36%)	182,044 (45%)	195,447 (37%)
1500	194,387 (43%)	163,679 (64%)	182,566 (46%)
2000	177,983 (55%)	145,513 (83%)	158,489 (69%)
2500	157,444 (77%)	125,450 (107%)	127,304 (108%)
3000	135,534 (100%)	100,591 (147%)	93,236 (176%)

The impact of EBIT for Dairy support is summarised in the table above for each of 3 locations across 6 flow scenarios. For each location there is an increase in impact as the reliability drops. The Alexandra location shows the greatest impact where water demand is greater. Under the 3000l/sec flow scenario at Omakau, the EBIT drops 38% relative to base while at Alexandra the drop is 56%.

Results for both EBIT and EBIT CoV follow similar patterns to those observed for the dairy farm. Of note is the greater quantum of impact at Alexandra, this reflects the higher level of variability in dryland production at Alexandra and the subsequent cumulative impact of severe water restrictions in years with poor dryland growth.

Impact on Sheep and beef Farm

The sheep and beef system has a greater reliance on dryland area and as such has a greater variability in profitability. An example of the variability can be seen at Lauder where the status quo reliability is lower. In 9 out of 47 years, the EBIT for this model is negative reflecting the impact of variability of both the irrigation but also the dryland production. While annual pasture production across the farmed area averages 7180KgDM/Ha the standard deviation is 2060KgDM and variance is 29%. As each allocation is modelled, the dryland variability remains constant and only the impact of irrigation change is accounted for.

The graph below shows the distribution of EBIT over the 47 years for each of the flow scenarios modelled for Sheep and Beef at Lauder.

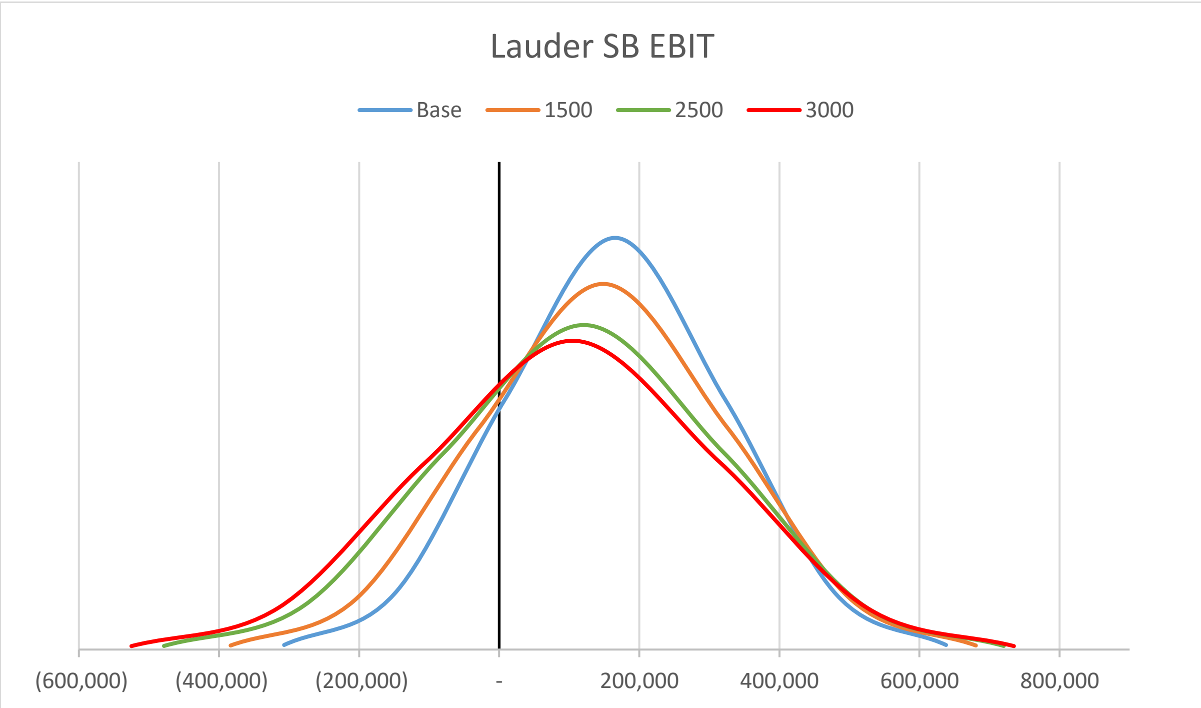


Figure 3 Distribution of Annual EBIT for Lauder Sheep-Beef Farm Across 4 Scenarios

The blue line represents the status quo situation where the farm system is variable with 9/47 years returning a negative EBIT and one instance of 2 consecutive years of negative EBIT. Mean EBIT is $165,450 across the 47 years. As the allocations change (1500l/sec = orange, 2500l/sec = green, 3000l/sec = red), the average EBIT drops to $104,933 but the number of years where the EBIT is negative climbs to 13/47 with one instance of 3 negative years in succession.

The table below shows the impact of 6 flow scenarios on mean EBIT for 47 years across 3 locations.

Table 3 EBIT Results - Sheep-Beef Farm

Mean Sheep & Beef EBIT (CoV)			
Scenario	**Omakau**	**Lauder**	**Alexandra**
Base	$173,771 (87%)	$165,450 (95%)	$205,950 (61%)
900	$163,913 (101%)	$165,034 (96%)	$184,187 (84%)
1500	$156,948 (110%)	$148,544 (119%)	$172,306 (97%)
2000	$153,200 (115%)	$135,009 (140%)	$148,456 (130%)
2500	$131,812 (150%)	$120,897 (165%)	$119,472 (183%)
3000	$118,400 (176%)	$104,933 (200%)	$86,965 (282%)

As reliability drops EBIT is reduced for all scenarios and locations. The tributary flow scenario at Lauder shows little impact between base and 900 as the reliability of water between these scenarios is very similar. As with the dairy support model, the increased demand at Alexandra has a greater relative impact on EBIT between each flow scenario. Irrigation is supplied at 5.5mm/d at Alexandra and 4mm/d to all farm systems and types at the other locations. With a higher supply at base, the Alexandra base model grows more feed and begins at a higher EBIT. However the impact of restrictions is also greater reducing average EBIT.

Impact on Horticulture (Cherries)

For each storage dam a series of assessments and calculations are made as to how or if the storage can be achieved at a viable price. Design usually optimises the amount of storage relative to the volume of material shifted to achieve the required storage volume. Pricing for storage varies greatly as a result. For this analysis we have estimated the storage cost per unit volume at $\$10/M^3$

Where insufficient suitable space exists to build additional storage the option will be less palatable due to the high value of Horticultural land in crop.

In all flow scenarios above status quo, there is a significant additional storage required to provide an equivalent reliability. We have utilised outputs from the hydrology model along with reasonable requirements from our case study crop (Cherries under UFO orientation) up until harvest (end of January). The additional storage volume is calculated for each flow scenario and multiplied by the nominal cost of $\$10/m^3$ to give a per hectare capital cost imposition.

Table 4 Cost per Ha of Additional Storage Capacity to Maintain System Reliability for Cherry Production

Scenario	**Per Ha Storage vol (m^3)**	**Add Storage (m^3)**	**Cost/Ha @ $\$10/m^3$ of additional storage**
Base	1,213.2		
900	2,255.1	1041.9	$ 10,419
1500	2,837	1623.8	$ 16,238
2000	3799.9	2586.7	$ 25,867
2500	4591.2	3378	$ 33,780
3000	5136.9	3923.7	$ 39,237

The capital cost that is required to be incurred to equate reliability with status quo is significant. For the more restrictive scenarios the additional storage required is around 3 times existing volume placing pressure on space as well. It is important to note the scenario considered is for cherries where crop demand was met to the end of January.

Crops such as grapes, apples, apricots and other stone fruits have different requirements in terms of amount and timing of water requirement. However, we expect that most high intensity production systems will react to any reliability change by taking a similar approach.

Discussion

Profitability

Each farm differs in terms of the level of debt that is serviced and the amount of depreciation that is expected in normal running of the operation. Dairy platforms generate greater income and as a consequence, typically service a greater debt. The dairy system is set to carry a debt equivalent to 50% of opening value of land and this remains constant across the scenarios. For the base farm producing 1285KgMS/Ha this equated to a term debt of $18.67 per Kg of Milk solids.

The sheep and beef farm was assigned a term debt of 18% of the land value or $1.35M serviced at 4%. The Dairy support model was run with a term debt of 14% of the capital value and at 4% interest.

The amount of debt a farm carries is very particular to the circumstances in play. If there has been recent development to irrigation infrastructure or a succession has occurred, additional debt is loaded against that business. We can see from modelling the impact of increased debt loading on returns and while we report an average, those farmers with higher debt loadings are more vulnerable to reduced income and increased costs in their business. As an indication of the impact, the dairy support model shows a negative profit in 4 years out of 47 modelled when servicing $950K of term debt. When the model is challenged with $2.5M term debt the business returned a loss in 14 of the 47 seasons modelled. The indication is that properties carrying a higher debt at current allocations are more vulnerable to reduced irrigation reliability. Irrespective of the farming type, the portion of the farmers in the area carrying higher debt will be more vulnerable to allocation change.

Farm Value impacts

Two aspects are in play regarding potential impact on land value being the reduced profit and also the increase in variability or risk. In simple terms we can estimate the potential change in land value required to achieve the same Return on Assets (ROA) as the base scenario at the reduced level of EBIT reflected in the restricted flow scenarios above. The table below applies the approach to when the reduction in land value (farm level) required to maintain ROA at base levels when 1500l/sec restrictions are imposed.

Table 5 Estimated Land Value Reduction at 1500 L/Sec Scenario

System	Omakau	Lauder	Alexandra
Sheep and Beef	$838,854	$885,353	$1,419,705
Dairy support	$834,268	$800,052	$1,125,511
Dairy	$1,174,811	$1,160,433	N/A

While the methodology is simplistic and does not account for the increased variability of returns (risk), it does highlight that land values would need to reduce (in the absence of other mitigation/adaptation) to maintain the same ROA as the base scenario.

Even at the 1500l/sec scenario the potential capital value impacts are significant and it is likely that farmers would consider mitigation (eg installation of storage or upgrading flood to spray irrigation) to preserve their capital value. As potential writedowns in land value become more extreme under the more restrictive scenarios, it is increasingly likely that farmers would seek mitigation opportunities. However, capital works of this nature are expensive and banks could be concerned that additional borrowing may be required, affecting the ability of some farmers to seek mitigation.

As farming is and has been both a cashflow business and a capital growth business over time, the potential impacts on land value are very important considerations for farmers. With rural banks looking more at cashflow, there is less appetite for increased variability and lower EBIT forecasts. These pressures inevitably affect land value over time.

Business viability

At some point, each farm system can be placed under sufficient pressure to render the business financially unviable. As we have described, each farm is different in its system and structure and ability to react.

For the case study farm systems we can see the relative impacts of flow scenario change on the farm EBIT over time. For all flow scenarios above 1500l/sec the impacts are very significant with sufficient risk involved and an increase in negative EBIT years likely.

As a way of determining the tipping point for a viable operation we can look at the ability of a business to operate profitability, replace capital (cover depreciation), owners are able to draw or pay themselves a salary commensurate with a professional farm manager, and the business is able to pay down debt over a reasonable (20yr) timeframe. When looking across the models, each of the base models (except the dairy support farm) fail to meet this standard of viability, as demonstrated in Appendix 2.

It is important to note that these models reflect an average farm. Better-performing enterprises would more readily meet the financial targets associated with this framework.

In practice, many farms shortcut one or more of these areas, for example servicing debt on interest-only terms, or borrowing to fund major capital expenditure projects. Rising land values have also typically acted to support farm balance sheets where borrowings have increased to cover cashflow shortfalls.

Rural financing over time has considered both the cash and equity position when funding businesses. More recently, banks have changed to require that farm businesses are able to cashflow themselves and repay some debt. If we apply this standard of viability, the average farm, with the exception of dairy support, is unable to cope with any significant reduction in irrigation reliability.

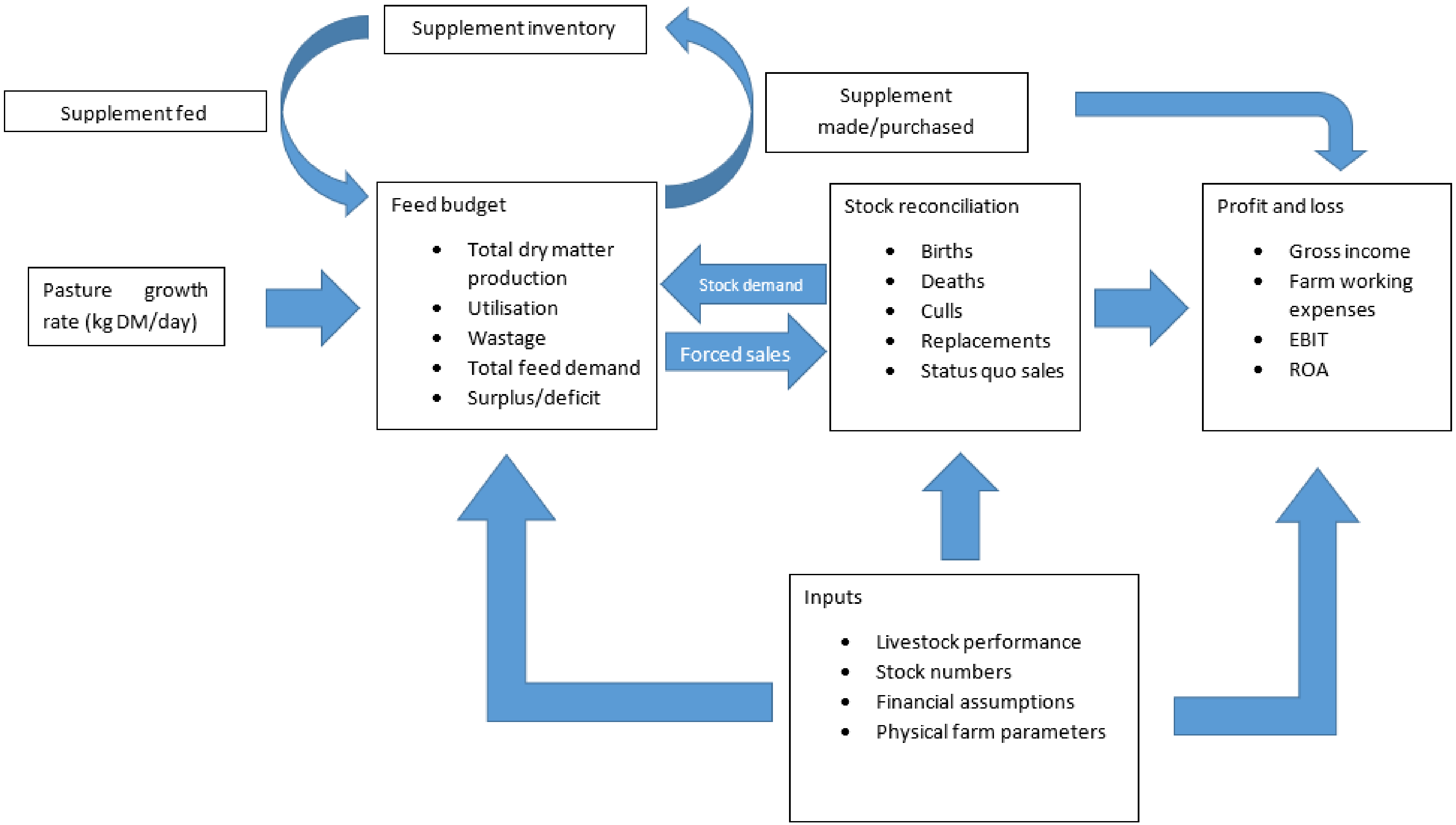
Key Findings

AbacusBio has modelled the impact of a range of minimum flow scenarios on the profitability of representative livestock enterprises throughout the Manuherikia catchment.

Based on the results of this analysis, AbacusBio believes that scenarios above 1500L/sec would likely threaten the viability of typical livestock enterprises within the catchment. Indeed, more conservative scenarios would be preferable in the context of farm viability. This assessment is based on:

- At current irrigation reliability an average farm across sheep-beef, dairy and dairy support is generally challenged in terms of remunerating its owners, meeting debt principal repayments and funding capital expenditure out of its post-tax cash profit. Reductions in profitability due to loss of irrigation reliability further exacerbate this situation.
- In the context of the above, the ability of a vulnerable farm to manage this shortfall will be constrained by:
    - Potential impacts on land values impacting farm balance sheets and constraining borrowing capacity.
    - Potential need to borrow funds for capital works to offset the reduction in reliability.
    - Willingness of lenders to maintain or increase lending under the sudden reduction in profitability, increased variability of returns, and potential reduction in land values.
    - Increased sales of farms in response to the restrictions could impact land values and further constrain balance sheets.
- Increasing levels of restriction increase the frequency of years where the average farm business is unprofitable, as well as the quantum of loss incurred in these years. The increased risk of back-to-back dry seasons, or an extreme dry season, increases with the level of irrigation restriction.

Appendix 1


Supplement inventory
Supplement fed
Supplement made/purchased
Feed budget
Total dry matter production
Utilisation
Wastage
Total feed demand
Surplus/deficit
Pasture growth rate (kg DM/day)
Stock demand
Forced sales
Stock reconciliation
Births
Deaths
Culls
Replacements
Status quo sales
Profit and loss
Gross income
Farm working expenses
EBIT
ROA
Inputs
Livestock performance
Stock numbers
Financial assumptions
Physical farm parameters

Appendix 2

	Sheep & Beef				Dairy			Dairy Support		
	Omakau	**Lauder**	**Alexandra**		**Omakau**	**Lauder**		**Omakau**	**Lauder**	**Alexandra**
Principal Payments	$79,624	$79,624	$79,624		$269,361	$269,361		$66,186	$66,186	$66,186
Cap Ex	$52,813	$52,813	$52,813		$225,000	$225,000		$73,071	$73,071	$73,071
Required Cash Surplus (Post Tax)	**$132,437**	**$132,437**	**$132,437**		**$494,361**	**$494,361**		**$139,257**	**$139,257**	**$139,257**
Required Cash Surplus (Pre Tax)	**$183,940**	**$183,940**	**$183,940**		**$686,613**	**$686,613**		**$193,413**	**$193,413**	**$193,413**
Interest Payments	$77,632	$77,868	$75,992		$291,352	$293,531		$57,456	$57,316	$57,382
Required EBITDA	**$261,572**	**$261,808**	**$259,932**		**$977,965**	**$980,144**		**$250,869**	**$250,729**	**$250,795**
Base EBIT	$173,771	$165,450	$205,950		$569,340	$499,401		$217,677	$182,393	$213,433
Depreciation Adjustment[1]	$42,250	$42,250	$42,250		$180,000	$180,000		$58,457	$58,457	$58,457
Base EBITDA	**$216,021**	**$207,700**	**$248,200**		**$749,340**	**$679,401**		**$276,134**	**$240,850**	**$271,890**
Shortfall in Average Farm EBITDA	**$45,551**	**$54,108**	**$11,732**		**$228,625**	**$300,743**		**-$25,266**	**$9,879**	**-$21,096**

1. Depreciation is removed due it being a non-cash item.