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SUPPLEMENTARY FEED USE IN THE BEEF INDUSTRY

MPI service contract 405567

Prepared for

Joel Gibbs

Ministry for Primary Industries

By

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AbacusBio Limited

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Executive summary

The primary purpose of this project is the development of the framework suitable for future use by the Ministry and its partners. The project builds on previous work that quantified the use of supplementary feed usage in the New Zealand (NZ) sheep industry. The models used in the initial report have been further extended to include beef, dairy grazing and finishing of cattle exiting the dairy system.

Outcomes within this report are focussed on the beef and other cattle industries, with results summarised according to the quantity and quality of pasture and supplements consumed (within each month and season) and then scaled to allow changes in feed intake and quality to be evaluated for each of the enterprises across seasons.

A summary of key results for the beef and other cattle industry shows that over the last 25 years:

- Supplementary feed usage in beef has remained relatively constant at 5-7% of total dietary intake, with just small increases observed in the amount of feed supplied to the cow and heifer stock classes.
- At 14-16%, supplementary feed usage is considerably higher in the other cattle enterprises, with large amounts of feed being utilised by dairy heifers and winter grazing of dairy cows
- Winter brassicas form the major feed group, with swedes and kale accounting for up to 80% of supplements used in both the beef and other cattle enterprises. Moving forward, fodder beet is likely to form an increasingly important source of supplementary feed, and is expected to be used to ensure that cattle growth rates are maintained through late winter/ early spring.
- At a national level, changes in total supplement usage mirror changes observed in total feed demand. Results for the Class 9 datasets for beef and other cattle are not consistent with what would be expected given the known increases in dairy production, which would be expected to show a steady increase in total feed demand from dairy grazing and ex-dairy beef finishing. The beef demand estimates were also considerably lower than previously estimated, with these anomalies likely due to anomalies in classification of animals as beef versus ex-dairy beef, and the prevalence of beef cattle on small holdings, which are not captured within the Beef + Lamb New Zealand Economic Service Class 9 data sets.
- Whilst the average energy content of feed consumed on Class 9 farms has increased over time, the quality of feed consumed by beef is consistently lower than the other cattle and sheep enterprises. This is primarily due to preferential feeding of sheep relative to cattle, the use of beef cattle to help manage pasture quality, and the use of high quality supplements for winter dairy grazing.

Contents

Introduction

This work follows on from MPI project 405376, *Analysis of supplemental feed use in the sheep industry*, where AbacusBio developed a feed tracking model to quantify usage of different feed types for sheep and other dry stock farm enterprises.

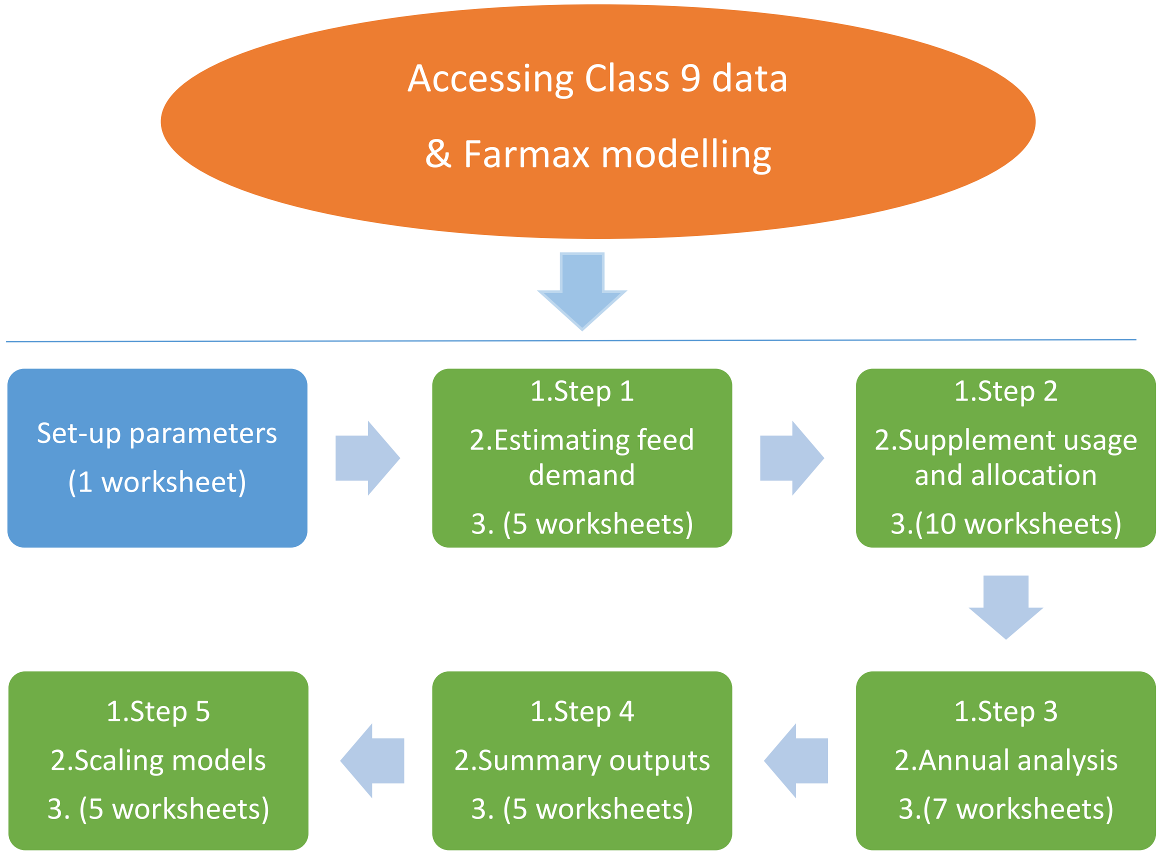
This project reports on the extension of the feed tracking model to quantify feed usage in the beef industry, including feed consumed by cattle exiting the dairy system (ex-dairy beef) and through off-platform dairy grazing. This report focusses on the architecture of the model, with a full description of the inputs used to generate the outputs required by MPI. Historical results are presented for all livestock enterprises, with the beef and other cattle enterprises used to profile the result outputs. An explanation on the rationale for the allocation of supplements to individual livestock classes is also provided, along with a guide for use of the model by MPI or other external parties.

Note that this report focusses on usage of the model, and interpretation of model outputs, with additional technical detail on the principles and methods used within the model provided within the original project 405376 report.

Model architecture

The feed tracking model has been developed within a single Excel workbook. The workbook comprises 33 individual worksheets, which include an initial parameters worksheet, and the input and calculation worksheets which have been classified into 5 main sections. An overview of the feed tracking model architecture is shown in Figure 1, where the initial steps involve accessing a range of data representing the Beef + Lamb New Zealand Class 9 farming system. Class 9 is a weighted average of the 8 farm classes used in the annual Economic Service survey, and as such is a representation of the average sheep and beef farm. This then leads to the development of Farmax whole farm models for each of the years considered, which are required to profile the changes in stock numbers, on-farm productivity and supplementary feed usage; Farmax data outputs were then used directly within the Excel feed tracking model framework. A brief description of the methodologies and outputs generated within each section of the feed tracking model are provided, with additional detail on the Class 9 data inputs, Farmax modelling, and use of the model itself, included within Appendix 1.

Figure 1. Overview of the feed tracking model architecture



Two versions of the feed tracking model have been developed. The first version (reported on here) contains the historical feed demand estimates used in the original project #405376 report, and the second model has been set up to enable future use of the model by MPI staff or contractors. The overall model architecture and functionality is identical for both models, with each allowing a comparison of up to 7 different years or scenarios. The historical model spans the 1990-91 to 2014-15 period, with annual changes modelled in a series of four-year blocks. The future model uses the 2014-15-year data as the initial reference point for future evaluations, with a 2030 scenario model also included for comparison.

Section 1: Estimating feed demand

In the historical model, Farmax data has been used to develop a sequential set of annual models representing B+LNZ Class 9 farms, with the Farmax outputs then used to track total monthly feed demand, supplement usage and feed quality for each stock class, and the year modelled. The historical model caters for a total of 39 individual stock classes including 9 sheep, 10 beef, 3 dairy grazing, 5 beef ex-dairy and 12 deer stock classes, with a summary of the stock classes provided in Table 1[1].

[1] Note that within the feed tracking model, the 3 dairy-grazing and 5 beef ex-dairy stock classes are reported as a single enterprise; however within the Class 9 Farmax model, they are set up as separate enterprises.

Table 1. Stock classes included within the feed tracking model enterprises.

Sheep	Beef	Other cattle	Deer
Ewes	Cows	Dairy grazing	Hinds
Ewe Hoggets	R2 heifers	Wintered dairy cows	R2 replacement hinds
Ewe Lambs	R1 heifers	Heifer calf grazing	R1 replacement hinds
Mixed Lambs	Heifer calves	R1 heifer grazing	Hind fawns
Wintered lambs	Steer calves	Ex-dairy beef[2]	R1 finishing hinds
Terminal ewes	R1 steers	Ex-dairy bull calves	R2 finishing hinds
Rams	R2 steers	Ex-dairy bull R1	R2 venison Stags
Ram Hoggets	Bull calves	Ex-dairy bull R2	R1 venison Stags
Ram Lambs	R1 bulls	Ex-dairy heifer calves	Stag fawns
	Bulls	Ex-dairyR1 heifers	R1 velvet stags
			R2 velvet stags
			MA velvet Stags

The key Farmax outputs used within the feed tracking model include:

1. Average daily demand per head
2. Average number of animals within each stock class for the given month and year
3. Percentage of monthly feed demand met by each of the supplementary feed types available

These values are used to calculate the total feed demand for each enterprise on an annual basis.

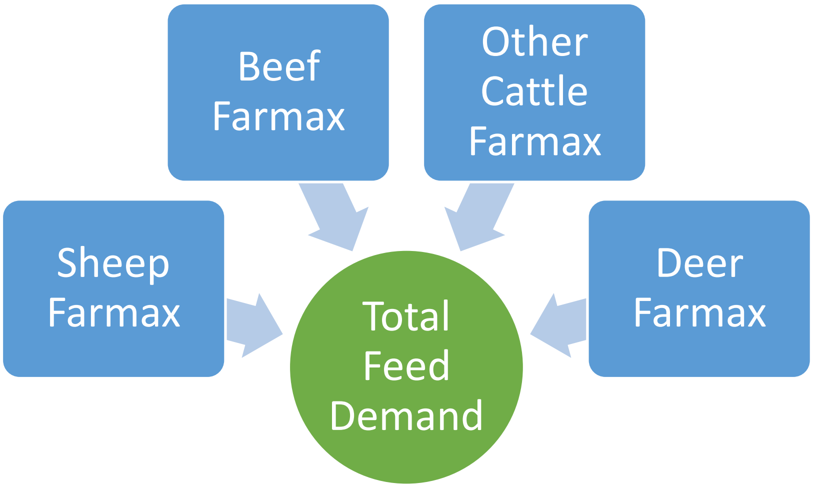
With Farmax utilising a “whole farm” approach, the Farmax models have been optimised to ensure adequate pasture covers with respect to estimated supplement usage and total feed demand, over all stock classes and years[3]. This ensures the models developed were biologically feasible.

Figure 2 shows a summary of the Farmax demand information for each of the enterprises, which within the feed tracking model are combined to estimate total feed demand.

[2] Note that within the current model no allowance has been made for ex-dairy R1 and R2 steers or R2 heifers. There was no data available within the class 9 data sets to split ex-dairy makes into bulls and steers, or to track ex-dairy R2 heifers separately from beef heifers, with the ex-dairy males included within the bull data sets and the R2 heifers within the beef.

[3] Within the future model, further Farmax analyses will be required to assess the impact of changes in on-farm productivity, stock numbers, and land area on estimates of supplemental feed usage and total feed demand. Further detail on the Farmax modelling is provided within Step 1 of the Guide for Use.

Figure 2. Summary of the 5 worksheets used to capture Farmax data and summarise total Class 9 feed demand.



Feed demand worksheet outputs

Three key outputs are shown on the feed demand worksheet

1. Figure 3 shows estimated changes in total annual feed demand (Tonnes of dry matter) for a typical Class 9 farm over time. The blue line shows changes in average farm size (effective area) over the same period.
2. Effective farm area is then used to scale all results to 1,000 hectares, with Figure 4 showing changes in feed demand per hectare for each of the enterprises. This shows that demand from sheep remained relatively consistent at 2.5-2.7 Tonnes of dry matter per hectare (DM/ha), whilst demand from all other enterprises has increased over time.
3. These changes are shown more clearly in Figure 5, where feed demand from sheep dropped from 69% to about 60% during the period 1990-91 to 1998-99 (then was relatively stable at that level), whilst demand in the cattle enterprises increased by 4-5% during the 90s.

Figure 3. Changes in total feed demand for a typical Class 9 farm over time

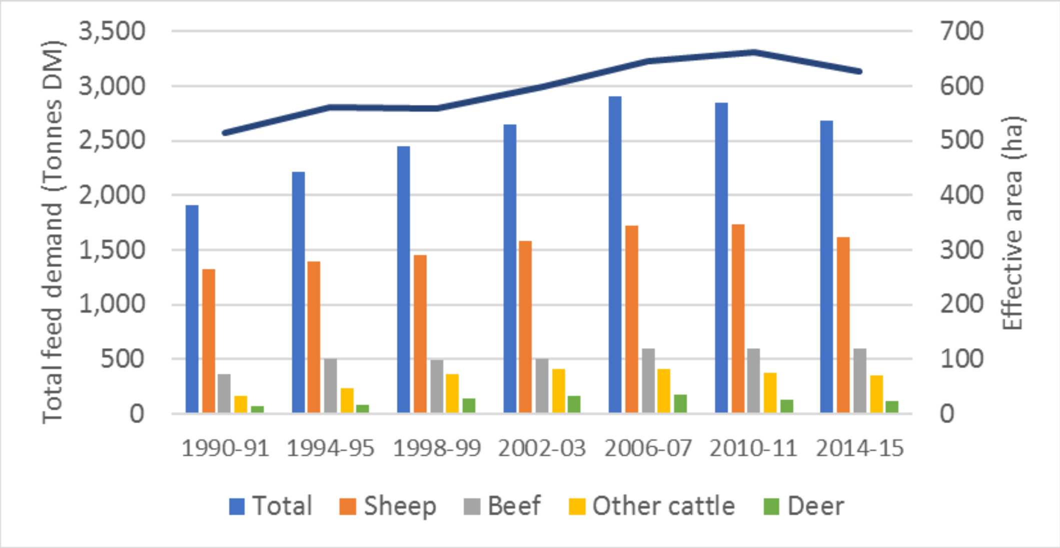


Figure 4. Changes in feed demand estimates/ha for the individual enterprises over time.

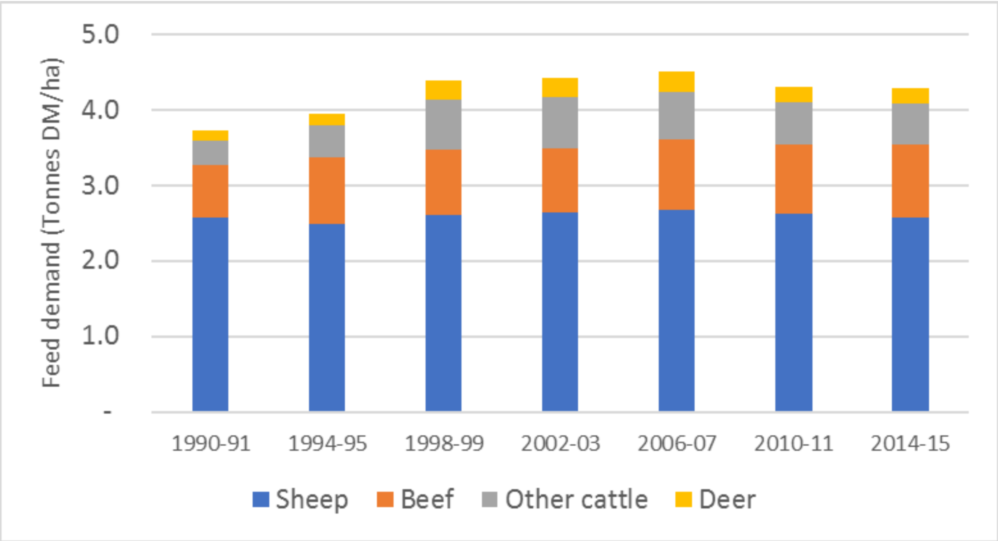
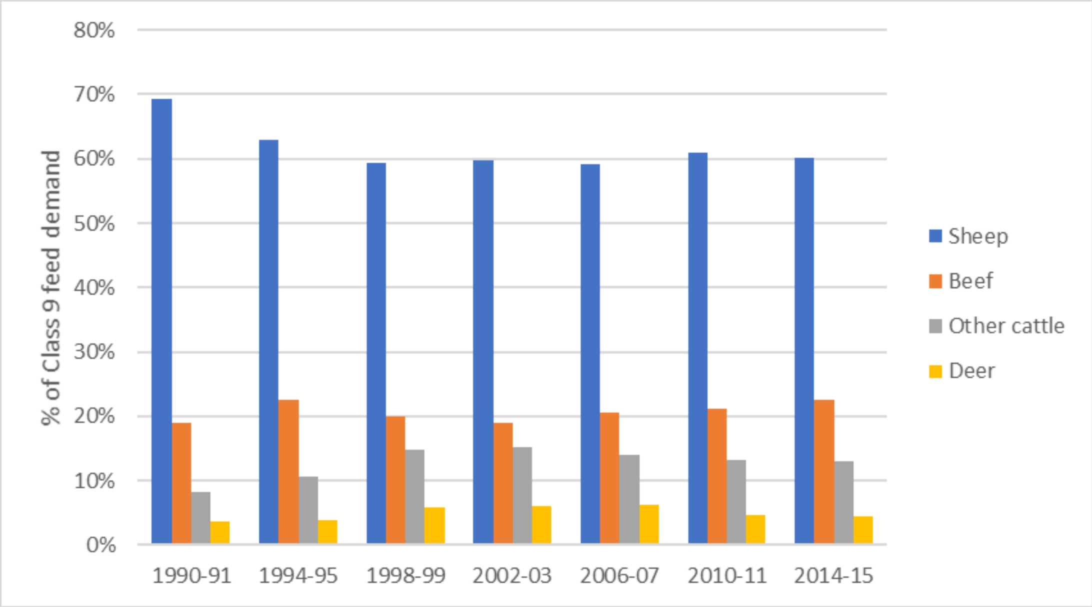


Figure 5. Changes in the percentage of Class 9 feed demand over time.



Section 2: Supplement usage and allocation

Within Farmax, supplements are applied to the whole farm, and usage is tracked according to the total percent of monthly demand met by supplements. The feed tracking model uses this data to "allocate" supplements to individual stock classes.

The total volume of each supplement is calculated as a percentage of total feed demand (over all stock classes) for the month, and then allocated to individual stock classes according to the percentage of diet expected to be met by each supplement, with "fine balancing" used to ensure supplement allocation equals supplements used.

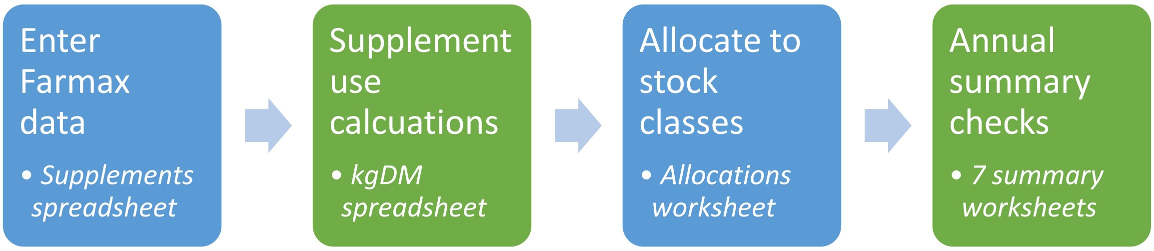
Three spreadsheets are used within this part of the model:

1. The **supplements spreadsheet** is used to capture the total percentage of monthly feed demand met by each supplement type, and then (by subtraction), generate the pasture demand.
2. The **kgDM spreadsheet** uses the supplement data to calculate the amount of each supplement type consumed each month.
3. The **allocations spreadsheet** is then used to allocate supplements to individual stock classes for each month and year
    a. Pivot tables are then used within the 7 **annual summary worksheets** to interrogate the data according to supplement usage by stock class and enterprise type.

The workflow for the supplement usage section of the model is shown in Figure 6, where the blue boxes represent the data entry components and the green boxes worksheets show the automated calculations and checks.

A full description of the usage of the allocations worksheet is provided in the "supplement allocation" section of the guide to use, with key outputs from this part of the model outlined below.

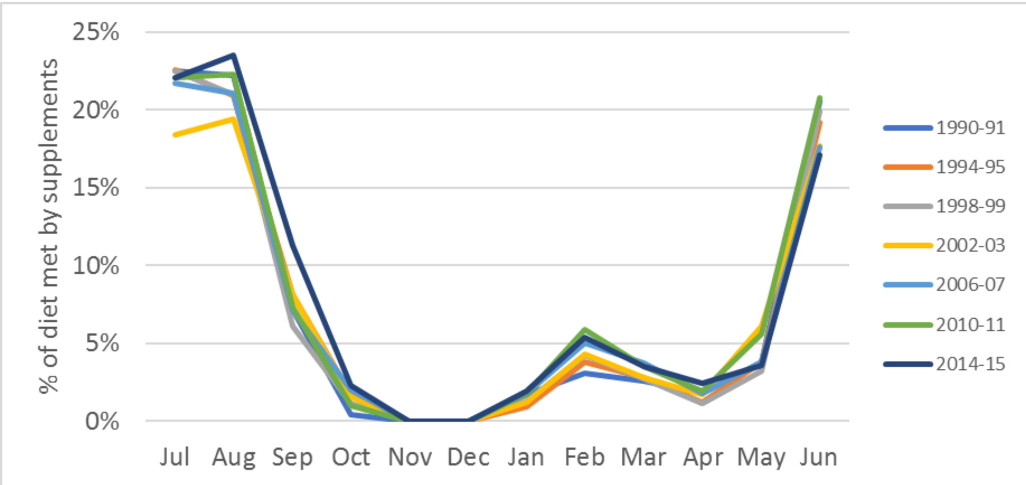
Figure 6. Workflow for the supplement usage section of the model.



Supplement worksheet outputs

Annual differences in supplement usage as a percentage of historical feed demand are summarised in Figure 7, with this output used to identify both trends and unexpected changes in supplement usage over time.

Figure 7. Supplement usage as a percentage of historical monthly feed demand.



A series of annual worksheet summaries has also been developed to allow interrogation of the data by stock class, enterprise and supplement group over time.

Four key outputs are monitored with data from 2014-15 used to display the pivot table functionality.

1. Total annual amount of each supplement type consumed by each enterprise (Table 2).
2. Total annual amount of each supplement type consumed by each stock class (Table 3).
3. Total amount of each supplement type consumed by an individual stock class within each month of the year, with an example for supplemental feed consumed by the cow stock class shown in Table 4.
4. Percentage of feed demand met by individual supplement types though-out the year, with Table 5 showing an example for cows, with 5-11% of dietary intake from baleage and swedes over the August to October period.

Table 2. Estimated total amount of supplements (kg DM) consumed by each farm enterprise (Class 9, 2014-15 year).

	Baleage	Barley silage	Kale	Leafy turnip	Sheep nuts	Swedes	Grand Total
Sheep	14,577	3,068	0	28,363	4,251	43,120	93,379
Beef	6,752	0	10,230	0	0	23,394	40,376
Other cattle	11,255	0	26,300	0	0	22,731	60,286
Grand Total	**32,584**	**3,068**	**36,530**	**28,363**	**4,251**	**89,245**	**194,041**

Table 3. Estimated total amount (kg DM) of supplements consumed by each stock class (Class 9, 2014-15 year).

		Baleage	Barley silage	Kale	Leafy turnip	Sheep nuts	Swedes	Total
Sheep	Ewes	8,177	3,068			4,251	9,427	24,923
	Ewe Hoggets	4,694					20,880	25,574
	Ewe Lambs	1,706			7,031		6,799	15,536
	Mixed Lambs	0			21,332		2,402	23,734
	Wintered lambs						3,612	3,612
Beef	Cows	2,738					2,343	5,081
	R2 heifers	1,175		1,879			2,132	5,186
	R1 heifers	1,131		2,468			3,719	7,318
	Heifer calves	59		1,445			470	1,974
	Steer calves	85		1,458			396	1,939
	R1 steers	1,195		726			8,511	10,432
	R2 steers	363		2,129			5,779	8,271
	Bull calves	6		125			44	175
Other cattle	Wintered dairy cows	7,338		8,560			8,560	24,458
	Heifer calf grazing	891		1,144			1,022	3,057
	R1 heifer grazing	1,675		7,407				9,082
	Ex-dairy bull calves	709		1,141			829	2,679
	Ex-dairy bull R1	642		1,263			11,456	13,361
	Ex-dairy bull R2			6,785			864	7,649
Total		**32,584**	**3,068**	**36,530**	**28,363**	**4,251**	**89,245**	**194,041**

Table 4. Estimated total amount of supplements (kg DM) consumed by the Beef cows (Class 9, 2014-15 year).

	August	September	October	Grand Total
Baleage	1,018	597	1,123	2,738
Swedes		996	1,347	2,343
Grand Total	**1,025**	**1,594**	**2,243**	**5,081**

Table 5. Estimated contribution of supplements (%) to total feed demand from Beef cows (Class 9, 2014-15 year).

	August	September	October
Baleage	5%	3%	5%
Swedes	0%	5%	6%
Grand Total	**5%**	**8%**	**11%**

Section 3: Seasonal analysis

The seasonal worksheets contain a series of matrices summarising supplement usage by stock class and supplement type for each month of each year. The monthly summaries include the following:

- Total amount of supplements (kg DM) consumed by each stock class (summary).
- Total feed demand (kg DM) for each stock class (summary).
- Total pasture demand (kg DM) for each stock class, which is calculated as the difference of total feed demand minus supplement intake.
- Estimated quality (as megajoules of metabolizable energy per kg DM intake, MJME/kgDM) of pasture consumed by each of the stock classes. This is calculated according to the average MJME values for pasture used within the Farmax models, and then adjusted to account for preferential feeding of the different stock classes.[4]
- Average quality (MJME/kg DM) of all feed consumed (pasture and supplements) by each of the stock classes.

Data from the monthly summaries are then summarised according to the following.

1. Total amount of each supplement type used by month across the year (Table 6), with a cross check against the total amount of supplement allocated to individual stock classes, relative to the total amount recorded as used on farm (modelled).
2. Total feed intake and feed quality estimates for each month across the year (Table 7).
3. Total amount of each supplement type used by stock class and enterprise (Table 8).
4. Breakdown of the percentages of supplemental feed (by supplement type) by stock class and enterprise (Table 9).
5. Average monthly MJME/kgDM intake for each stock class and enterprise (Table 10).

[4] More detail provided in the section on Stock class pasture quality assumption contained within Appendix 2.

6. Average MJME/kgDM intake for each stock class and enterprise across the year (Table 11), compared to MJME estimates using the Farmax pasture and NZGHG inventory estimates.

Table 6. Example of the monthly supplement summary (kg DM) for the 2014-15 season.

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
Baleage	8,113	10,040	4,722	1,901	0	0	0	0	0	0	2,383	5,425	32,584
Barley silage	0	1,900	1,168	0	0	0	0	0	0	0	0	0	3,068
Kale	11,104	10,244	3,067	0	0	0	0	0	0	0	1,799	10,316	36,530
Leafy turnip	0	0	0	0	0	0	4,777	11,363	7,555	4,668	0	0	28,363
Sheep nuts	776	1,227	475	0	0	0	0	437	937	399	0	0	4,251
Swedes	23,800	25,800	17,204	4,352	0	0	0	0	0	0	2,934	15,155	89,245
Total supplements (kg DM) allocated	43,793	49,211	26,636	6,253	0	0	4,777	11,800	8,492	5,067	7,116	30,896	194,041
Reported as consumed on farm (modelled)	43,802	49,247	26,639	6,262	0	0	4,764	11,820	8,494	5,081	7,101	30,893	194,102

Table 7. Example of the total feed intake (kg DM) and quality estimates (MJME/kg DM) for the 2014-15 year.

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Total
KG DM Pasture	154,395	160,316	209,101	266,009	268,529	267,488	245,951	207,060	234,184	206,617	190,161	149,769	2,559,581
KG DM Total	198,197	209,563	235,740	272,271	268,529	267,488	250,715	218,880	242,678	211,698	197,262	180,662	2,753,683
Average MJME/kgDM	10.29	10.69	11.16	10.98	10.85	10.44	10.28	10.24	9.70	9.93	10.08	10.04	10.42

Table 8. Example of the annual supplement usage across the beef cattle stock classes for the 2014-15 year

Supplement type	MJME/kgDM	Cows	R2 heifers	R1 heifers	Heifer calves	Steer calves	R1 steers	R2 steers	Bull calves	R1 bulls	Bulls	Total Beef
Baleage	**10.0**	2,738	1,175	1,131	59	85	1,195	363	6	0	0	6,752
Kale	**11.0**	0	1,879	2,468	1,445	1,458	726	2,129	125	0	0	10,230
Swedes	**12.8**	2,343	2,132	3,719	470	396	8,511	5,779	44	0	0	23,394
Total supplements (kg DM)		5,081	5,186	7,318	1,974	1,939	10,432	8,271	175	0	0	40,376
Total demand (kg DM)		285,785	61,823	84,254	18,583	15,434	89,220	23,091	3,708	9,170	12,627	603,695

Table 9. Example of the breakdown of supplement types used within the beef cattle enterprise for the 2014-15 year.

	Cows	R2 heifers	R1 heifers	Heifer calves	Steer calves	R1 steers	R2 steers	Bull calves	R1 bulls	Bulls	Beef average
% of total as supplements	1.8%	8.4%	8.7%	10.6%	12.6%	11.7%	35.8%	4.7%	0.0%	0.0%	6.7%

	Cows	**R2 heifers**	**R1 heifers**	**Heifer calves**	**Steer calves**	**R1 steers**	**R2 steers**	**Bull calves**	**R1 bulls**	**Bulls**
Baleage	54%	23%	15%	3%	4%	11%	4%	3%	0%	0%
Kale	0%	36%	34%	73%	75%	7%	26%	71%	0%	0%
Swedes	46%	41%	51%	24%	20%	82%	70%	25%	0%	0%

Table 10. Example of the monthly average quality estimates (MJME/kgDM) for feed consumed by each beef cattle stock class for the 2014-15 year.

	Cows	**R2 heifers**	**R1 heifers**	**Heifer calves**	**Steer calves**	**R1 steers**	**R2 steers**	**Bull calves**	**R1 bulls**	**Bulls**	**Beef average**
July	9.29	9.64	10.29	0.00	0.00	11.04	10.82	0.00	10.10	9.29	9.86
August	9.68	9.88	10.55	0.00	0.00	11.51	11.67	0.00	10.50	9.66	10.29
September	10.74	11.09	11.56	0.00	0.00	11.64	11.95	0.00	11.10	10.66	11.18
October	10.67	10.75	11.11	0.00	0.00	11.11	11.11	0.00	11.00	10.56	10.86
November	10.46	10.46	10.90	0.00	0.00	10.90	10.90	0.00	10.90	10.46	10.65
December	9.88	9.88	10.40	0.00	0.00	10.40	0.00	0.00	10.40	9.88	10.05
January	9.69	9.69	10.20	0.00	0.00	10.20	0.00	0.00	10.20	9.69	9.85
February	9.60	9.60	10.10	0.00	0.00	10.10	0.00	0.00	10.10	9.60	9.75
March	9.12	9.12	9.60	9.98	0.00	9.60	0.00	9.98	9.60	9.12	9.29
April	9.60	9.60	9.80	10.19	10.19	9.80	0.00	10.19	9.80	9.60	9.79
May	9.80	0.00	10.14	10.30	10.30	10.14	0.00	10.30	10.00	9.80	10.02
June	9.11	0.00	10.41	10.25	10.23	10.12	0.00	10.25	9.90	9.11	9.70

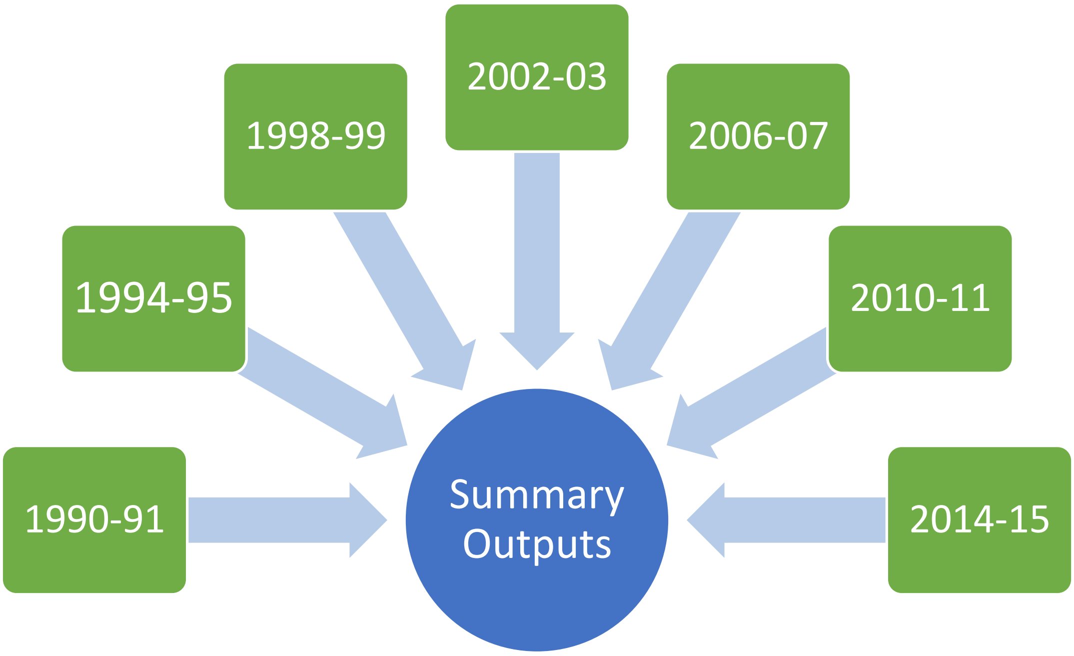
Table 11. Example of the average quality estimates (MJME/kgDM) for feed consumed by the beef cattle stock classes over the 2014-15 year.

	Cows	R2 heifers	R1 heifers	Heifer calves	Steer calves	R1 steers	R2 steers	Bull calves	R1 bulls	Bulls	Beef average

Average (Modelled)	9.82	10.00	10.45	10.24	10.25	10.59	11.31	10.20	10.38	9.82	10.13
Average (Farmax pasture)	9.80	9.88	10.34	10.10	10.09	10.37	10.74	10.14	10.38	9.82	10.03
Average (Inventory)	10.39	10.52	10.46	9.98	10.04	10.47	11.17	9.78	10.46	10.50	10.43

Key outputs from each of the 7 annual worksheets are then compiled into the summary output worksheets, with the workflow for this shown in Figure 8.

Figure 8. Summary of the data flow from the Step 3 annual worksheets into the Step 4 Class 9 summary outputs tab.



Section 4: Summary Outputs

This section of the model contains 5 worksheets which summarise results for each of the sheep, beef cattle, other cattle and deer enterprises, and the overall Class 9 farm system outputs.

Class 9 farm results

The Class 9 summary worksheet summarises data over all of the enterprises and years. To remove anomalies due to changes in effective farm area, results are scaled to 1000 hectares of effective area. For example in 1990-91, total feed demand is estimated at 1.91 million kg DM, on an effective area of 514 hectares[5], with feed demand per hectare calculated as:

1.91 million kg *1000/514 = 3.72 million kg DM/1000 ha = 3.72 Tonnes /ha

Table 12 shows a summary of total feed demand and supplement usage within each of the historical farm enterprises.

Table 13 summarises changes over the Class 9 farm system as a whole. Note that Table 13 also includes an additional check function to ensure that the total quantity of supplements allocated, is in close alignment with the amount of supplements modelled, with variances of +/- 0.05% highlighted to easily identify supplement allocation errors or inconsistencies.

[5] See Figure 3 from the feed demand section above, for changes in historical total feed demand and effective area.

Table 12. Summary of changes in total feed demand and supplement usage (all stock classes) within each of the historical farm enterprises (at 4-year intervals from 1990-91, based on scaling of enterprises to a constant area to adjust for anomalies with Class 9 data associated with changes in effective farm area over time)

	Sheep (Tonnes DM/ha)				Beef (Tonnes DM/ha)				Other cattle (Tonnes DM/ha)				Deer (Tonnes DM/ha)				Total All feed
	Pasture	Sup.	Total	% sup	Pasture	Sup.	Total	% sup	Pasture	Sup.	Total	% sup	Pasture	Sup.	Total	% sup	
1990-91	2.42	0.15	2.57	5.8%	0.66	0.05	0.70	6.4%	0.27	0.04	0.31	13.7%	0.13	0.00	0.13	0.00	3.72
1994-95	2.35	0.14	2.48	5.5%	0.84	0.05	0.89	5.7%	0.35	0.06	0.42	14.6%	0.16	0.00	0.16	0.00	3.95
1998-99	2.46	0.14	2.60	5.4%	0.83	0.05	0.88	5.5%	0.41	0.07	0.48	15.3%	0.26	0.00	0.26	0.00	4.21
2002-03	2.52	0.13	2.64	4.8%	0.79	0.04	0.84	5.3%	0.63	0.10	0.73	13.3%	0.27	0.00	0.27	0.00	4.48
2006-07	2.53	0.15	2.67	5.5%	0.88	0.05	0.93	5.7%	0.54	0.09	0.63	13.9%	0.28	0.00	0.28	0.00	4.51
2010-11	2.47	0.15	2.62	5.8%	0.86	0.05	0.91	6.0%	0.48	0.09	0.57	15.7%	0.20	0.00	0.20	0.00	4.30
2014-15	2.42	0.15	2.57	5.8%	0.90	0.06	0.96	6.7%	0.57	0.10	0.67	14.4%	0.19	0.00	0.19	0.00	4.39

Table 13. Summary of changes in total feed demand and supplement usage within the historical Class 9 farm models, with an additional check included to ensure that the total quantity of supplements allocated within each year is in close alignment with the total amount of supplements included within the Class 9 farm system models.

	(Tonnes DM/ha)			% Supplements	Allocation check
	Pasture	Supp.	Total		
1990-91	3.48	0.24	3.72	6.4%	100%
1994-95	3.70	0.25	3.95	6.3%	100%
1998-99	3.95	0.26	4.21	6.2%	100%
2002-03	4.21	0.27	4.48	6.0%	100%
2006-07	4.22	0.29	4.51	6.4%	100%
2010-11	4.01	0.30	4.30	6.9%	100%
2014-15	4.08	0.31	4.39	7.0%	100%

Additonal results within the Class 9 summary spreadsheet include:

1. Changes in **annual feed demand profiles**, with Figure 9 showing changes in total feed demand/ha over the historical winter, spring, summer and autumn periods.
2. Changes in **annual supplemental feed profiles**, where Figure 10 highlights changes in supplemental feed usage as a percentage of total feed demand over the same time periods.
3. Changes in **supplement usage per hectare**, with Figure 11 showing increases in the usage of kale, leafy turnips and swedes, whilst the amount of baleage used per hectare remained relatively unchanged over time.
4. Changes in **total feed demand/ha**, where Figure 12 shows a slight drop-off in total feed demand/ha since 2006, with this likely attributed to changes in land type (as discussed in the earlier project 405376 sheep supplementary feed report).
5. Changes in **total supplement used by each of the enterprises**, with Figure 13 showing historical changes in the total quanity of supplements used relative to effective farm area.
6. Changes in **supplemental feed usage as a percentage of total feed demand**, where Figure 14 highlights differences in supplemental feed usage between the sheep, beef cattle and other cattle enterprises.

Figure 9. Changes in the seasonal total feed demand profiles over the period from 1990-91 to 2014-15.

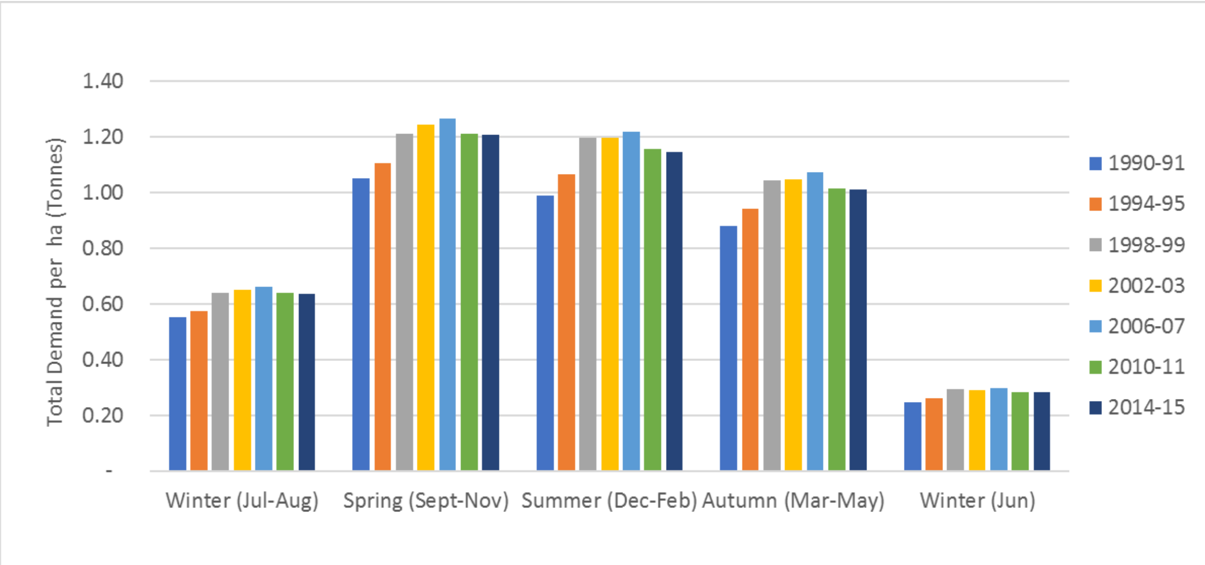


Figure 10. Changes in the seasonal feed demand profiles for supplements over the period from 1990-91 to 2014-15

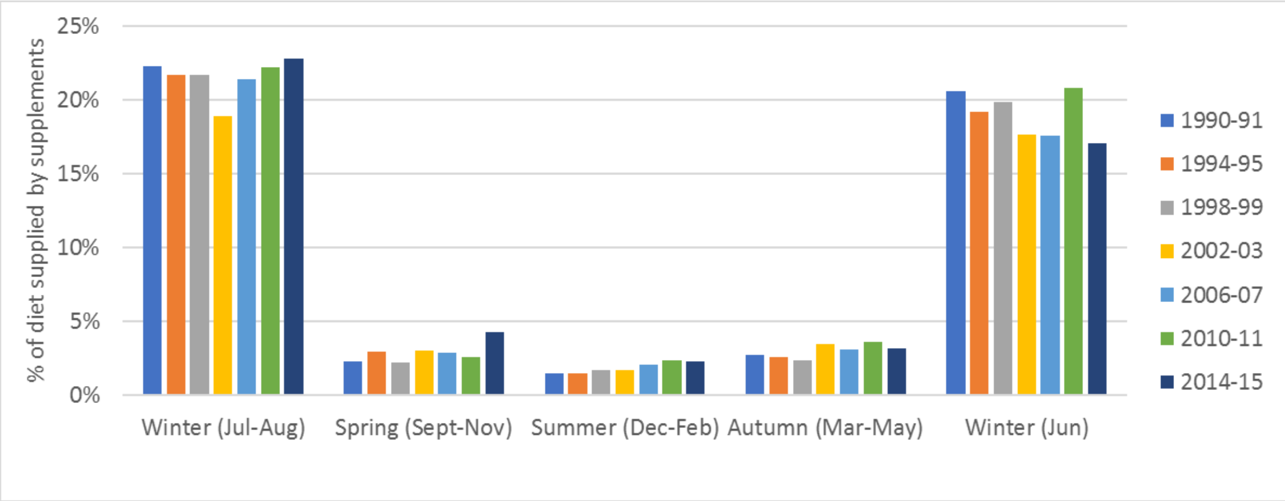


Figure 11. Supplement usage per hectare of effective farm area.

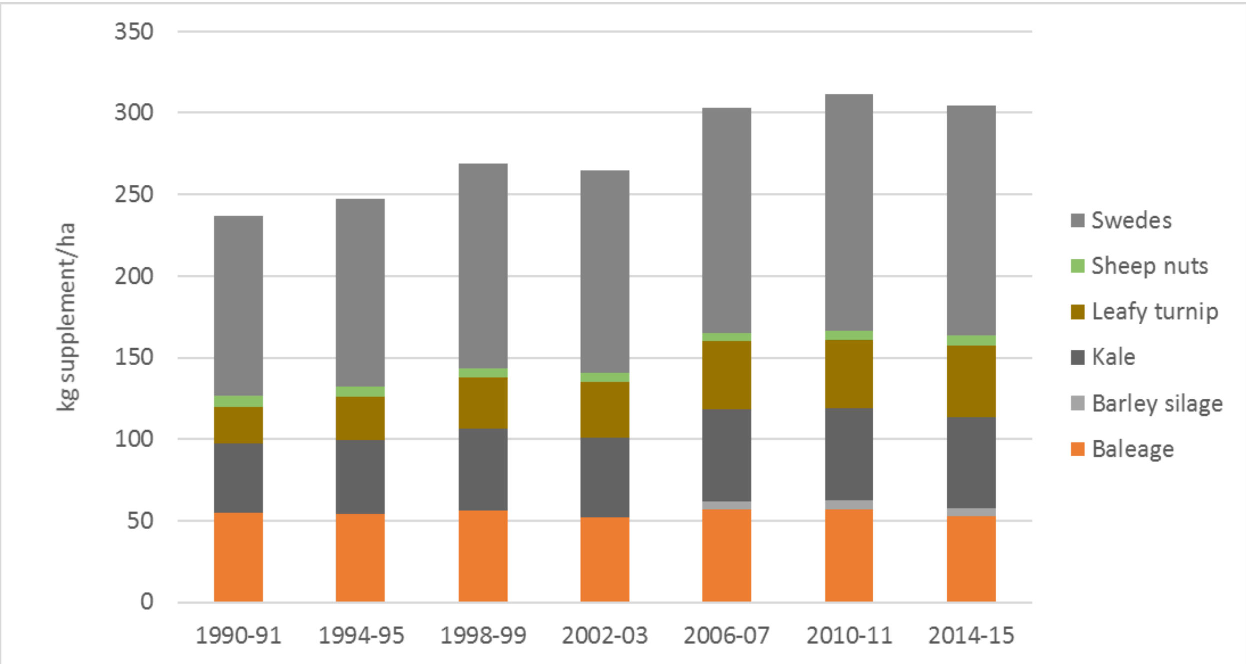


Figure 12. Changes in Class 9 pasture and supplement intake over time (Tonnes DM/ha).

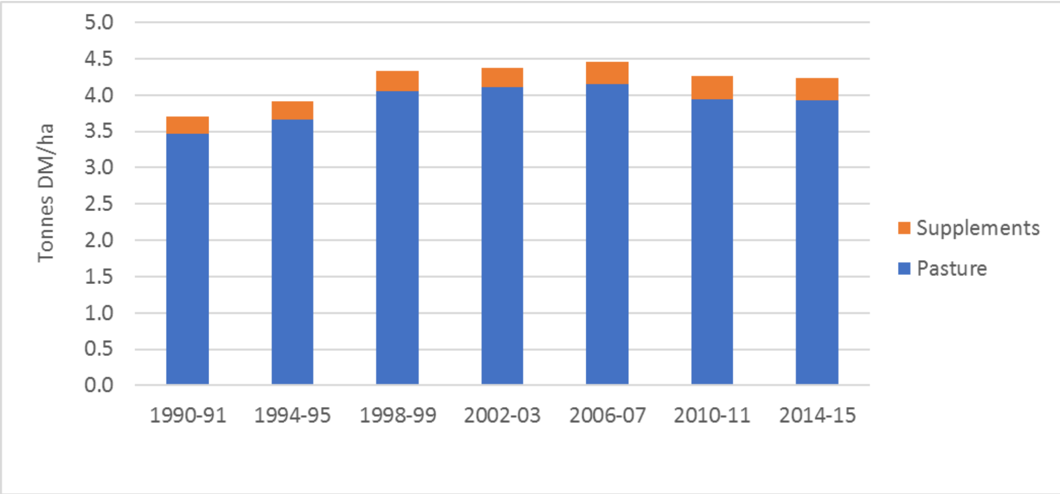


Figure 13. Class 9 farm enterprise supplement usage[5].

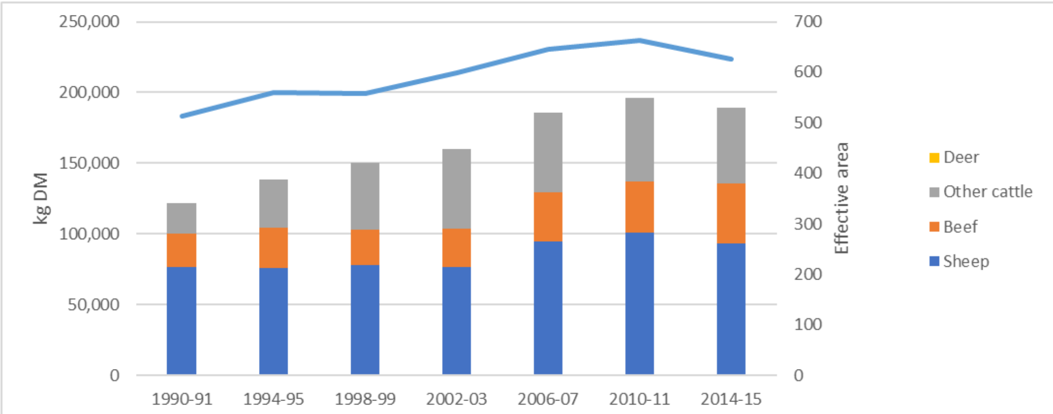
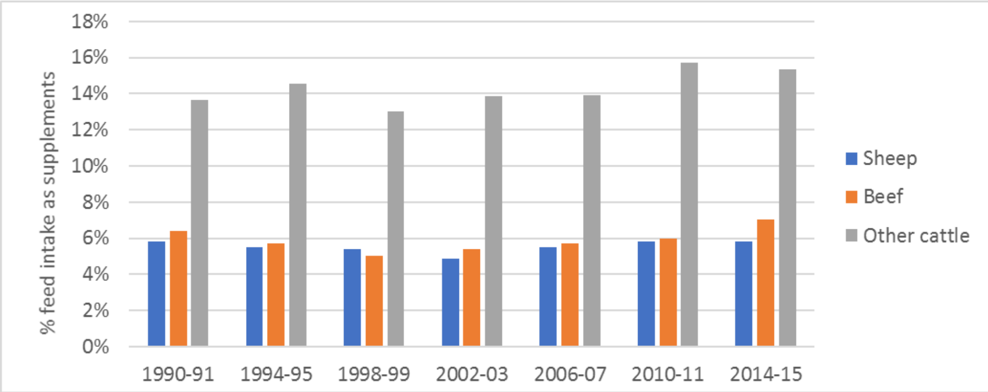


Figure 14. Percentage of supplemental feed intake for Class 9 livestock enterprises[6].

[6] Note that within the historical models, no supplements have been allocated to deer (with deer accounting for less than 5% of total feed demand), therefore results are not displayed. The select data function can be used to display results for deer if required.



Farm enterprise results

Results presented within the farm enterprise summary worksheets have been designed to focus in on changes in supplementary feed usage and total feed demand for individual stock classes within each enterprise. This also allows an assessment of changes in the average energy content of feed consumed, which combined with feed intake, has a flow-on effect for estimates of greenhouse gas (GHG) emissions.

The key outputs presented for each of the farm enterprises are summarised below, with results for the beef and other cattle enterprises used to profile the outputs[7].

1. Changes in **feed demand per hectare** for individual stock classes.
2. Changes in **supplemental feed intake per hectare** for individual stock classes.
3. Changes in **% of total feed intake provided by supplements within individual stock classes.**
4. Changes in the **% of total feed intake provided by supplements** within the enterprise.
5. Changes in the **quantity of individual supplements consumed** by the enterprise per hectare.
6. Changes in the **average energy content (MJME/kgDM) of feed consumed** by the enterprise.
7. Changes in the **average energy content (MJME/kgDM) of feed consumed** by individual stock classes within the enterprise.

1. Changes in feed demand per hectare for individual stock classes.

To ensure a fair comparison across all stock classes and enterprises, the Class 9 results for each season are initally scaled to 1000 hectares, and then further scaled to account for changes in the percentage of total feed demand from each enterprise relative to the analyses for the first year (1990-91).

For example, in 1990-91, beef cattle accounted for 19% of total on-farm feed demand. By 1994-95, feed demand from beef cattle had increased to 23% of total, with some of this increase coming from gains in on-farm productivity, and some simply from changes in the numbers of stock run, namely more beef cattle, less sheep. To account for these changes, feed demand per hectare for each of the enterprises is scaled to enable a fair comparison with 1990-91. For example:

For the 1990-91 season,

[7] A full summary of the results for sheep is contained within the project 405376 report, with the deer enterprise assumed to receive no supplemental feed.

Total feed demand for beef = 361,446 kg DM (**19%** of total Class 9) & effective area = 514 ha

- Total feed demand/ha = 361,446/514 = 703 kg/ha = **0.703 Tonnes/ha**

For 1994-95,

Total feed demand for beef = 500,003 kg DM (**23%** of total Class 9) & effective area = 560 ha

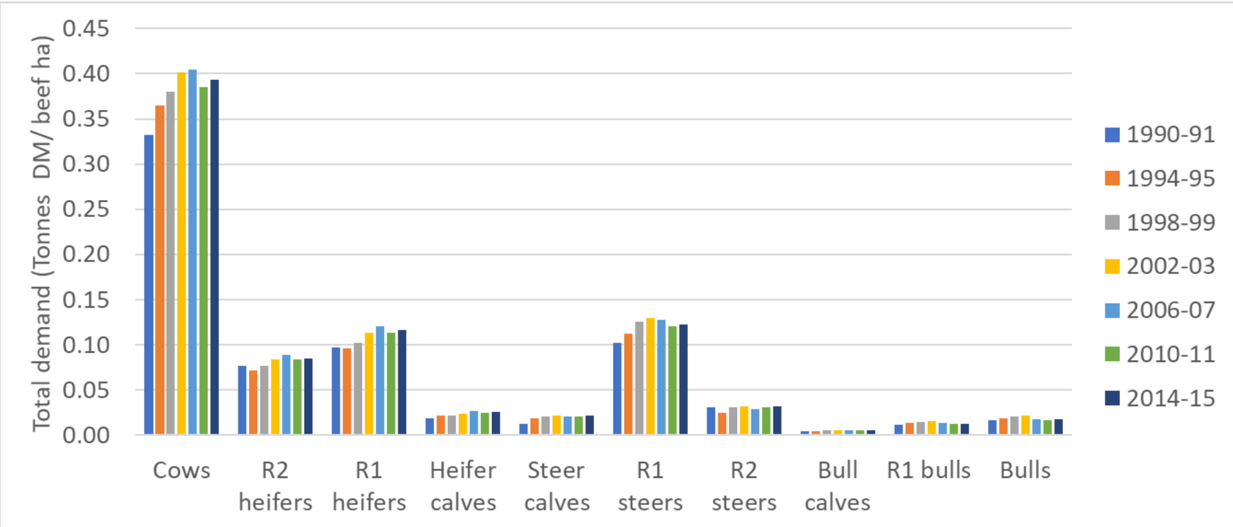
- Total feed demand/ha = 500,003/560 = 893 kg/ha = **0.893 Tonnes/ha**

Adjustment to account for increases in beef relative to other farm enterprises

- Adjusted total feed demand = 0.893 * 19%/23% = **0.747 Tonnes/ha.**

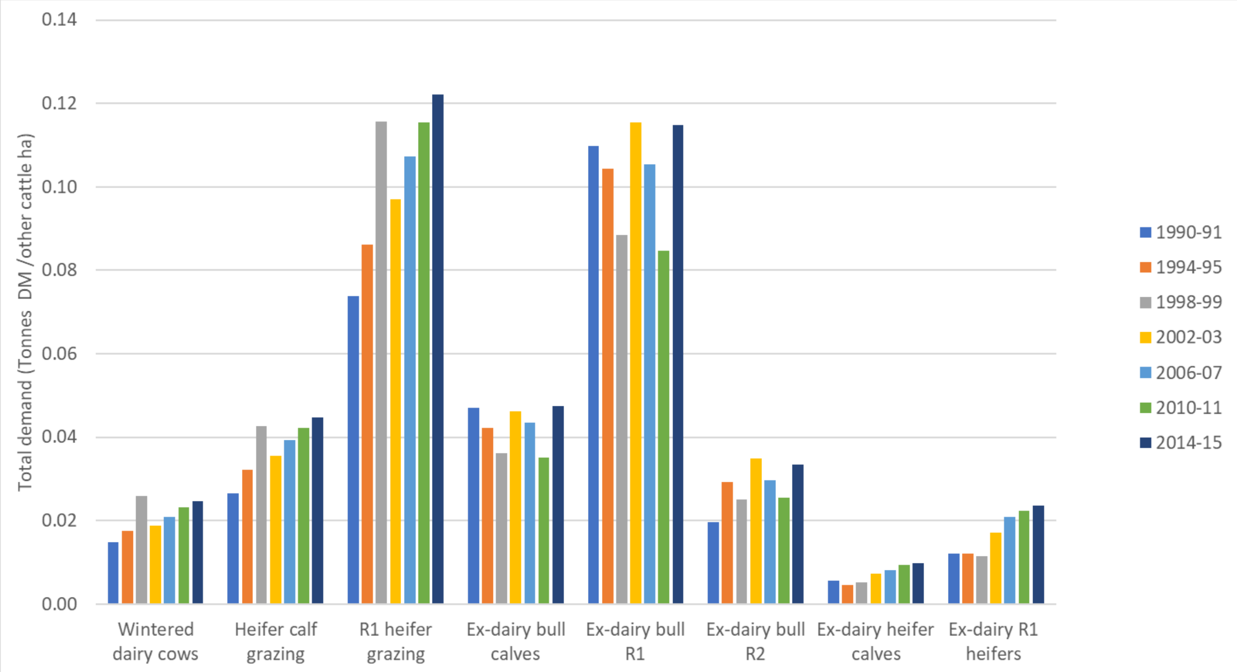
Figure 15 shows the historical changes in total feed demand/ha with the farm area grazed by beef cattle, with increases in demand/ha observed for the cows, and the R1 and R2 stock classes, but little change in other stock classes. These increases are likey to be driven by increases in growth rate and mature weights in beef cattle, with increases in demand for R2 steers not fully recognised due to animals reaching slaughter weight at an earlier age.

Figure 15. Historical changes in total feed demand per hectare of effective area grazed by beef cattle.



Changes in total feed demand/ha for the other cattle enterprises are shown in Figure 16, where there have been small but steady increases in most stock classes over time.

Figure 16. Historical changes in total feed demand per hectare of effective area grazed by other cattle (including land used for dairy grazing and finishing of cattle exiting the dairy system).



2. Changes in supplemental feed intake per hectare for individual stock classes.

In this output, results for supplemental usage are also scaled to account for differences in the percentage of total feed demand from the enterprise relative to analyses for the first yearconsidered (1990-91). Figure 17 shows changes in the amount of supplements consumed per hectare grazed by beef with some 'noise' observed in the results for the cow and heifer stock classes. This is due to minor changes in the average percentage of feed intake provided by supplements, as shown in outputs 3 and 4 below. Figure 18 shows changes in supplement usage per hectare for other cattle, where the increases in feed demand have also resulted in increased supplement usage. For example with the wintered dairy stock grazing having 95%-100% of their feed requirements met through supplemental feed, supplemental feed usage has increase from 15 to 25 kg DM/ha grazed. With very few ex-dairy heifer calves coming onto the Class 9 farms for finishing, these stock are assumed to have recieved good quality pasture but no additional supplements.

Figure 17. Historical changes in the amount of supplemental feed consumed per hectare of effective area grazed by beef cattle.

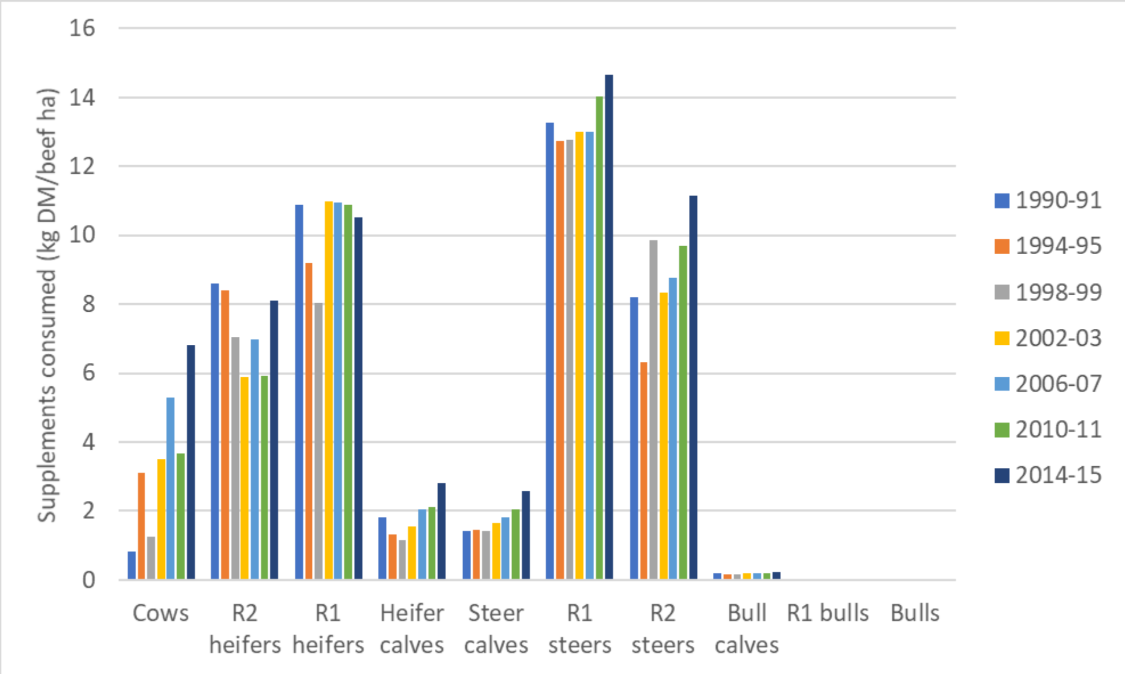
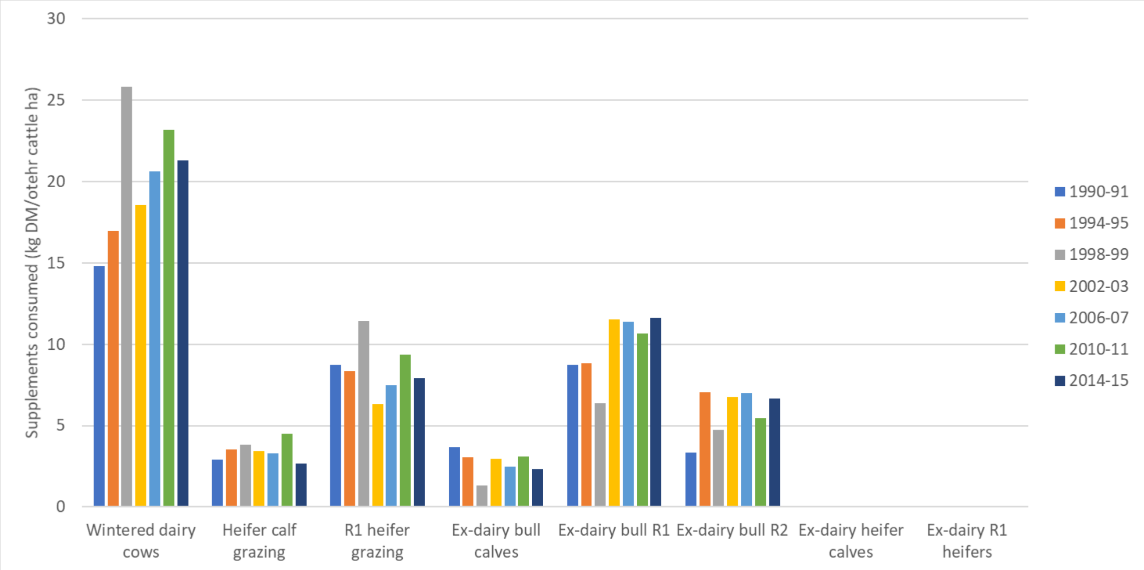

16
14
12
10
8
6
4
2
0
Supplements consumed (kg DM/beef ha)
Cows
R2 heifers
R1 heifers
Heifer calves
Steer calves
R1 steers
R2 steers
Bull calves
R1 bulls
Bulls
1990-91
1994-95
1998-99
2002-03
2006-07
2010-11
2014-15

Figure 18. Historical changes in the amount of supplemental feed consumed per hectare of effective area grazed by other cattle (including land used for dairy grazing and finishing of cattle exiting the dairy system).



3. Changes in percentage of total feed intake provided by supplements within individual stock classes

Figure 19 shows historical changes in the percentage of total feed intake provided by supplements for individual stock classes within the beef cattle enterprise, where minor reductions in supplement usage were observed in some stock classes betrween 1990 and 1998. As a percentage of feed intake there was little change identified in the other cattle enterprise, although minor increases have been identified in the ex-dairy R1 and R2 bull stock classes (Figure 20).

Figure 19. Historical changes in the percentage of total feed intake provided by supplements for individual stock classes within the beef cattle enterprise.

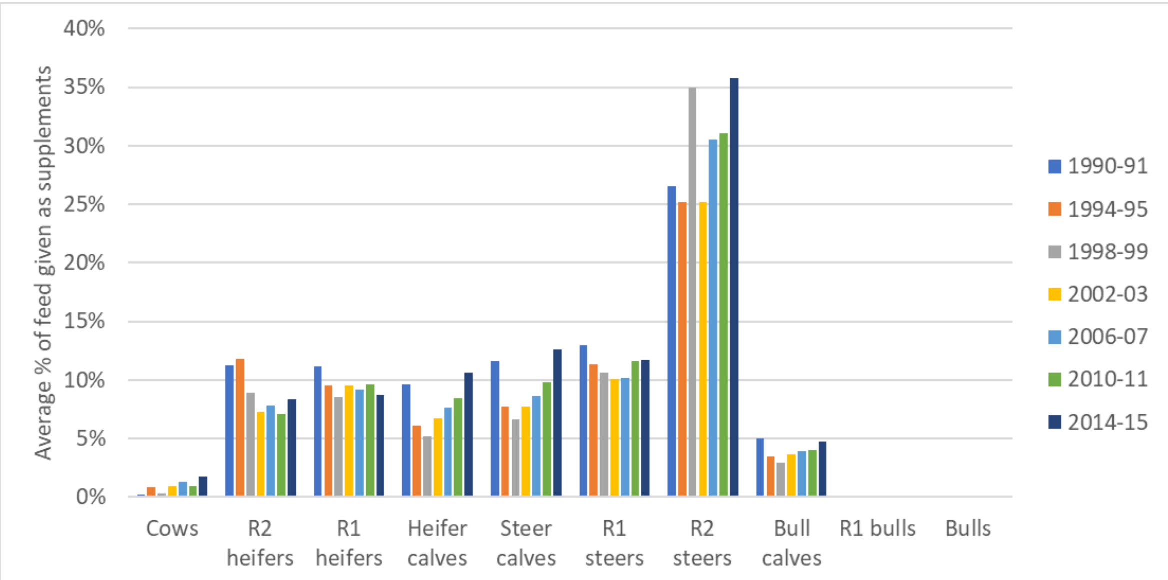
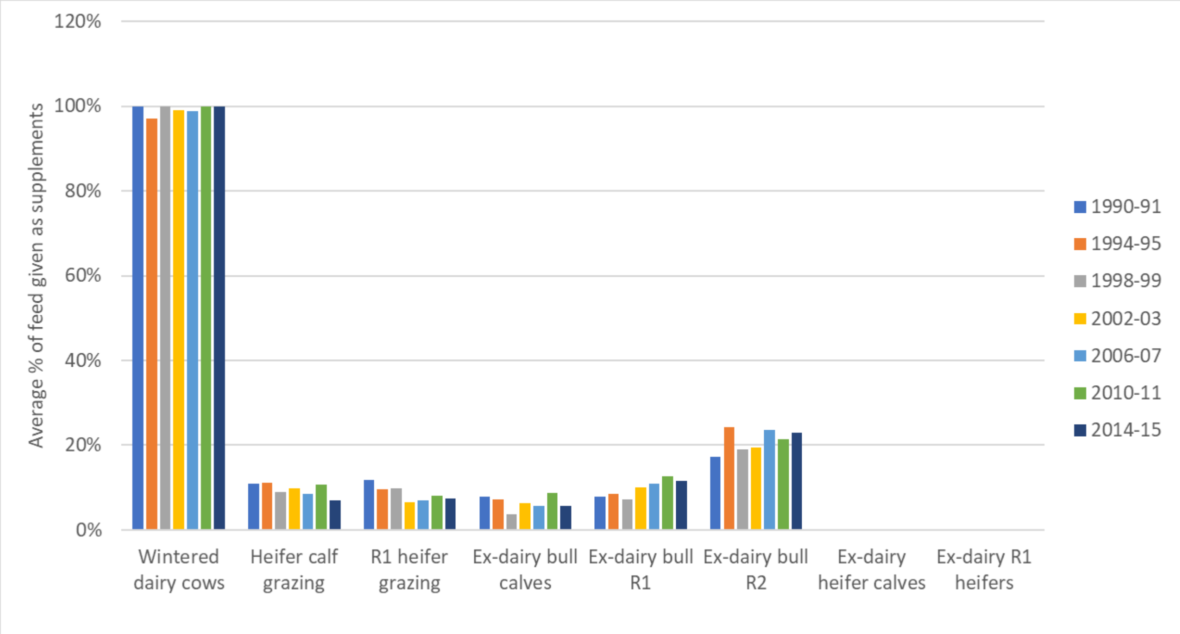


Figure 20. Historical changes in the percentage of total feed intake provided by supplements for individual stock classes within the other cattle enterprise.



4. Changes in the percentage of total feed intake provided by supplements within the enterprise

Figure 21 shows historical changes in the percentage of total feed intake provided by supplements within the beef cattle enterprise, with a small decline in overall usage observed beween 1990-91 and 1998-99. This pattern is also observed in the sheep (data not shown) and likely due to improved pasture management and a period where many farmers apply all grass wintering systems to ensure better utilisation of pastures. This was followed by an increase in total feed demand from supplements as there was a return to growing forage crops, partly as a means towards pasture renewal and also as a low-cost option to feed livestock as overall productivity has increased. The changes are less noticeable in the "other cattle" enterprise (Figure 22); however, at 14-15% the percentage of demand met through supplemental feed is substantially higher than for both sheep (5%-6%) and beef (6%-7%).

Figure 21. Historical changes in the percentage of total feed intake provided by supplements within the beef cattle enterprise.

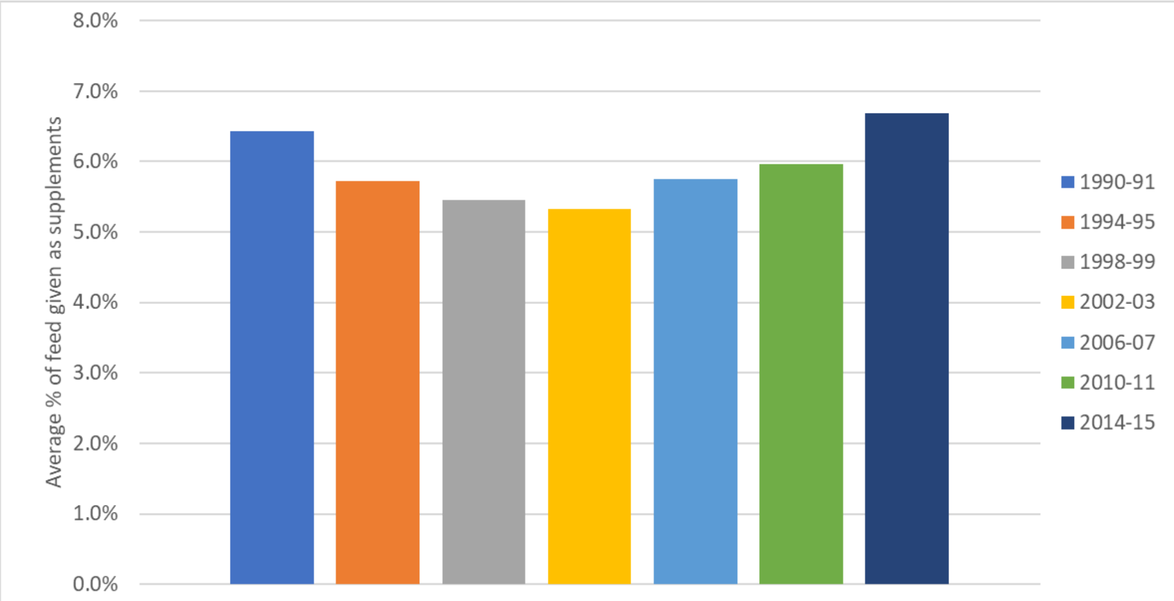
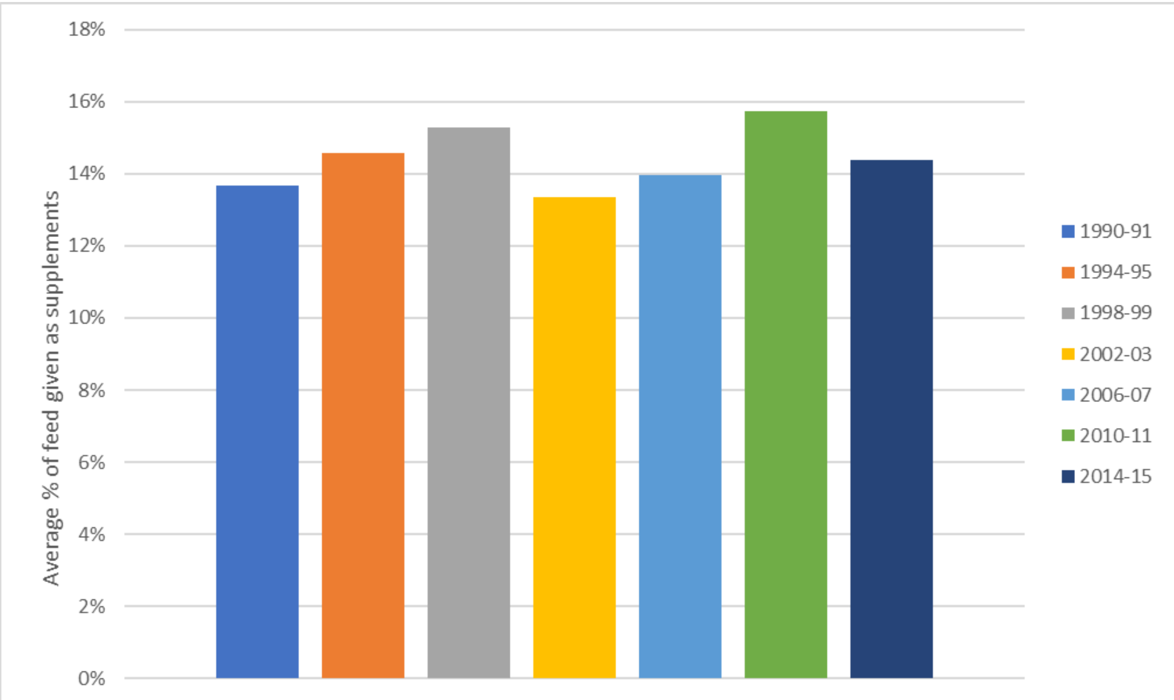


Figure 22. Historical changes in the percentage of total feed intake provided by supplements within the other cattle enterprise.



5. Changes in the **quantity of individual supplements consumed** by each enterprise per hectare

Figure 23 shows historical changes in the amount of individual supplement types consumed per hectare grazed by beef cattle, and Figure 24 changes for the other cattle enterprise, with increasing usage of fodder crops such as kale and swedes through the winter and early spring over time[8].

Figure 23. Historical changes in the amount of individual supplement types per hectare grazed by beef cattle.

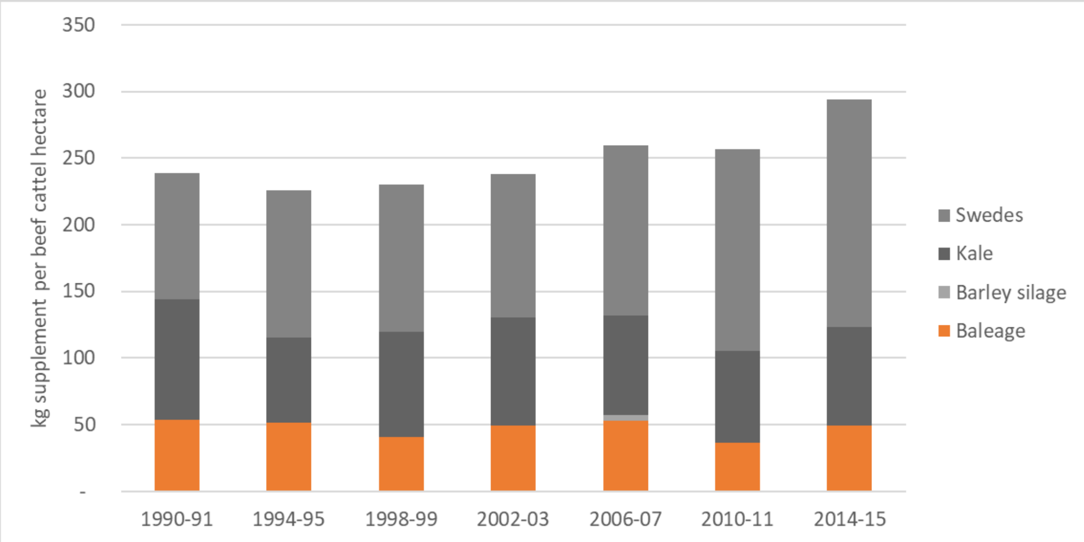
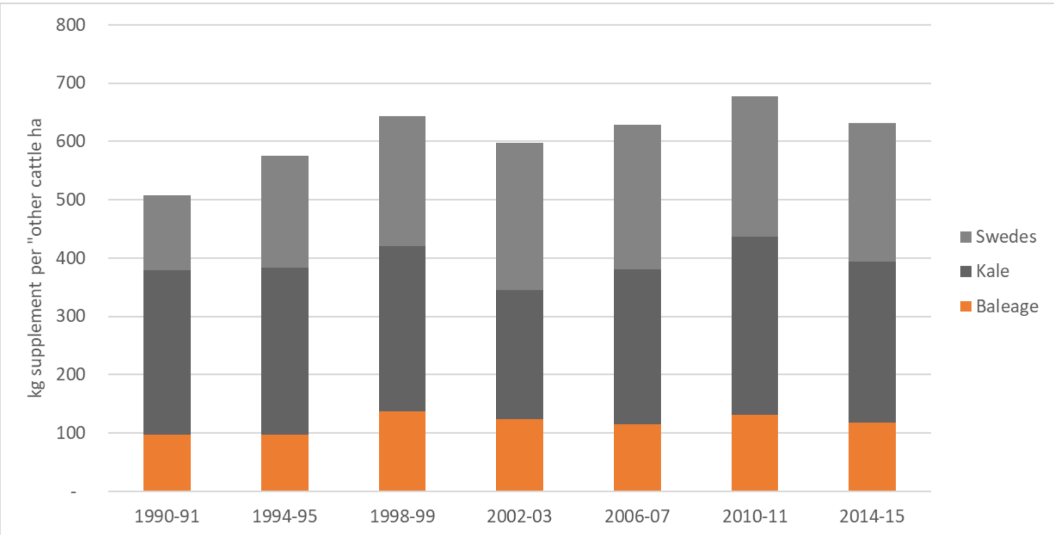


Figure 24. Historical changes in the amount of individual supplement types per hectare grazed by other cattle.



[8] This is partially a function of the productivity gains made in sheep, with spring pasture allocated to ewes with lambs at foot.

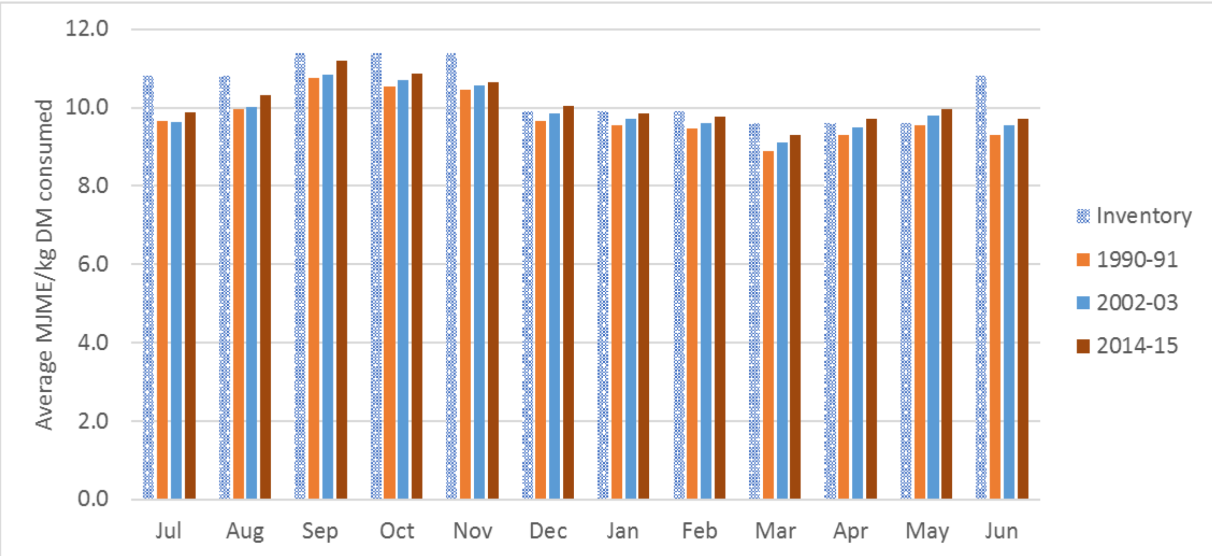
Changes in the average quality (MJME/kgDM) of feed consumed

Figure 25 shows historical changes in the average quality (ME content) of feed consumed by beef cattle, and for the individual beef stock classes (Figure 26) relative to values used by the NZGHG inventory for beef. Similar results were observed for the other stock classes and enterprises (data not shown).

Average feed quality is estimated as a weighted average of the MJME content of the pasture and different supplement types used, with the estimated increases in pasture quality driven primarily by the impovements required to generate known productivity gains[9] in the sheep and beef sector[10].

- *It is important to note that the feed quality assumptions used within the inventory are higher than those used within the Farmax models. This has an impact on GHG estimates, where for the same quanitiy of dry matter, GHG estimates would be lower using the inventory feed quality parameters.*

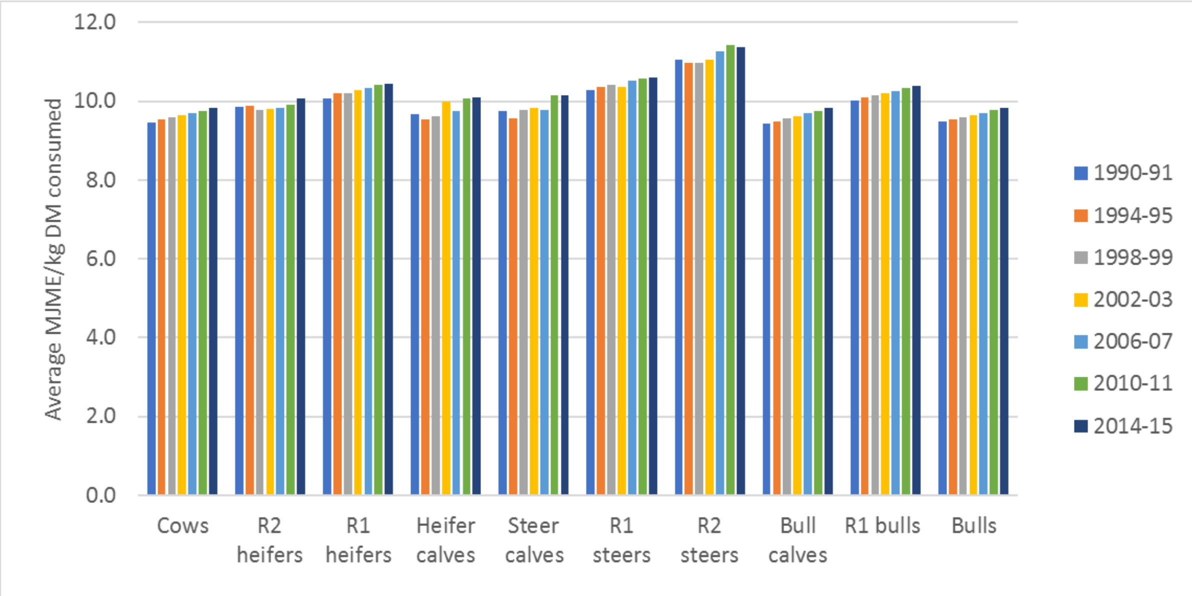
Figure 25. Changes in estimates of the average energy content of feed consumed, relative to monthly values used by the NZGHG for beef cattle.



[9] Analysis of the potential to increase emission intensity improvements through productivity gains. AbacusBio report (MPI tender 17893) by Jude Sise, Jason Archer, Tom Kirk, Brue McCorkindale, Tim Byrne, Peter Fennessy (June 2016).

[10] See Appendix 3 of the project 405376 report for a full description of the assumptions used to estimate historical changes in pasture quality.

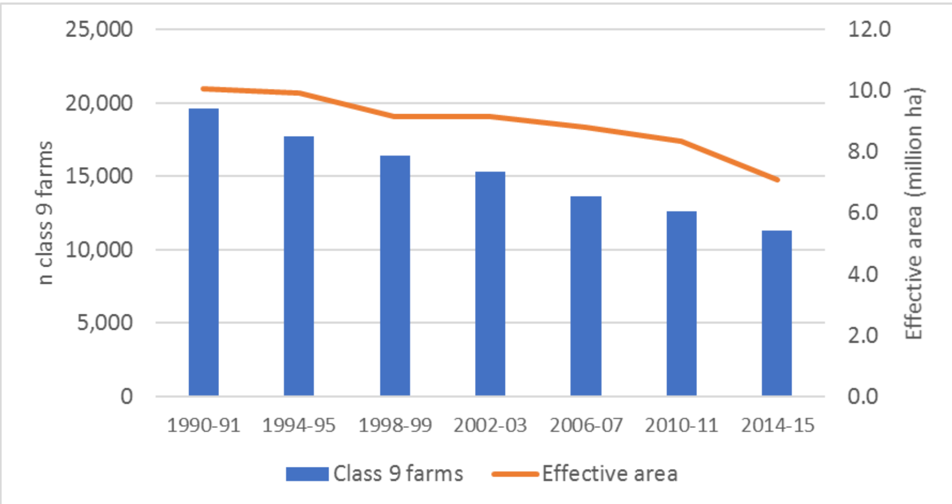
Figure 26. Changes in estimates of the average energy content (MJME/kgDM) of feed consumed by individual stock classes within the beef cattle enterprise.



Section 5: Scaling models

This section of the model contains 5 worksheets which scale results according to the total number of Class 9 farms recorded for each year. Figure 27 shows a summary of historical changes in the number of Class 9 farms, relative to effective area, with the increase in average farm size partially off-setting the reduction in total farm numbers[11]. National results are reported for each of the annual Class 9 farm system models, and for the sheep, beef cattle, other cattle and deer farming enterprises.

Figure 27. Summary of changes in the total number of Class 9 farms and the total effective area.



[11] Average effective area reported as 514 ha in 1990-91 and increasing to a peak of 663 in 2010-11 prior to dropping to 627 in the 2014-15 season.

National results

National Class 9 results are summarised according to 4 key ouputs, with results presented in both tabular and graphical format for ease of display.

1. Changes in **total national feed demand**
2. Changes in **total national supplement usage** for each of the four farm enterprises
3. Changes in the **total amount of individual supplements** used
4. Changes in the **average quality (MJME/kgDM)** of feed consumed for each of the four farm enterprises, and by the Class 9 farming system as a whole, compared to NZGHG inventory estimates.

The feed demand and supplement usage data are also independently reported for each of the 4 farm enterprises, with results for the beef and other cattle enterprises used to profile the results. Note that monthly feed quality estimates are not impacted by the scaling process, with the quality data (MJME/kgDM) already included within the farm enterpise summary outputs.

1. Changes in total national feed demand estimates

Figure 28 shows historical changes in total feed demand estimates for the Class 9 enterprises, where demand has dropped from 37 million tonnes of dry matter in 1990-91 to 31 million tonnes in 2014-15. This drop is primarily driven by reductions in the national sheep flock, with estimated feed demand for sheep dropping from 26 to 18 million tonnes over this period.

Figure 28. Historical changes in total feed demand for Class 9 farms

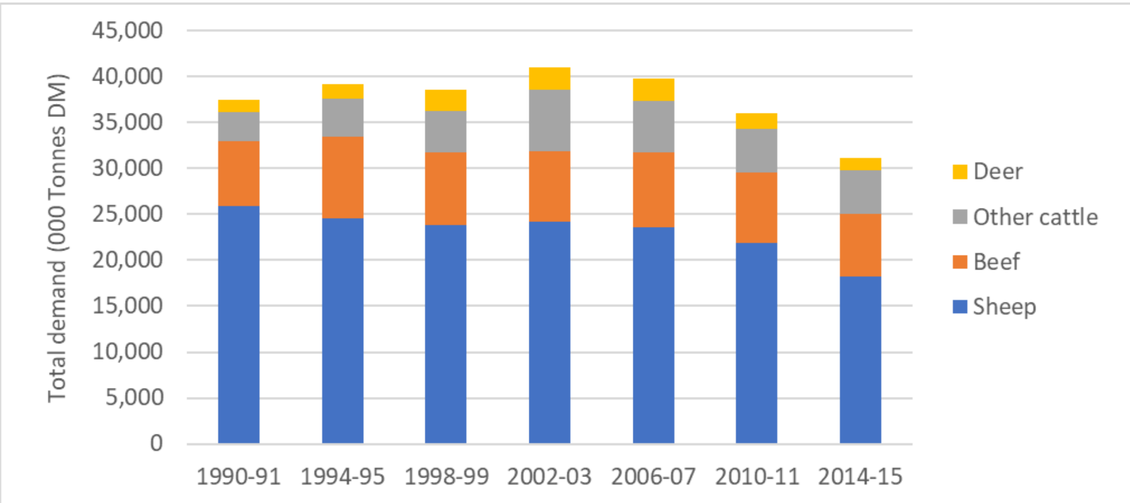


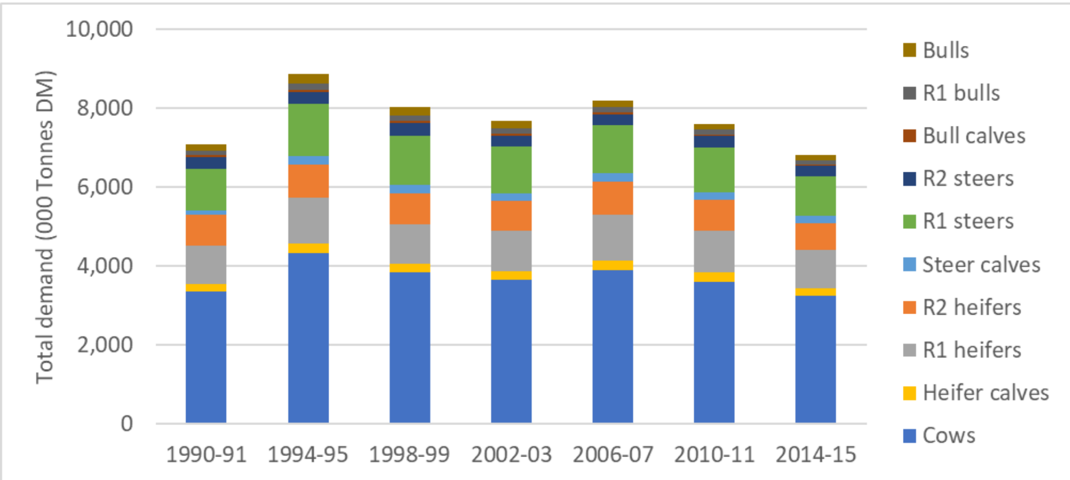
Figure 29 shows changes in total feed demand for the individual beef cattle stock classes, and Figure 30 for the other cattle enterprise stock classes (dairy grazing and ex-dairy beef). It must be noted that these results are not consistent with the known increase in dairy production, which would be expected to show a steady increase in total feed demand from dairy grazing and ex-dairy beef finishing. Changes in dairy support are only partially captured within the Class 9 models with much of the grazing support conducted within dairy run off blocks, and through the use of higher yielding crops such as fodder beet within the dairy system. This is also consistent with industry perceptions that fodder beet plantings have historically been dominated by dairy systems.

The beef demand estimates were also considerably lower than previously estimated, where in a previous analysis[12] of production data for the 1990-91 seasons showed beef feed demand was 54% higher than those estimated using the Class 9 data.

These anomalies are likely due to anomalies in classification of animals as beef versus ex-dairy beef (including cull dairy cows), and the prevalence of beef cattle on small holdings, which are not captured within the Beef + Lamb New Zealand Economic Service Class 9 data sets. To account for anomalies in classification, the feed demand estimates for all cattle types have been combined according to sex and age group, with results shown in Figure 31.

The main driver for the decline in total demand appears to be a steady decline in demand from beef cows and their replacement R2 heifers. This is consistent with the steady replacement on farm of these breeding animals with ex-dairy cattle options.

Figure 29. Historical changes in estimates of national feed demand in the beef cattle livestock classes.



[12] *Analysis of the potential to increase emission intensity improvements through productivity gains. AbacusBio report (MPI tender 17893) by Jude Sise, Jason Archer, Tom Kirk, Brue McCorkindale, Tim Byrne, Peter Fennessy (June 2016).*

Figure 30. Historical changes in estimates of national feed demand in the other cattle livestock classes.

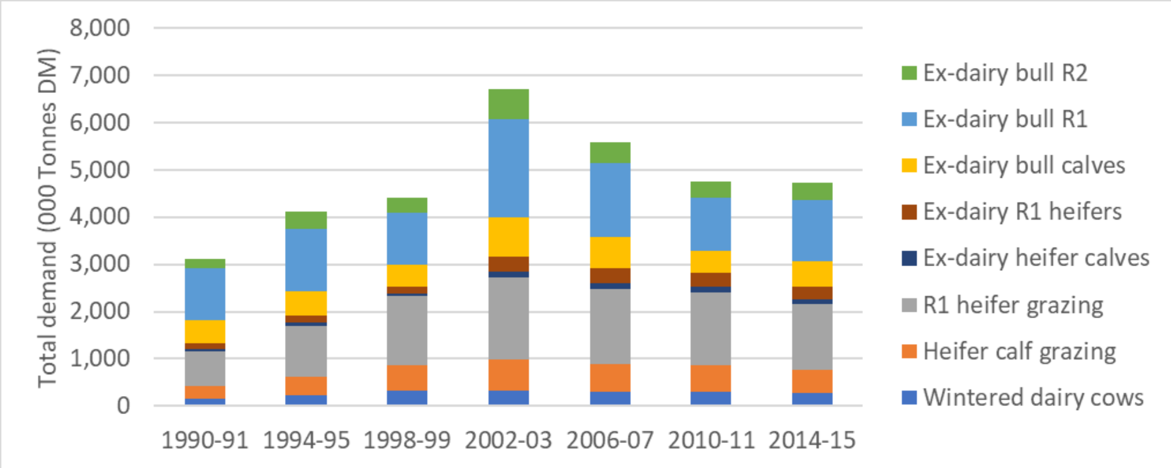
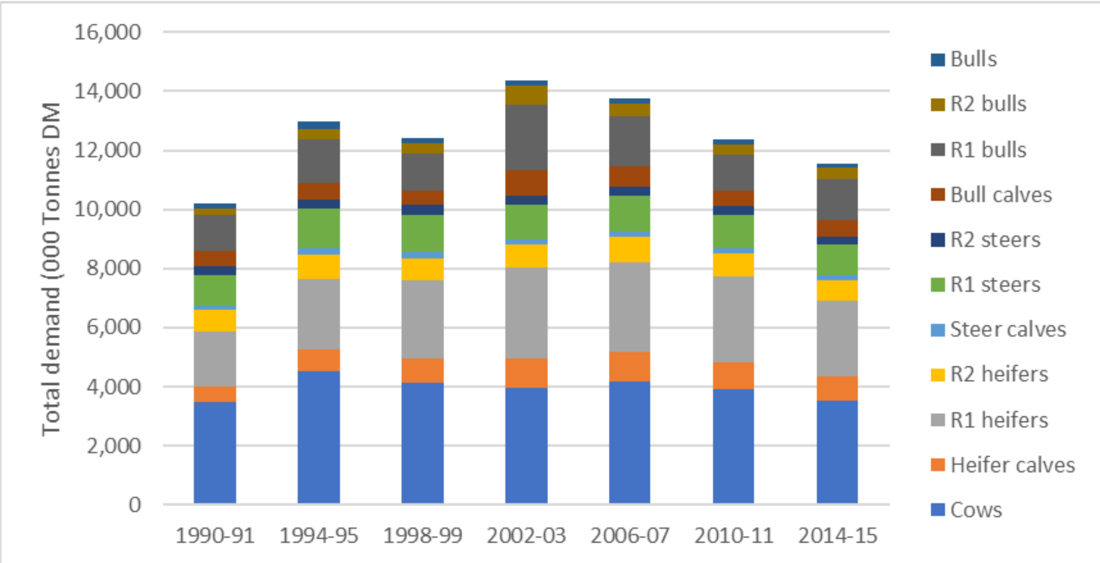


Figure 31. Historical changes in estimates of national feed demand for the combined beef and other cattle enterprises.



2. Changes in total national suppment usage

Figure 32 shows a summary of historical changes in estimates of the total quantity of supplement used on Class 9 farms which has remained relatively constant over time, with the drop shown in 2014-15 in alignment with the drop in total Class 9 feed demand[13].

Figure 32. Historical changes in estimates of the total supplement usage by Class 9 farms.

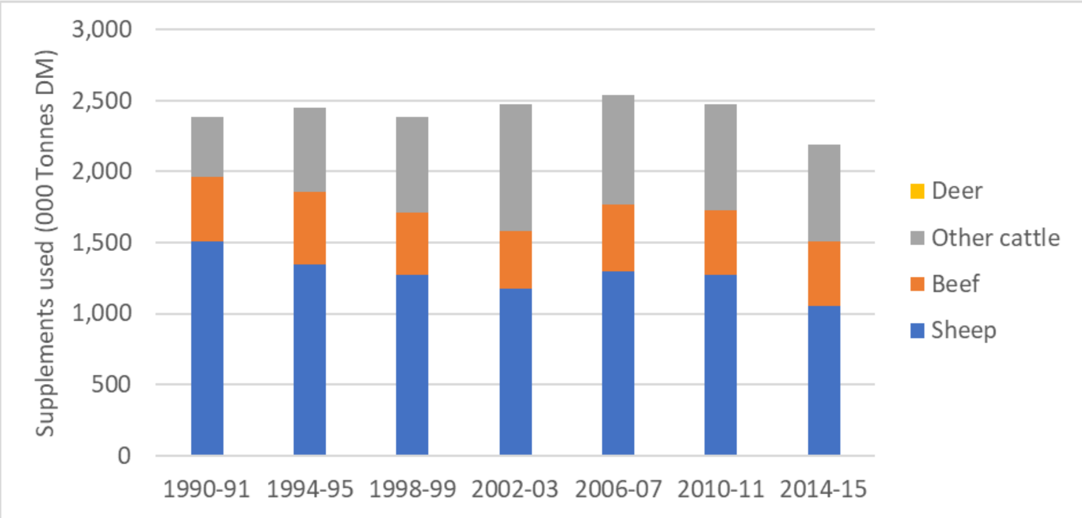


Figure 33 shows supplement usage within the individual beef stock classes, with the R1 stock classes estimated to consume approximately 50% of supplemental feed used within the beef enterprise. Figure 34 shows results for the other cattle enterprises with dairy grazing (cows and heifers) accounting for 60-70% of total supplements used, and ex-dairy bulls entering the beef system for finishing accounting for the remaining 30-40%. When data for the two systems are combined, the impact of increased dairy grazing is readily apparent with the proportion of the supplemental feed available to cattle, and consumed by cows (both beef and wintered dairy) having increased from 18% in 1990-91 to 30% in 2014-15 (Figure 35).

[13] Note that within the historical models, no supplements have been allocated to deer (with deer accounting for less than 5% of total feed demand), therefore results are not displayed. The select data function can be used to display results for deer if required.

Figure 33. Historical changes in estimates of the quantity of supplements used nationally in the beef cattle livestock classes.

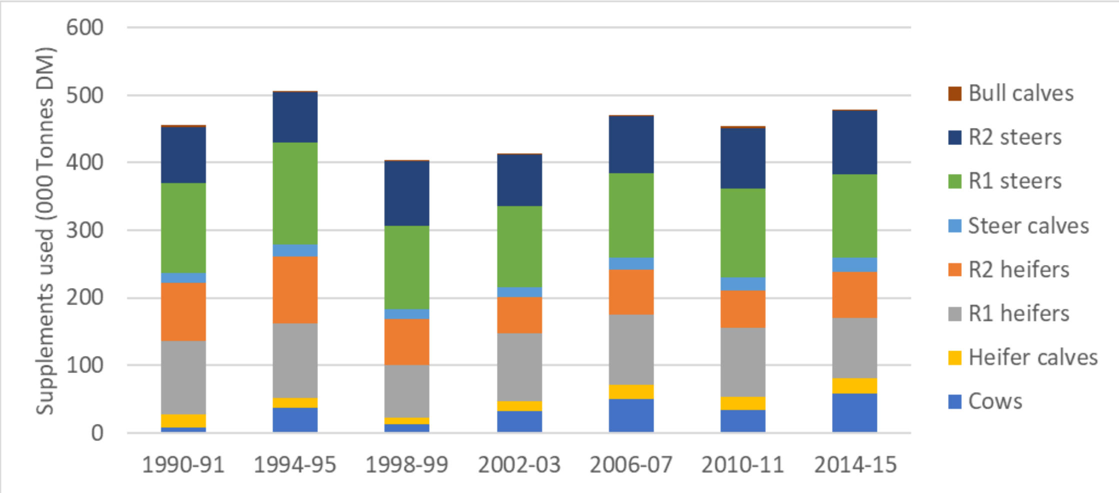


Figure 34. Historical changes in estimates of the quantity of supplements used nationally in the other cattle livestock classes.

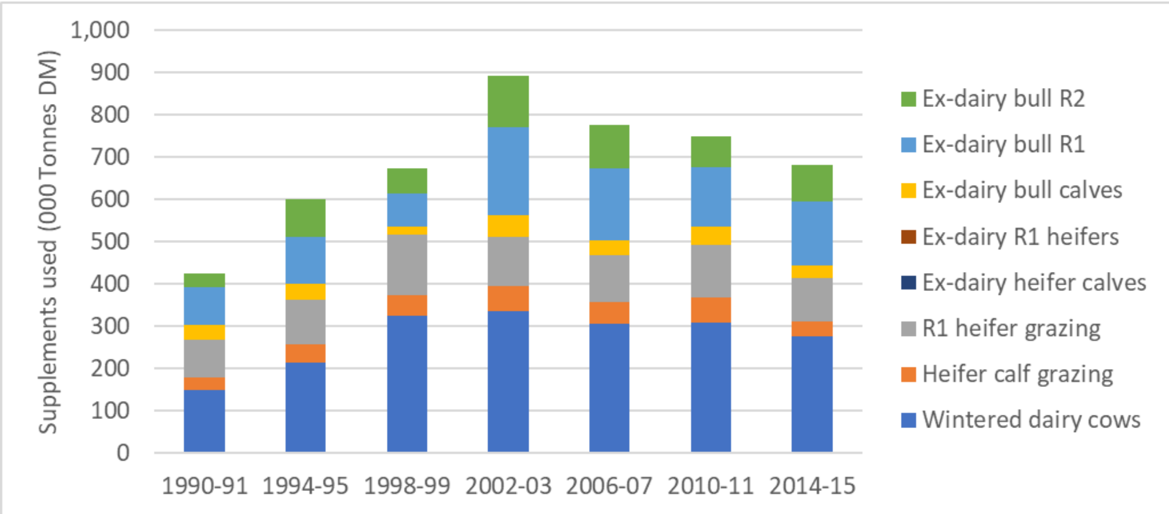
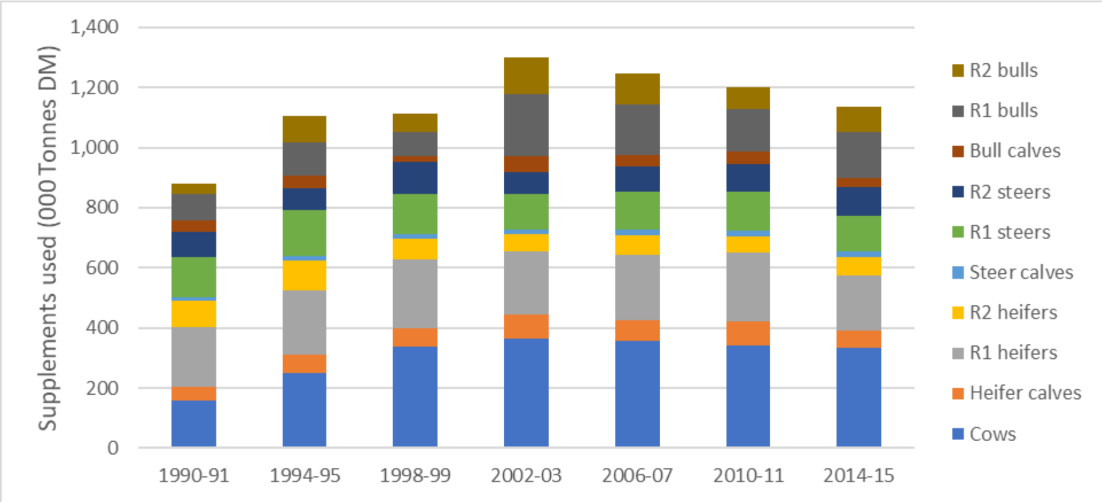


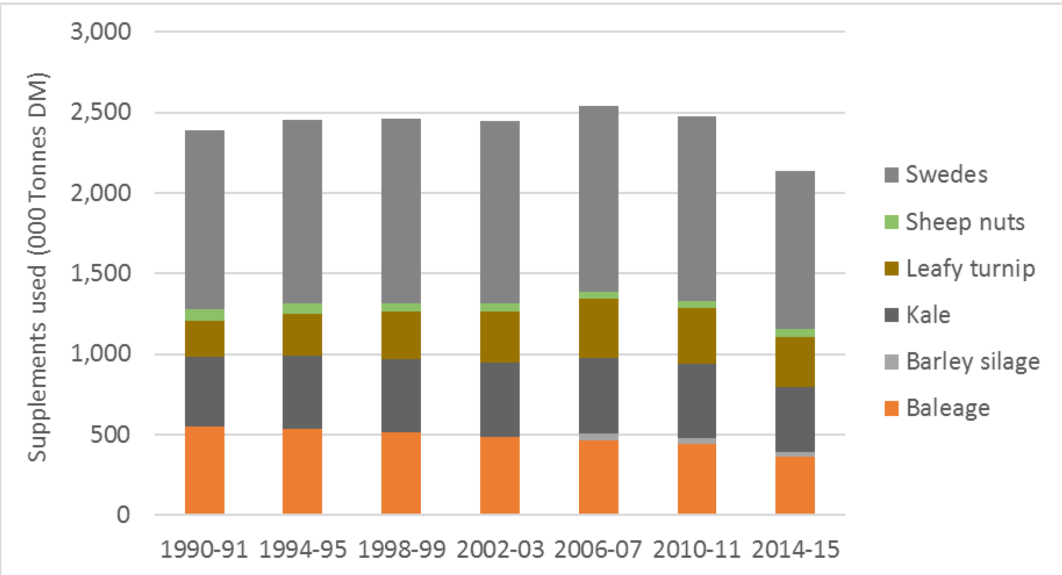
Figure 35. Historical changes in estimates of the quantity of supplements used nationally in the combined beef and other cattle enterprises.



3. Changes in the total quantity of individual supplements used nationally by each enterprise.

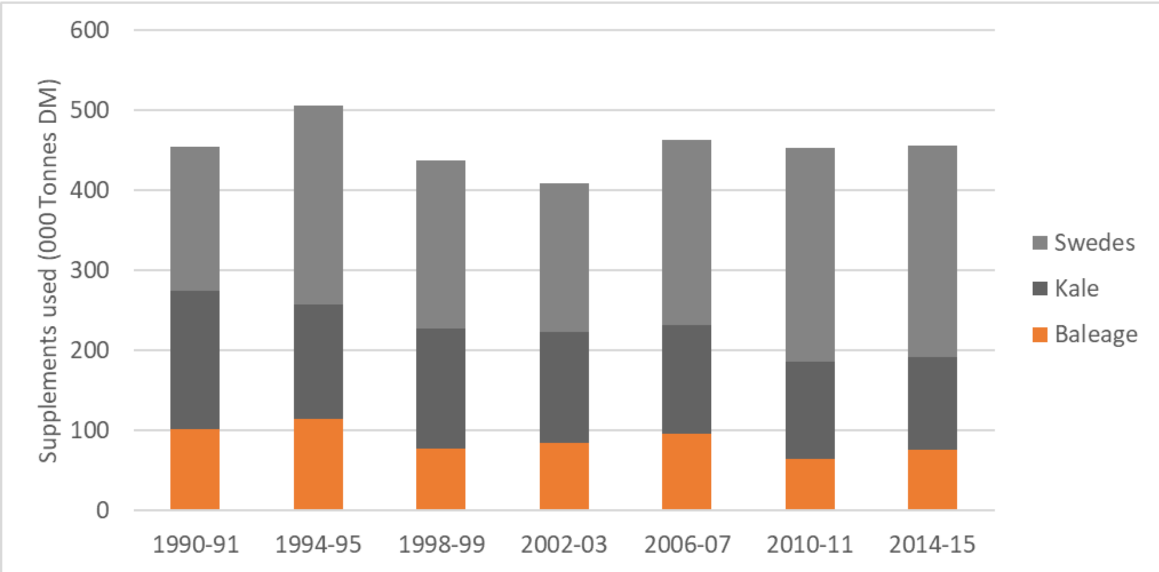
Figure 36 shows a summary of historical changes in estimates of the quanitity of individual supplements used on Class 9 farms. Winter brassicas such as swedes and kale have remained relatively constant, accounting for approximately 65% of supplemental feed used on farm. Usage of summer brassicas such as leafy turnip has increased, from 10% in 1990-91 to 15% in 2014-15 whilst conserved crops (baleage and barley silage) have dropped from 23% to 18% over the same period.

Figure 36. Historical changes in estimates of the quantity of individual supplements used on Class 9 farms.



Within both the beef and other cattle enterprises, winter brassicas account for approximately 80% of total supplemental feed used (Figure 37), with baleage accounting for the other 20%. Note that because fodder beet usage is currently very low[14], no allowance was made for its usage within the historical analysis. Moving forward, fodder beet is likely to form an increasingly important source of supplementary feed, and is expected to be used to ensure that cattle growth rates are maintained through late winter/ early spring.

Figure 37. Historical changes in estimates of the quantity of individual supplements used nationally in the beef cattle livestock classes.



4. Changes in the the average quality (MJME/kgDM) of feed consumed

The average quality of feed consumed is tracked monthly for each livestock class. Average feed quality is estimated as a weighted average of the metabolisable energy content of the pasture and different supplement types used, with additional adjustments then made to account for preferential pasture feeding of some stock classes over others (see Appendix 1). Figure 38 shows changes in the average annual estimated energy content of feed where:

- The steady increase in average ME content observed within the historical scenarios reflects the increase in ME required to realise the productivity gains made between 1990 and 2015.
- The differences between the enterprises are a function of both supplemental feed usage and preferential feeding, where lambs and calves are allocated high quality pasture to encourage good growth rates, whilst cows and R2 heifers are typically allocated low quality pasture relative to all other stock classes.

[14] No fodder beet data was available at the time of analysis, but industry sources have estimated that fodder beet currently makes up approximately up 2% of the winter crops in summer reliable areas and up to 5% in summer dry areas.

Figure 39 shows a comparison of changes in the weighted estimate of average feed quality for the Class 9 system as a whole compared to the Inventory estimates calculated using a weighted average of the monthy MJME values for feeding of sheep, beef and deer.

Figure 38.Estimates of the historical average energy content (MJME/kgDM) of feed consumed by each of the Class 9 farm enterprises.

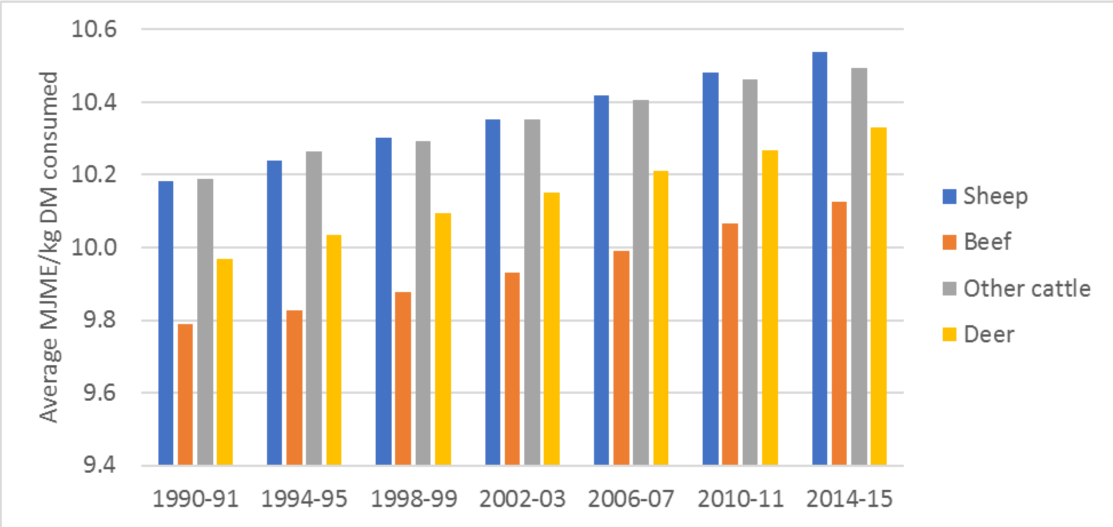
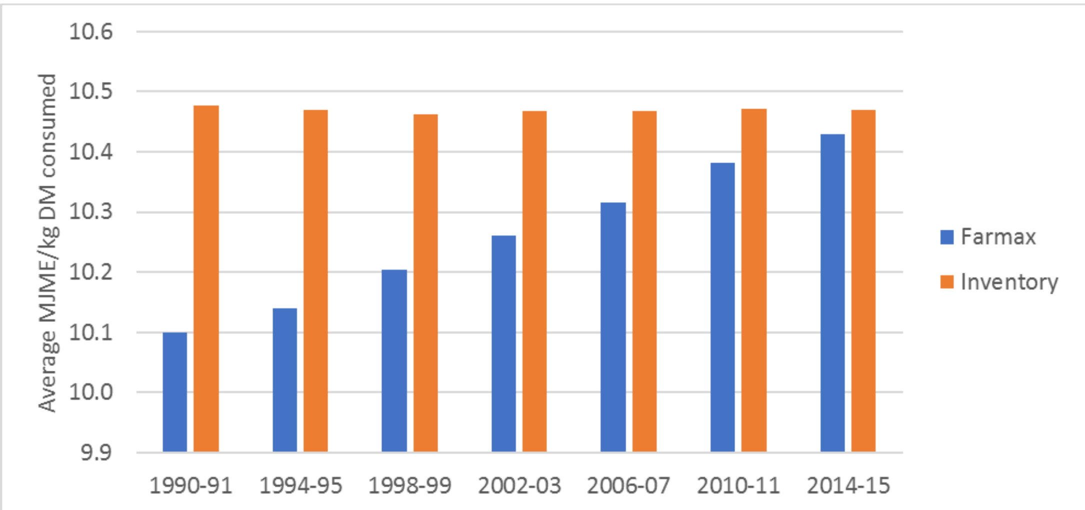


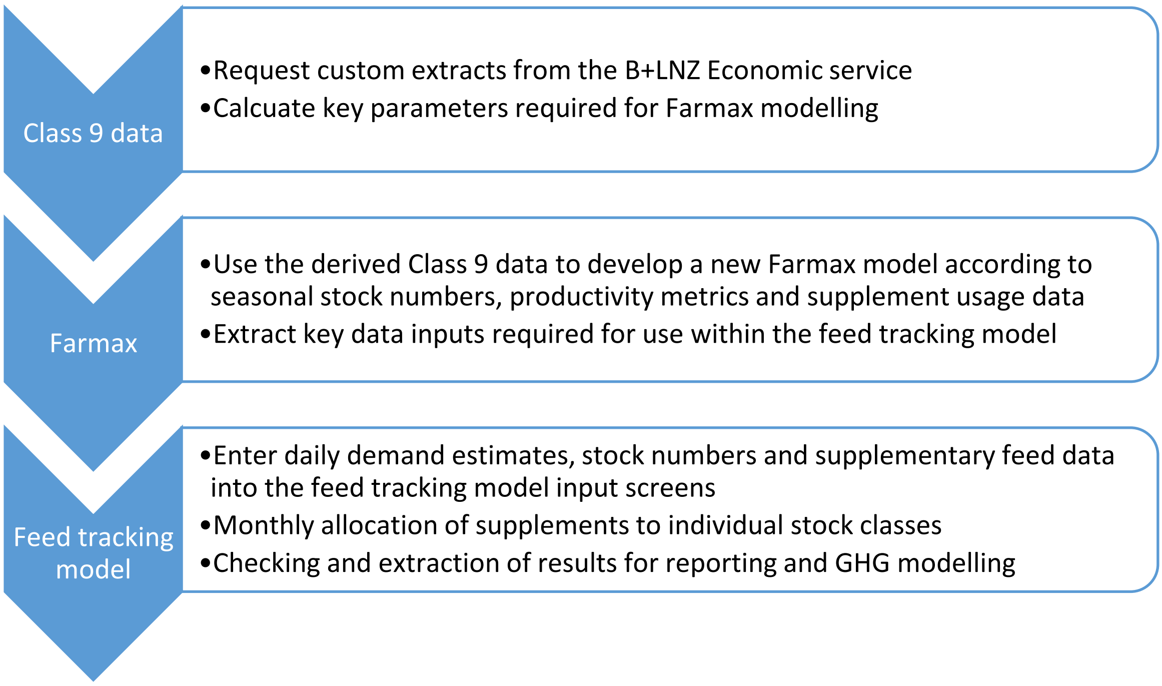
Figure 39. Estimates of the historic average energy content (MJME/kgDM) of feed consumed on farm relative to the NZGHG inventory estimates.



Appendix 1: Guide to use

This section provides a brief outline on the use of the model, including the metrics required to create additional Class 9 models using the Beef + Lamb Economic Service data. The key steps are outlined in Figure 40 below.

Figure 40. Summary of the steps required to use the feed tracking model.



Step 1: Economic Service data used in the Farmax models

Data on changes in land area, terrain types, area and type of crop plantings, stock numbers and production values are available on request from the B+LNZ Economic Service, with further data provided by Statistics New Zealand. Expert opinion was used to ensure that the models provide an accurate representation of a typical Class 9 farm for each season. The key pieces of information required include the following.

Data 1: Land area and terrain type

Table 14 shows a summary of the B+LNZ Economic Service data for changes in land area and terrain type used in development of the historical Class 9 models, where all non-effective terrain is assumed to be classified as steep. The key Farmax inputs include:

- Effective area
- Flat, rolling and steep terrain as a percentage of effective area

Table 14. B+LNZ Class 9 land area data, with calculated values highlighted in green.

	Land area			Terrain type				% of Effective terrain		
Season	Effective	Total	% Effective	Flat	Rolling	Steep	Steep[1]	Flat	Rolling	Steep
1990-91	514	515	100%	114	133	268	267	22%	26%	52%
1994-95	560	605	93%	129	160	316	271	23%	29%	48%
1998-99	558	604	92%	131	166	307	261	23%	30%	47%
2002-03	599	650	92%	143	201	306	255	24%	34%	43%
2006-07	645	716	90%	133	203	380	309	21%	31%	48%
2010-11	663	754	88%	128	217	409	318	19%	33%	48%
2014-15	627	732	86%	123	233	376	271	20%	37%	43%
Change relative to 1990-91								**-3%**	**+11%**	**-9%**

[1]Adjusted Steep = Steep terrain minus non-effective area.

Data 2: Crops and new grass plantings

Class 9 data used to account for crops and new plantings in the historical Farmax models are shown in Table 15.

Table 15. B+LNZ Class 9 feed data.

	Land area		Seasonal plantings (Feed type and area)				
	Effective area	Total area	Summer feed	Winter feed	New Grass	Over-sown grass	Hay & Silage
1990-91	514	515	2	10	7	4	13
1994-95	560	605	2	10	7	3	13
1998-99	558	604	2	12	10	2	15
2002-03	599	650	4	15	14	1	16
2006-07	645	716	4	14	11	2	17
2010-11	663	754	4	18	12	3	18
2014-15	627	732	5	16	11	3	15

The crop data was then used to populate the Farmax, as below.

Summer feed: has been modelled as leafy turnips, but could also include other commonly used supplements such as rape.

Winter feed: has been modelled as swedes and kale, but could also include other winter feeds such as fodder beet, winter turnips and cereal green-feeds. Note that differences between the area of winter crops and areas of new pasture sown have been interpreted as the area sown into a second year in winter crop as kale.

Concentrates: have been modelled as sheep nuts or barley grain, with data supplied by the Farmax support group, showing a small amount of concentrates having been used over the last 20 years.

The pasture replacement rates for new grass and over-sown grass were then entered directly into Farmax, as below.

Pasture renewal has been restricted to flat and rolling terrain, with a 50% higher renewal rate on flat than rolling land.
Over-sowing has been restricted to rolling and steep terrain, with the total over-sowing split in proportion to land type (i.e. average rate of re-sowing was independent of terrain type). Over-sowing is assumed to exclude any crop establishment, and instead focussed on pasture improvement though the introduction of new seed and fertiliser.
The annual pasture renewal cycle which follows crops has included use of species such as chicory and plantain, which in this analysis are regarded as pasture components as distinct from supplementary feed through crops.

Hay and silage: has been modelled predominantly as baleage with small amounts of barley silage included to account for the small area of cereal silages that are normally grown after a winter crop and before being sown into new pasture.

Within Farmax, the crops and feed section can be used to define a range of supplemental types (see Figure 41), with the feed quality (MJ ME/kg DM) and utilisation rates for supplements used summarised in Table 16.

Figure 41. Snapshot of the Farmax “Crops & Feed” data input screen.

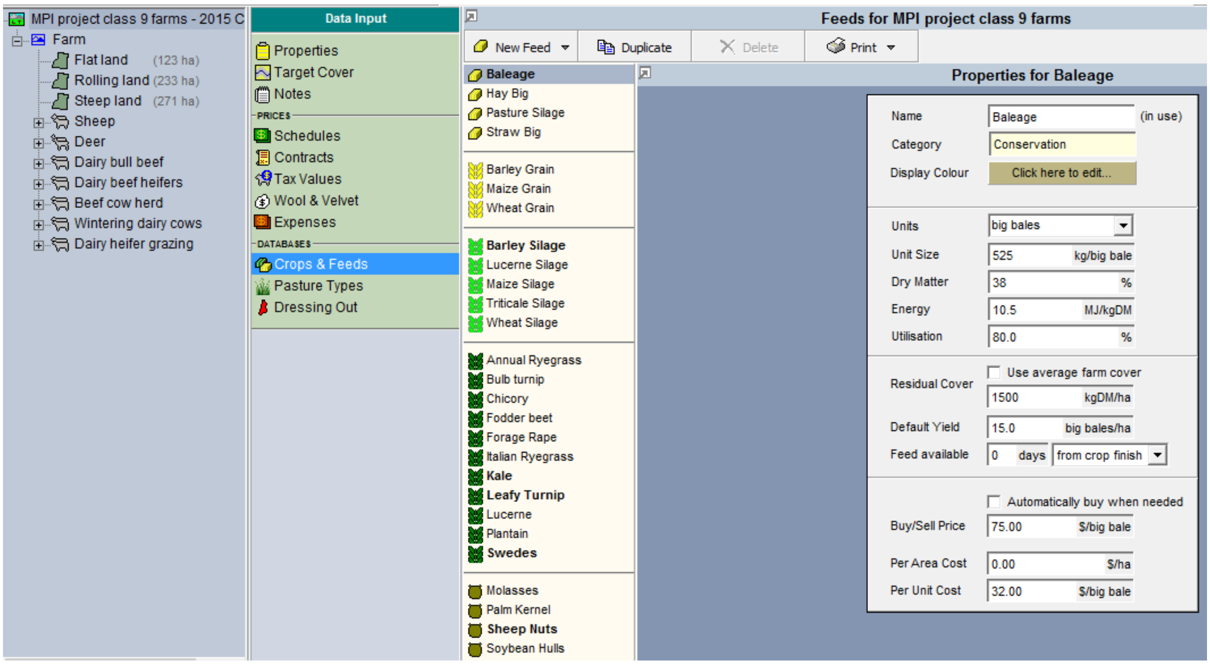


Table 16. Supplement Dry Matter (DM) percentage, utilisation rates and kg of DM intake per kg of supplement consumed.

	Unit size (kg)	DM%	MJME/kgDM	Utilization	Kg DM consumed/unit
Baleage (big bales)	525	38%	10.0	100%	200
Barley silage	1000	100%	10.0	75%	750
Fodder Beet	1000	100%	12.8	100%	1000

Kale	1000	100%	11.0	75%	750
Leafy turnip	1000	100%	12.5	82%	820
Sheep nuts	1002	100%	13.0	90%	902
Swedes	1000	100%	12.8	80%	800

Data 3: Livestock enterprises

The key data inputs for each of the livestock enterprises including stock numbers (n), live weights and carcase weights (CW), and reproductive performance are summarised in Table 17. Further detail is provided within the appendices of the project 405376 report[15].

In the sheep enterprise:

- Ewe replacement rates are calculated as the proportion of mixed age maternal ewes mated as 2-tooths, with the terminal ewes accounted for as a separate livestock class.
- Lambing percentages are calculated according to the number of lambs tailed ex mixed age + 2-tooth ewes, divided by the numbers mated. Hogget lambing percentages are calculated separately.
- Total lamb slaughter data including export approved, local and condemned grades, is used to calculate the seasonal slaughter pattern (% of lambs/month). These data are then used within Farmax to predict the average number of lambs slaughtered per month after accounting for expected losses. Similarly, the total ewe slaughter data including export approved, local and condemned grades, are used to calculate the seasonal slaughter pattern for cull ewes.

In the beef cattle enterprise:

- Farmax uses the number of R2 heifers and cows to determine the expected numbers for all livestock classes
  - The number of R1 bulls is estimated according to the number of mature bulls on hand
  - The number of growing heifers and steers are then calculated according to industry standard pregnancy and survival rates
- The average weights of heifers, cows and bulls mated are derived according to industry data[16]
- Heifer and steer carcase weights are derived according to industry data.

In the dairy grazing enterprise:

- The number of wintered cows and heifers grazing are determined according to the number of G-In dairy heifers and cows reported as arriving on farm within the Class 9 data sets.

In the ex-dairy beef enterprise:

- The number of R1 bulls are determined according to the number of sales of bull beef reported for Class 9 farms as primer/boned each year.

[15] Note that within the original report, rolling 3-year averages were used to “smooth out” seasonal variation allowing trends to be observed over time. this process may not be required within any future analyses.

[16] Average weights of cows and bulls mated for the 2014-15 season were estimated within the project 17893 report at 489 and 583 kg respectively.

- The number of heifers and steers are then derived from the bull beef data, assuming steers accounted for an additional 10% of the total number of males slaughtered, and that the ratio of females (heifers) to males (bulls + steers) was consistent to that previously reported, where for the 2014-15 season:
  - n steers = n bulls * 10%* n bulls/90%
  - n heifers = (n bulls + steers) * 19%/ 81%[17]
- Average carcase weight at slaughter are derived from industry data.

In the deer enterprise:

- The Class 9 data for number of hinds mated is used to calculate the number of 2-year old and mature hinds with mature hinds expected to account for 79% of total hinds mated.
- The Class 9 data for number of stags on hand on the 30th of June is used to determine the number of animals in each of the stag stock classes where:
  - The number of R1 venison stags is assumed to account for 85% of total stags whilst R2 venison accounts for the remaining 15%.
  - Velveting stags are assumed to account for an additional 40% of total stags on hand, with 85% assumed to be mature stags.
- The average live-weight of hinds and stags mated, and stock slaughtered are derived from industry data, where project 17893 reported average mating weights of 115 and 219 kg for the 2014-15 respectively.

[17] Within the project 17893 report, the ratios of heifers: bulls + steers slaughtered ranged from 88% in the 1990-91 season to 81% in the 2014-15 season, with a recommendation to use a 80:20 ratio for any future analysis.

Table 17. Key Farmax stock and performance data inputs.

Sheep	Beef cattle	Dairy grazing	Ex-dairy beef	Deer
n mixed age ewes mated	n cows mated	n wintered cows	n bulls	n hinds mated
n 2-tooths mated	n R2 heifers on hand 30 June	n R2 heifers	n heifers	average hind weight
n hoggets mated	average cow weight	average dairy cow weight	n steers	average stag weight
average mixed age ewe live-weight	average heifer CW	average heifer CW		n stags on hand 30 June
average mating date	average bull weight			
average lambing date	Average mating date			
n lambs tailed/ewe mated (excl. hoggets)				
n hogget lambs tailed				
average age at slaughter				
average carcase weight (CW)				
Monthly slaughter pattern				
Average number of cull ewes				

Step 2: Farmax modelling

The Farmax models are developed to reflect a typical Class 9 farming system for land area, supplement usage, stock numbers and production.

Because the effective land area of a typical Class 9 farm is changing, a separate (new) Farmax model is required for each of the annual analyses. To ensure the best possible outcomes, we recommend that these models are developed by an experienced Farmax consultant. Access to the existing Class 9 models can be made available if required.

Step 3: Using the feed tracking model

The feed tracking model has been set up to enable the evaluation of up to 5 new annual analyses. Results have been populated for 2014-15, and a 2030 scenario developed under project 405376 for comparison. The key inputs and checks required for effective use of the model are described below, with the spreadsheets numbered for ease of use.

Section 1: Data inputs

The key Farmax outputs required for use within the feed tracking model include:

1. Average Class 9 farm effective area (hectares), and topography: percentage of flat, rolling and steep land.
2. Daily demand estimates, and average stock numbers for each livestock class and month.
3. Percentage of Class 9 total feed demand supplied through each of the supplementary feed types.

<u>Effective area and topography</u>

Entered in cells G37:K43 of the "*parameters*" worksheet, these inputs are used to calculate the average pasture quality of feed consumed, with the land area then used to scale results to enable comparisons across year (feed demand/ha) and across New Zealand as a whole[18].

<u>Daily demand estimates and average stock numbers</u>

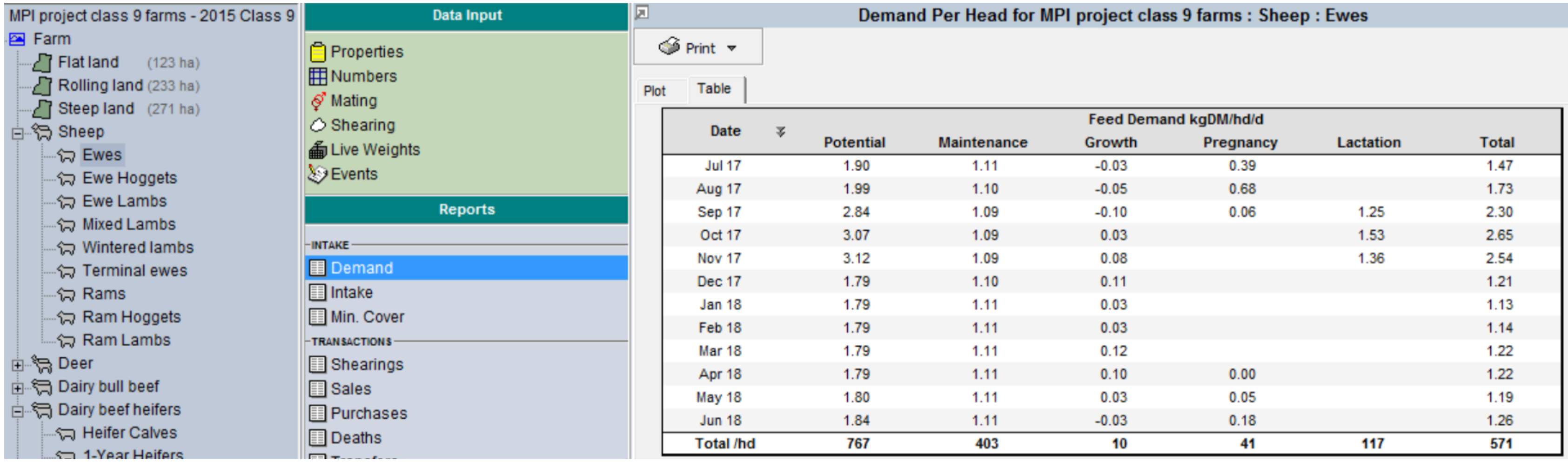
The daily demand, and stock number estimates are entered in rows 4:15, and 20:31 of each of the four Farmax input worksheets (*1. Sheep Farmax, 1. Beef Farmax, 1. Other cattle Farmax and 1. Deer Farmax*), with separate columns of each stock class and year. The daily demand and stock number values are then used to estimate total monthly feed demand for each stock class and enterprise.

Daily demand estimates are copied from the **demand report** for each farm/enterprise/stock class output with results inputted as "total feed demand, kgDM/hd/d", with a snapshot of the Farmax data

[18] Note that the input parameters for the preferential feed model are also included within cell B3:AO14 of the parameters worksheet, with further information on the preferential feed assumptions provided within Appendix 1.

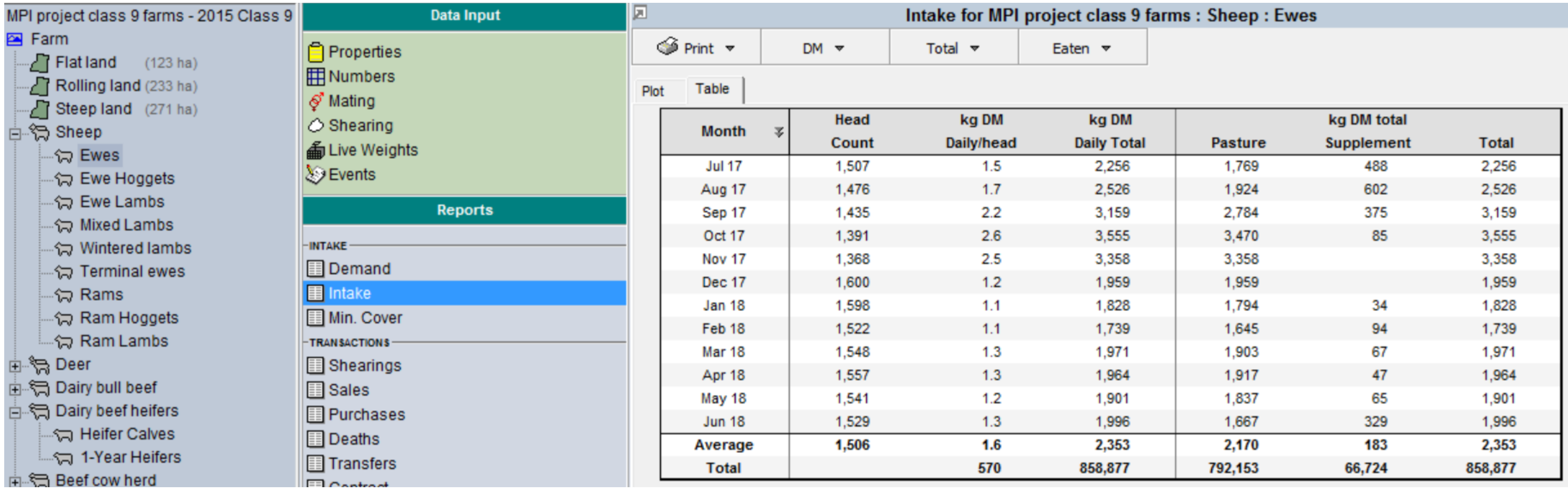
screen shown in Figure 42. Average monthly stock numbers are extracted from the monthly head count shown in the **Intake report** for each farm/enterprise/stock class (Figure 43).

Figure 42. Snapshot of the Farmax data export screen for the feed demand for Ewes for the 2014-15 season.



Date	Feed Demand kgDM/hd/d					
	Potential	Maintenance	Growth	Pregnancy	Lactation	Total
Jul 17	1.90	1.11	-0.03	0.39		1.47
Aug 17	1.99	1.10	-0.05	0.68		1.73
Sep 17	2.84	1.09	-0.10	0.06	1.25	2.30
Oct 17	3.07	1.09	0.03		1.53	2.65
Nov 17	3.12	1.09	0.08		1.36	2.54
Dec 17	1.79	1.10	0.11			1.21
Jan 18	1.79	1.11	0.03			1.13
Feb 18	1.79	1.11	0.03			1.14
Mar 18	1.79	1.11	0.12			1.22
Apr 18	1.79	1.11	0.10	0.00		1.22
May 18	1.80	1.11	0.03	0.05		1.19
Jun 18	1.84	1.11	-0.03	0.18		1.26
Total /hd	**767**	**403**	**10**	**41**	**117**	**571**

Figure 43. Snapshot of the Farmax data export screen for the head count for Ewes for the 2014-15 year.



Intake for MPI project class 9 farms : Sheep : Ewes

Month	Head Count	kg DM Daily/head	kg DM Daily Total	kg DM total Pasture	kg DM total Supplement	kg DM total Total
Jul 17	1,507	1.5	2,256	1,769	488	2,256
Aug 17	1,476	1.7	2,526	1,924	602	2,526
Sep 17	1,435	2.2	3,159	2,784	375	3,159
Oct 17	1,391	2.6	3,555	3,470	85	3,555
Nov 17	1,368	2.5	3,358	3,358		3,358
Dec 17	1,600	1.2	1,959	1,959		1,959
Jan 18	1,598	1.1	1,828	1,794	34	1,828
Feb 18	1,522	1.1	1,739	1,645	94	1,739
Mar 18	1,548	1.3	1,971	1,903	67	1,971
Apr 18	1,557	1.3	1,964	1,917	47	1,964
May 18	1,541	1.2	1,901	1,837	65	1,901
Jun 18	1,529	1.3	1,996	1,667	329	1,996
Average	**1,506**	**1.6**	**2,353**	**2,170**	**183**	**2,353**
Total		**570**	**858,877**	**792,153**	**66,724**	**858,877**

Percentage of Class 9 total feed demand met though supplement usage

The "*2. Supplements"* worksheet is used to capture the total percentage of monthly feed demand met by each supplement type, and then (by subtraction) pasture demand.

Data are copied from the **Farm/supplements report** (see Figure 44) into the "*2. Supplements*" worksheet, and these values are then used in the "*2. kgDM*" worksheet to calculate the total amount of supplements used per month. These values are carried through to the "*2. Allocations*" worksheet, with further detail provided on use of the allocation spreadsheet provided in the section below.

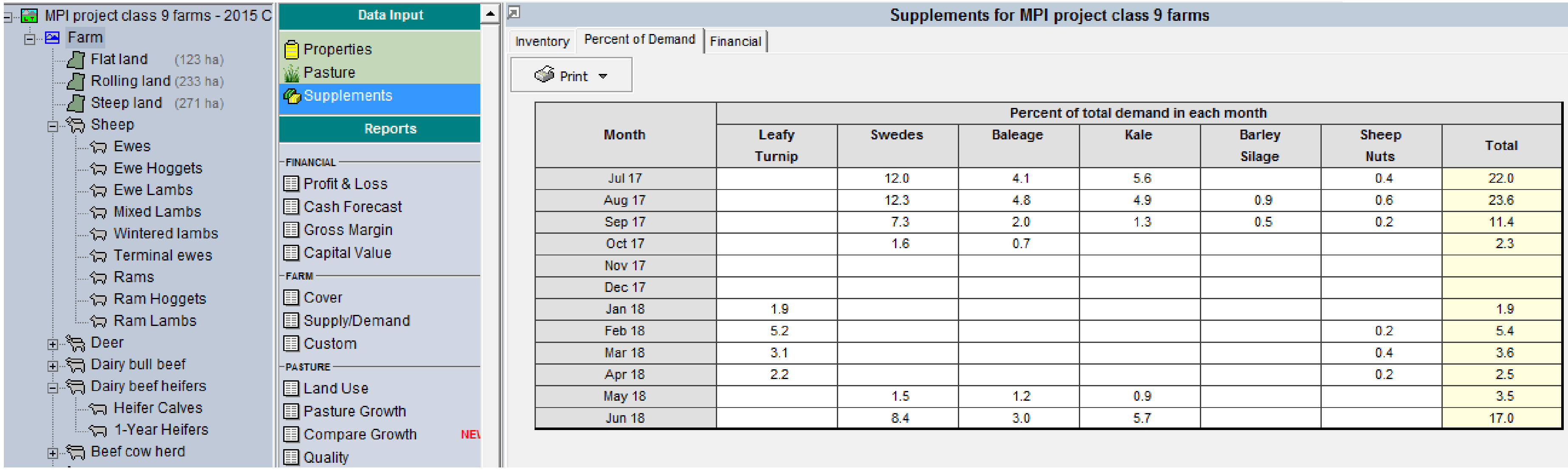
Section 2: Supplement allocation

Within Farmax, supplements are applied to the whole farm, and usage is tracked according to the percentage of monthly demand met by supplements. The feed tracking model uses these data to "allocate" supplements to individual stock classes. The total amount of each supplement is calculated as a percentage of total feed demand (over all stock classes) for the month, and then allocated to individual stock classes according to the percentage of diet expected to be met by each supplement, with "fine balancing" used to ensure supplement allocation equals supplements used.

Table 18 shows an example of the allocation model for July in the 2014-15 Farmax system model. In this model, there was a total of 42.7 tonnes of DM supplied through non-pasture supplements, including baleage (7.9 tonnes), kale (10.8 tonnes), sheep nuts (0.7 tonnes), and swedes (23.2 tonnes). Within this model, being mid-winter, the ewes were allocated 5% of their diet to be supplied by swedes, with top-ups supplied through baleage and sheep nuts. In contrast, 55% of the hoggets' diet was comprised of swedes, with an additional 8% supplied through baleage, leaving just 37% of the diet met through pasture grazing. The rationale for this is that ewes are mainly rotated around paddocks grazing pasture, whilst hoggets are more frequently confined to a single crop paddock over winter, to ensure adequate winter growth rate.

At a macro level, 39% of the supplemental feed used in July was allocated to sheep, and 36% to the ex-dairy bulls, whilst the beef and dairy grazing enterprises accounted for 16% and 9% respectively. The rationale for allocating supplements to the different livestock classes and enterprises is further explained below, and it is important to note that the allocations reflect a whole of NZ farm approach, with regional variation expected across the underlying B+LNZ farm types.

Figure 44. Snapshot of the Farmax data export screen for the percentage of demand provided by supplement within the 2014-15 year.



Month	Percent of total demand in each month						
	Leafy Turnip	Swedes	Baleage	Kale	Barley Silage	Sheep Nuts	Total
Jul 17		12.0	4.1	5.6		0.4	22.0
Aug 17		12.3	4.8	4.9	0.9	0.6	23.6
Sep 17		7.3	2.0	1.3	0.5	0.2	11.4
Oct 17		1.6	0.7				2.3
Nov 17							
Dec 17							
Jan 18	1.9						1.9
Feb 18	5.2					0.2	5.4
Mar 18	3.1					0.4	3.6
Apr 18	2.2					0.2	2.5
May 18		1.5	1.2	0.9			3.5
Jun 18		8.4	3.0	5.7			17.0

Table 18. Supplement allocation model for July 2014[19].

Livestock enterprise	Feed demand and supplement usage (by stock class)				Supplements allocation	
	Stock class	**Demand (kgDM)**	**Supplement type**	**% of diet**	**kg DM**	**%**
Sheep	Ewe Hoggets	14,373	Baleage	8%	1,150	15%
	Ewe Hoggets	14,373	Swedes	55%	7,905	34%
	Ewes	68,674	Baleage	2%	1,483	19%
	Ewes	68,674	Sheep nuts	1%	776	100%
	Ewes	68,674	Swedes	5%	3,434	15%
	Wintered lambs	8,898	Swedes	23%	2,002	9%
Beef	R1 heifers	5,714	Baleage	8%	457	6%
	R1 heifers	5,714	Kale	25%	1,429	13%
	R1 steers	5,850	Baleage	8%	468	6%
	R1 steers	5,850	Swedes	35%	2,048	9%
	R2 heifers	5,811	Baleage	3%	174	2%
	R2 heifers	5,811	Kale	12%	697	6%
	R2 steers	4,352	Swedes	35%	1,523	7%
Dairy grazing	R1 Heifer grazing	6,653	Baleage	8%	532	7%
	R1 Heifer grazing	6,653	Kale	50%	3,327	31%
	Wintered dairy cows	11,487	Baleage	30%	3,446	42%
	Wintered dairy cows	11,487	Kale	35%	4,020	36%
	Wintered dairy cows	11,487	Swedes	35%	4,020	17.0%
ex-Dairy	ex-Dairy bull R1	3,933	Baleage	6%	216	3%
	ex-Dairy bull R1	3,933	Swedes	58%	2,261	10%
	ex-Dairy bull R2	4,334	Kale	32%	1,365	13%

Allocation rationale (and process)

The "*2. Allocations*" worksheet is used to allocate supplements as a percentage of diet for each stock class, month and year. The rationale for each enterprise is outlined below and should be used as a guide, with fine balancing then used to adjust the weight of supplement allocated relative to the total weight of each supplement used on farm.

The allocation spreadsheet has been constructed as a matrix, with a separate section for each month and season. An example of the worksheet is shown in Table 19, with the user required to enter data for the percentage of dietary intake met through supplement intake for each of the different livestock classes. The percentage of each supplement type that has been allocated is automatically updated, allowing the user to fine-tune the allocations according to availability and need. A summary is also provided at the bottom of each monthly section, with checks required to ensure that supplement allocation is in close alignment with supplement usage.

[19] Note that an error was identified in Table 32 of the project 405376 report (sheep supplementary feed), where the supplement allocation results for July 2002 were incorrectly reported as results for July 2014.

Sheep

Ewes are typically managed according to the pasture feed supply, with a small percentage of the diet supplied through baleage, barley silage and fodder crops such as swedes used to allow pasture covers to build prior to lambing in spring.

Table 20 shows a summary of the historic seasonal pattern of supplement usage in the "sheep" enterprise, where ewe lambs age up to become hoggets on the 30th of June in model, with the hoggets generally the highest priority sheep category for winter forage allocation. However, there is massive variation in the use of forage as winter feed for hoggets (20-100%), and this has been modelled as an average of 50-60% of winter feed (July/August) as swedes. Summer forage crops such as leafy turnips are typically used to supplement the lambs in late summer and autumn.

Beef cattle

Beef cows are typically managed with little supplementation through summer, autumn and most of winter, with supplementation typically starting around August, with baleage used throughout the August to October period, and fodder crops sometimes used through to October to conserve spring feed for ewes with lambs at foot (see Table 21). Supplemental feed is used more heavily in the growing beef stock classes, with the R1 heifers and steers likely to receive both baleage and fodder crops over winter but be moved back onto pasture to maximize growth rates in spring, whilst the R2 stock classes are typically held on supplemental crop feed longer.

Moving forward, fodder beet is likely to form an important part of the diet for the R1 and R2 beef stock classes, with the potential for fodder beet to be utilized from July through to November, with maximum use observed in August to October. The allocation priorities for fodder beef are typically to supply the R2 steer and ex dairy R2 bull stock classes, where fodder beef combined with other fodder crops can account for up to 80% of an animal's diet through the late winter and early spring. The R2 heifer, and R1 stock classes may also be supplemented with fodder beet if required.

Other cattle

Wintered dairy cows are only present over the winter period and fed primarily on forage crops such as kale and swedes, with the other 30% of their diet provided through baleage. The ex-dairy bull and heifer calf classes come onto the farm at the same time (May), with up to 30% of their diet met through supplements such as baleage and fodder crops (swedes). With the "age change" date for cattle set at 30 June, stock then move up into the R1 classes, where the usage of fodder crops increases over the winter, as pasture supply drops, with the R1 and R2 (other cattle) stock classes moving back onto pasture as soon as possible in spring.

Table 22 shows a summary of the historic seasonal pattern of supplement usage in the "other cattle" enterprise, but it is important to note that as fodder beet usage increases, this could be expected to contribute up to 80% of diet for the R1 and R2 stock classes through winter.

Table 19. Example of the allocation matrix used to allocate kale in July 2014, with data entry fields highlighted in green, and the monthly summary for all supplement allocations highlighted in green, at the bottom of each monthly section.

Season	Month	Enterprise [1]	Types [2]	Demand (kg) [3]	Supplement type [4]	% diet intake [5]	kg allocated [6]	kg available [7]	% allocated [8]	Balance (kg) [9]
2014-15	July	Other cattle	Wintered dairy cows	11,487	Kale	35%	4,020	10,826	37%	-12
2014-15	July	Beef	R2 heifers	5,811	Kale	12%	697	10,826	6%	-12
2014-15	July	Beef	R1 heifers	5,714	Kale	25%	1,429	10,826	13%	-12
2014-15	July	Other cattle	R1 HEIFER grazing	6,653	Kale	50%	3,327	10,826	31%	-12
2014-15	July	Other cattle	ex-Dairy bull R2	4,334	Kale	32%	1,365	10,826	13%	-12
2014-15	July	All	**All**	**Expect (kg)**	**42,725** [10]	**Allocated (kg)**	42,733 [11]	**Balance (kg)**	**(8)** [12]	

[1] Enterprise is automatically determined according to selected stock class type and can be used to “filter” and “group” the results for each month/year.
[2] Stock classes are selected from the drop-down list, with the model catering for up to 30 different allocations for each stock class and year.
[3] Total feed demand shows kg of DM consumed by each stock class (per month).
[4] For each allocation, supplements are selected from a drop-down list, with these inputs used to calculate the kg of that supplement type allocated, and still available according to the total weight consumed on farm.
[5] Usage of the selected supplement is entered as a percentage of total monthly feed demand.
[6] kg of supplement allocated is calculated as total feed demand * % dietary intake.
[7] kg of supplement available is calculated as total weight of supplement – total supplement allocated for that month.
[8] The % allocated is calculated as total supplement allocated for the month/total supplement consumed.
[9] Balance is the weight of unallocated supplement.
[10] Total weight of supplement reported as used on farm for the month (Expect), and that should be allocated using the model.
[11] Total weight of supplement allocated within the model.
[12] Total weight of unallocated supplement (Balance), where a negative value indicates overallocation of 1 or more supplements.

Table 20. Summary of average percentage of diet met through supplement usage for each of the sheep stock classes.

<table>
<tr><td colspan="12">Ewes</td></tr>
<tr><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td colspan="4"></td><td>0- 2% baleage</td><td>1-5% baleage</td><td>3-5% baleage</td><td>4-5% baleage</td><td>1-3% baleage</td><td colspan="3" rowspan="3"></td></tr>
<tr><td colspan="7"></td><td colspan="2">Up to 3% barley silage</td></tr>
<tr><td colspan="5"></td><td>1-3% swedes</td><td>2-6% swedes</td><td>3-7% swedes</td><td></td></tr>
<tr><td colspan="12">Ewe Hoggets</td></tr>
<tr><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td colspan="6" rowspan="2"></td><td>8-10% baleage</td><td>15% baleage</td><td>4- 5% baleage</td><td colspan="3" rowspan="2"></td></tr>
<tr><td colspan="2">50-60% swedes</td><td>15-20% swedes</td></tr>
<tr><td colspan="12">Ewe lambs</td></tr>
<tr><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2">5-10% baleage</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3-5% leafy turnips</td><td>10-15% leafy turnips</td><td colspan="2">5-10% leafy turnips</td><td>10-20% swedes</td><td>40-50% swedes</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Mixed lambs</td></tr>
<tr><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>5-10% leafy turnips</td><td>20-30% leafy turnips</td><td colspan="2">10-15% leafy turnip</td><td></td><td>20-30% swedes</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Wintered lambs</td></tr>
<tr><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">20-30% swedes</td><td></td><td></td><td></td><td></td></tr>
</table>

Table 21. Summary of average percentage of diet met through supplement usage for each of the beef stock classes. Note that as fodder beet usage increases, this could be expected to contribute to a significant proportion of the dietary intake for the R1 and R2 stock classes through winter.

Stock class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beef cows								3-5% baleage		3-5% baleage 5-10% fodder crops		
Heifer and steer calves						3-5% baleage 15-25% fodder crops						
R1 heifers & steers							5-15% baleage		Up to 5% baleage			
					5-10% forage crop	20-30% forage crop		40-50% forage crop	10-30% forage crop	Up to 5% forage crop		
R2 heifers							5-15% baleage 10-20% forage crops		5-15% baleage 20-30% forage crops	5-10% baleage 5-10% forage crops		
R2 steers							20-50% forage crops			5-10% baleage 10-20% forage crops		

Table 22. Summary of average percentage of diet met through supplement usage for each of the other cattle stock classes.

Wintered dairy cows											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				Up to 30% baleage 70% forage crops	30% baleage 70% forage crops such as kale and swedes						
Ex-Dairy bull calves											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				5-10% baleage 5-20% swedes	3-7% baleage 10-20% swedes						
Ex-Dairy bull R1											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				10-15% fodder crops Up to 5% baleage		30-60% fodder crops Up to 5% baleage					
Ex-Dairy bull R2											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						30-40% forage crops		10-30% forage crops			
Heifer calf grazing											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				5-15% baleage 5-30% fodder crops (swedes)							
R1 heifer grazing											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						10-20% baleage	5-15% baleage				
						40-60% forage crops		10-15% forage crops			

Checking and extraction of results

A range of checks have been built into the model to ensure that data has been correctly entered.

Feed demand worksheet

This worksheet contains graphical display for total feed demand and effective area for a typical Class 9 farm. Key questions to ask include:

1. Are the changes in total feed demand proportional to changes in total farm area?
2. Do the changes in feed demand/ha reflect expected changes in on-farm productivity?
3. Do the changes in the percentage of Class 9 feed demand per enterprise reflect expected changes in farm composition?

If any of these outputs contain unexpected results, then the Farmax input data worksheets for each enterprise and year should be checked against the Farmax data file exports.

Supplements worksheet

This worksheet contains the values for the percentage of total farm feed intake met through each of the supplements. Key questions to ask include:

1. Are the changes in the monthly percentage of total farm intake met through supplements consistent over time?
2. Has allowance been made within the Farmax models for new supplement types such as fodder beet, and are these included within the results?

If not, then enter information for the new supplements into the parameters worksheet, and ensure all data are correctly captured within the Supplements worksheet.

Allocations worksheet

This worksheet contains the allocation matrices for each month and season. Key questions to ask include:

1. Are there more than the 30 combinations of stock class and supplement within any month or year?
    a. If additional rows are included in the allocation matrix, then these should be inserted between records 29 and 30, and the formula from records 1-29 copied down across all months. Note that failure to insert a row above record 30 will impact on calculations made in the annual analyses section of the model.
2. Are there any anomalies in the values shown in the "check" row for each month and year?
    a. Note that using the % of diet approach, it is very difficult to get an exact alignment between the expected and allocated values for each of the supplements. Ideally the expected and actual values would be within the ranges of +/- 0.5%, with the % values applied to ewes typically used to fine tune results.

Note that a summary worksheet has also been provided for each of the annual analyses. These hidden worksheets contain a series of pivot tables that can be used to summarise supplement usage by enterprise type, stock class, and month of usage. Note that the pivot tables should be refreshed following any new data inputs or updates.

Annual analyses worksheets

These worksheets (3. 2014-15, 3. Scenario 1 etc) contain all calculations used to estimate total pasture and supplement intake, and average quality (metabolizable energy) content for each livestock class, month and year. The worksheets contain a range of cross-checks on total feed intake (including supplement allocation) with these checks further summarised within cells BK4:10 of the Class 9 summary worksheet.

These cells check that the total weight of supplement modelled within Farmax has been allocated for each year. If the weight of supplements allocated differs by more than 0.5% from the weight of supplement modelled, then results are highlighted, and the monthly allocation values for that year should be checked.

Results

Results are presented in a series of graphs and tables, as described within section 4 and 5 of this report.

Appendix 2: Stock class pasture quality adjustments

A range of adjustments have been made to account for preferential feeding of some stock classes over others. The rationale for these changes is that lambs will be fed preferentially compared to ewes, whilst the average quality of feed consumed by cattle is expected to be lower than that consumed by sheep, with the biggest impacts in the cows and R2 heifer stock classes. Conversely, ex-dairy beef and dairy grazing calves are likely to be treated like lambs throughout the December – February period, and as such consume higher quality feed than the other stock classes. Table 23 shows a summary of the preferential feed allocation values, where:

- Pasture ME values are multiplied by 1 + the adjustment value to calculate average quality for feed consumed by each stock class each month. For example, in December 2014, the average quality (MJME/kg DM) of feed consumed by the following stock classes is calculated as:
  - Ewes (post-weaning) and Rams: 10.4 * 0.98 = 10.2
  - Lambs (weaned), ex dairy and dairy grazing calves: 10.4 *1.05 = 10.9
  - Cows, R2 heifers & Bulls 10.4 * 0.95 = 9.9
- No adjustments have been made to account for preferential feeding in deer, with the average pasture quality for all deer, and all other stock classes assumed to be consistent with the Farmax pasture quality assumptions.

Table 23. Preferential allocation of feed relative to average pasture quality values for the sheep, beef cattle and other cattle farm enterprises in 2014-15 .

Month	MJME/ kgDM (Farmax)	Sheep			Beef			Ex dairy	Dairy grazing
		Ewes	Rams	Lambs	Cows, R2 heifers & Bulls	Calves		Ex dairy calves	Calves
July	10.1	-2%		0	-8%				
Aug	10.5				-8%				
Sep	11.1				-4%				
Oct	11.0				-4%				
Nov	10.9				-4%				
Dec	10.4	-2%	-2%	+5%	-5%			+5%	+5%
Jan	10.2	-2%	-2%	+5%	-5%			+5%	+5%
Feb	10.1	-2%	-2%	+5%	-5%			+5%	+5%
Mar	9.6	-2%	-2%	+5%	-5%	+4%		+4%	
Apr	9.8			+2%	-2%	+4%		+4%	
May	10			+2%	-2%	+2%		+2%	
Jun	9.9	-2%	-2%		-8%				