Review of population models within the national methane inventory (2010)

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Review of population models within the national methane inventory (2010)

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Final Report

June 2010

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General

Assess whether a regional model can be undertaken for sheep and beef and whether there are any benefits to taking this approach.

Sheep

1. Change mean lambing date from 1st September to 11th September
2. Have two lamb kills with 84% of the slaughter lambs killed at the end of February at a carcass weight of 16.8 kg and 16% killed at the end of August (called hoggets in the model) at a weight of 18.4 kg.
3. Change average date of cull ewe slaughter from the 31st March to 20th January.
4. Kill all ewes in the dry ewe category at the end of July rather than farming for a further 12 months.
5. Increase death rates to 4.5% in weaned lambs, 3.6% in hoggets and 5.6% in the ewes.
6. Change ewe deaths so that 40% of the ewe deaths occur in August and September to reflect deaths around lambing. Remaining ewe losses spread throughout the year.
7. Calculate ewe liveweights from carcass weights using a figure of 40.0% instead of 43% currently in the model. This will result in ewe liveweights increasing from 55.9 kg to 60.0 kg in 2009/10.
8. Adjust ram numbers at the end of February
9. Reduce ram liveweight gains to 0 g/d with a base ram liveweight of 84 kg (40% heavier than ewes).
10. Adjust wether numbers in October when wether hoggets enter the wether flock.

Beef

11. The current model appears to underestimate beef cow liveweight. Cow liveweights should be altered to 402 kg in 1990/91, increasing by 8.5 kg/year to 457 kg in 2009/10. Future beef cow liveweights could be calculated using annual carcass weight data from approximately 16,000 cows obtained from Landcorp and M&WNZ.
12. Change the mean calving date for beef cows from 1st September to 20th of September.
13. Cull beef cows at the end of March instead of the end of February
14. Retain 25% of beef heifers as replacements, with a 2% annual death rate. Add dry heifers to the slaughter group in March/April (as rising 2 year olds after pregnancy testing) so that after allowing for deaths between March and October, 17% of heifers enter the beef breeding herd as calving heifers.
15. Increase cow death rates to 2.7 % with 50% of cow deaths occuring in the month of calving (September).
16. Cull surplus bulls in January and February. Any increases in bull numbers occur through increasing the number of bull calves kept for replacements and which are introduced into the herd prior to mating
17. Change average slaughter age of heifers to 24 month of age (end of October).
18. Change average slaughter age of bulls from 24 months to 18 months of age

19. Change average slaughter age of steers from 24 months (1st September) to 28 months (1st February).

Deer

20. Change calving date from 1st December to 17th of November in 2007/08 and adjust previous dates to fit the changes occurring since 1990/91.
21. Reduce the base liveweight of hinds from 110 kg to 95 kg.

Dairy

22. Evaluate dairy cow liveweight pattern to determine if the single weight currently used represents the average dairy cow liveweight
23. Incorporate a death rate of 21% - half of which occurs in August. Data on death rates to be improved using data from other sources e.g. MINDA
24. Add 107 litres of milk to each lactation to allow for the milk fed to calves.
25. Change average calving date to 13th August. The separation of the dairy model into regions will then be able to account for changes in each region over time.

1.0 Introduction

The methane inventory model uses population and slaughter data to model the methane output from the sheep, beef, dairy and deer sectors from 1990 onwards. The model endeavors to represent the mythical "average" New Zealand farm using the best and most verifiable data available. The calculation of methane produced by each sector is calculated from the total feed consumed and is a function of the total animal population, the productivity of those animals and the quality of the pasture being consumed. Total population numbers are available from the annual agricultural census data (Statistics, New Zealand) and total slaughter data is provided by meat processing companies (MAF slaughter statistics). Because of lack of verifiable data, some assumptions are necessary (e.g. average lambing and calving date). These assumptions are a source of error – for example, if the birth date of calves is assumed to be one month earlier than is actually the case, the total methane output will be artificially high because those calves will be slower growing and consume more feed over their lifetime.

The sheep model appears robust with good production data as most lambs are killed within 12 months and there is good separation of lambs and cull ewes in the slaughter statistics. Similarly within the dairy industry there is good data on animal numbers and levels of production from within the dairy industry. Moreover, the move to modeling the dairy industry within a region is likely to improve the accuracy of the dairy production model. Both the sheep and dairy industry use data which provides a good time sequence from 1990 on. The slaughter statistics from the deer industry do not separate slaughter animals on age, however, because the industry is relatively small, any impact on total agricultural methane output will be small. The complexity of the New Zealand beef industry provides the most challenges in delivering accurate and consistent data. This is largely because steers and heifers are slaughtered at various ages and there is no ageing of stock at slaughter. This creates real difficulties in reconciling age groups and total numbers with the annual census data. To compound the problem, a significant number of bulls, heifers and cull cows (and to a lesser extent steers) from the dairy industry end up as beef in the beef industry. This means that the current model struggles to reconcile the numbers slaughtered with the numbers collected within the annual census. Going forward, it is possible that the proposed national animal identification systems can be coordinated to provide a valuable tool for developing more accurate animal population data. Similarly, a move to regional population models for sheep and beef farms may also improve the accuracy of these production models.

To review the sheep, beef and deer populations, the figures used in the model have been compared with data collected by the Meat & Wool NZ Economic Service for the year ended 30th June 2008. This annual survey collects very detailed data from 560 farms across 8 New Zealand farm types and has been used as a proxy for the "average" New Zealand sheep/beef/deer farm (Appendix 1). The dairy models are currently being redone on a regional basis so the existing model was examined for weaknesses that would not be removed under a regional basis.

2.0 Sheep data

The data used in the sheep model comes from the census data and the National slaughter statistics. Generally, this model works within the limitations of the data and the different classifications between data sets. For example in the farm data (i.e. from the national agricultural census) a lamb is counted as a hogget from the 1st of July but this same animal is classified as a lamb for several months after this in the national slaughter statistics - this can cause confusion. In addition, there is at least one case (that of dry ewes) when the timing of the census creates what is in reality an artificial (and temporary) extra stock class. The other changes suggested by this review tend to be based timing of events rather than changes in the model structure itself. Future improvements may be obtainable by dividing the model into different farm types/systems so that improvements in efficiency are more easily observed and any bias that can occur in averaging reduced.

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2.1 Lambing date

The model currently assumes a mean lambing date of 1st September. There is no data collected nationally on lambing date but the lambing data collected for the M&WNZ survey farms indicates mean lambing dates range from the 4th September through to the 24th October for the SI High Country. Overall, the weighed mean lambing date is 11th September (Table 1). This has implications for lamb growth rate and the amount of feed required to rear lambs through to slaughter. The differences in regional lambing dates suggest that there may be some benefits in separating the model into farm classes. There appears to have been little change in lambing date since 1990. However, with increasing pressures from dairying on better land classes and retirement of poorer land classes through tenure review along with possible planting of trees for carbon credits, these estimates may need to be re-visited in the future.

Table 1: Mean lambing dates by farm class for the year ended 30th June 2008 (from M&WNZ survey data)

Farm Class	Estimated mean lambing date[1]
1	24/10
2	2/10
3	12/9
4	4/9
5	25/8
6	18/9
7	26/9
8	26/9
SI (no SI High)	21/9
SI High	24/10
NI	2/9
Mean NZ	**11/9**

[1]Estimated mean lambing date using ram out date, assumes a 17 day cycle, equal number of ewes cycling each day of the cycle, a 70% conception rate and a 154 day gestation. Overall mean for NZ is weighted by number of farms in each farm class.

Recommendation

- *Change mean lambing date from 1st to 11th September.*

2.2 Slaughter date

The current inventory model has all lambs growing at the same rate with growing animals disappearing (slaughtered or changing age class) at three points – lambs in February, hoggets in August and two tooths in February. In reality, lambs are slaughtered through the year (Table 2) with a peak between December and April. Lambs only become classed as mutton once they have two central incisors in wear. This typically occurs at 14-15 months of age but is affected by breed and date of birth with many lambs killed as late as Oct/Nov in the year after they are born. Because there is a large (50%) discount in value when an animal moves from lamb to mutton, there is a large incentive for early identification of surplus ewe hoggets. At present the model has surplus hoggets being killed in September with no obvious fit to the National slaughter statistics and more surplus lambs being killed as two tooths in February. In reality, the February slaughter proposed by the model would not occur because these animals would have been identified and slaughtered earlier to avoid being discounted in value.

It seems sensible to have two slaughter times with different lamb growth rates to correspond with what happens in practice. According to the national slaughter statistics (averaged over 6 years), 84% of all slaughtered lambs are killed between November and June at approximately 5 months of age. These lambs comprise 64% of the lambs in the model, have an average carcass weight of 16.8 kg (Table 2) and an average slaughter date of the 28th February. They tend to be faster growing as they are milk fed for most of their lives. A second group of older lambs (16% of slaughter lambs or 12% of the lambs in the model) are called hoggets in the model) are killed between the beginning of July and the end of October. These are surplus ewe lambs and slower growing lighter lambs which were not heavy enough to be slaughtered early because they were born as multiples or late lambs born to hoggets. These slower growing lambs are carried through the winter to realise higher spring prices. The average kill date for these lambs is the end of August aged 11 months old and the average carcass weight is 18.4 kg. After adjustment for death rates (Section 2.5), two slaughter points with differential lamb growth rates provides a better fit for both the slaughter data and what happens on farm.

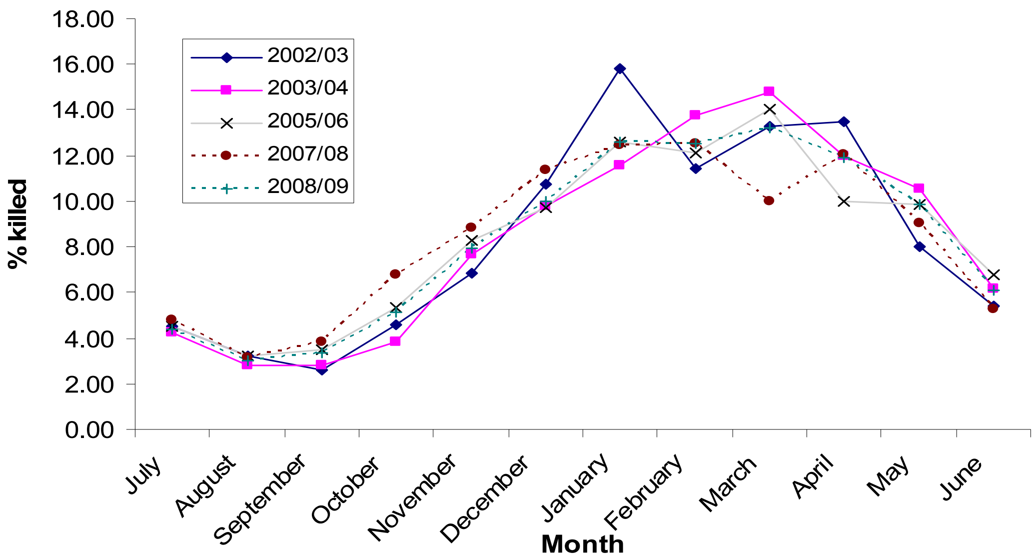
The pattern of lamb slaughter has changed over time. Figure 1 indicates the slaughter pattern between 2002/03 and 2008/09. The peak slaughter has reduced over time with more lambs slaughtered early in the season as well as lambs being kept longer and to heavier weights. These changes are the result of farmers responding to higher spring schedule prices and has been assisted by higher lambing percentages (more slower growing multiples) and hogget lambing (later, slower growing lambs).

The timing and pattern of lamb slaughter also varies by farm class reflecting differences in lambing date, hogget lambing, lambing percentage and pattern and quality of available feed available

Table 2: National slaughter pattern for New Zealand lamb (MAF slaughter statistics)

Inspected Numbers	2004/05	2005/06	2006/07	2007/08	2008/09	Tot %	Cwt 07/08	Aver Cwt
July	1037	1045	1221	1158	1158	4.4	17.1	17.5
August	767	680	869	758	758	3.0	17.4	18.3
September	628	696	950	853	853	3.4	18.4	19.2
October	1092	1 265	1444	1 443	1 568	5.1	18.3	18.6
November	1641	1 824	2257	2 384	2 045	7.9	16.6	16.7
December	2558	2 329	2649	2 503	2 623	10.0	15.9	16.2
January	3776	2 592	3433	3 570	2 890	**12.6**	16.1	16.5
February	2728	3 103	3302	3 555	2 894	**12.5**	16.2	16.8
March	3177	4 047	3817	3 072	2 318	**13.2**	16.3	17.0
April	3225	2 863	2715	3 473	2 782	**11.9**	16.3	17.2
May	1916	2 946	2686	2 741	2 090	9.9	16.1	17.1
June	1285	1 762	1851	1 611	1 219	6.1	16.3	17.2
Total	**24533**	**25641**	**27193**	**27122**	**23155**			

Figure 1: Variation in the pattern of lamb kill over time



Average lamb carcass weights have increased over time (from 14.1 kg in 1990/91 to 16.5 kg in 2008/09) and are captured in the existing model from MAF slaughter statistics. However, lamb carcass weights also change over the year, with MAF slaughter statistics showing that lamb carcass weights are lightest in December at 16.2 kg and heaviest in September (19.2 kg; Table 2), this occurs because of the culling of ewe hoggets and because specialist lamb finishers over-winter lambs to heavy weights to capitalize on high spring prices.

Recommendation

- *Kill lambs in two groups - 84% of the lambs destined for slaughter at the end of February and the remaining 16% at the end of August. Adjust growth weights so that the growth path of the 84% destined for slaughter at the end of February reach a carcass weight of 16.8 Kg in 2007/2008 and the remaining*

16% reach a carcass weight of 18.4 kg in 2007/08. These can be adjusted using the annual slaughter statistics.

2.3 Transfers in and out of the adult breeding ewe population

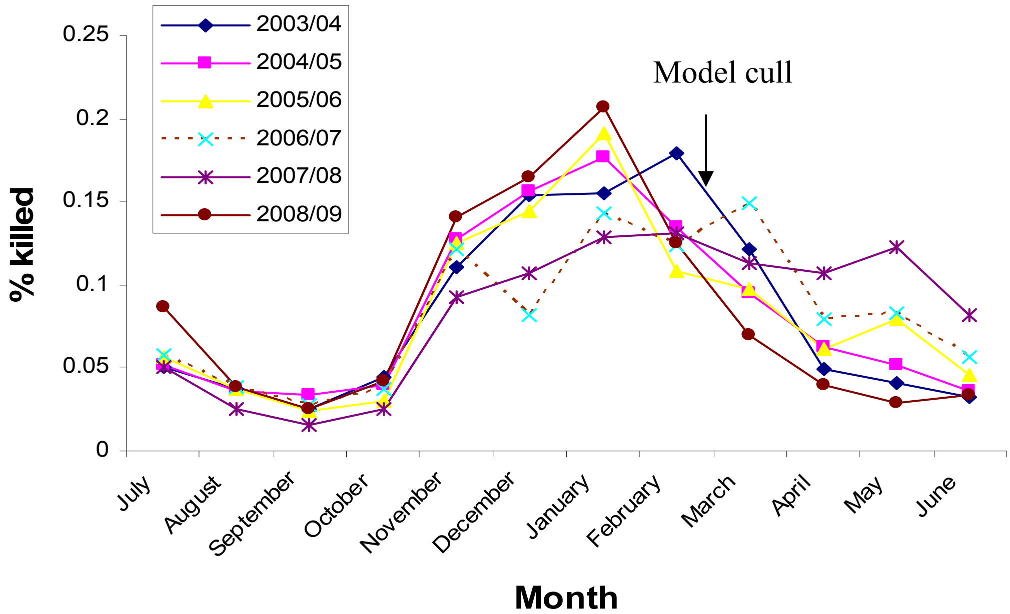
The model assumes that culling of adult ewes occurs at the end of March (i.e. immediately prior to mating). In another MAF project (0910011532), we found that farmers, generally, cull ewes between December and February depending on weaning date and feed supply. An examination of the national slaughter statistics for adult sheep between 2005/05 and 2008/09 shows the peak kill months are November to February with 58.6% of the adult sheep being killed before the end of January (Table 3). This equates to a mean cull ewe slaughter date of the 20th January and indicates that the model is currently carrying cull ewes for at least 2 months longer than occurs in practice. This will over-estimate the feed requirements for the national flock.

Table 3: National slaughter patterns for adult sheep (MAF slaughter statistics)

Inspected Numbers	2004/05	2005/06	2006/07	2007/08	2008/09	%	Cumulative
July	223	232	292	327	386	6.4	6.4
August	154	150	191	165	173	3.4	9.7
Sept	142	97	138	102	112	2.5	12.3
October	170	124	187	160	188	3.2	15.5
0November	**546**	**508**	**611**	595	**630**	**11.9**	27.3
December	**669**	**588**	**414**	**686**	**740**	**13.8**	**41.1**
January	**756**	**781**	**719**	**826**	**929**	**17.5**	**58.6**
February	**578**	442	**624**	**846**	**564**	**12.1**	70.8
March	409	398	**749**	**726**	312	9.3	80.1
April	271	250	400	**691**	176	6.9	87.0
May	220	324	417	**793**	128	7.7	95.0
June	155	185	287	530	150	5.4	100.0
Total	**4292**	**4080**	**5029**	**6447**	**4488**		

There will be between-year variation in average slaughter time. When there is pressure on for killing space lambs have the priority and cull ewes generally have to wait. This situation is compounded in a drought year (e.g.2007/08; Figure 2).

Figure 2: Year effects on ewe slaughter (MAF slaughter statistics)



Recommendation

- *Change the average date of cull ewe slaughter to 20th January.*

2.4 Dry ewes

The model carried approximately 0.7% of the total ewe flock in a dry ewe category in 2007/08, presumably because they are included in the national agricultural census at the end of June. These animals were then continued on as a stock class in the model for the following 12 months. We believe that the dry ewe category is an artifact of census timing. Many farmers pregnancy scan to identify dry ewes for culling as there is no merit in wintering an unproductive ewe. Ewes scanned in June are usually slaughtered shortly after. It is very likely that the 0.7% of total ewes identified as dry in the model are those that have been scanned as dry (hence the farmers are aware of their reproductive status) and are awaiting slaughter.

Recommendation

- *That all ewes appearing in the dry ewe category in the census data are slaughtered at the end of July.*

2.5 Death rates

This category covers deaths and missing. The model allows for an annual death rate of 5% for breeding ewes and 2% for weaned lambs and hoggets. The death rate for ewes in the M&WNZ survey farms is 5.2-6.0% so this figure appears to be a little light. The death rate for lambs and hoggets may be an underestimate as the estimates for the M&WNZ survey farms report death rates of 4.5% for lambs and 3.6% for hoggets.

The model assumes that the deaths are evenly dispersed throughout the year when in reality a large proportion of the ewe deaths are associated with the risks of giving birth, particularly in ewes carrying multiples- at Poukawa 26% of the all ewe deaths occur in the 4 weeks around peak lambing and a further 14% occur in the two weeks before and after this making a total of 40% over the eight week period around lambing.

Recommendations

- *That death rates be increased to 4.5% in weaned lambs, 3.6% in hoggets and 5.6% in ewes.*
- *That 40% of the ewe deaths occur in August and September to reflect deaths around lambing. The remaining ewe losses to be spread throughout the year.*

2.5 Replacement ram purchases

The model assumes that the breeding ram and adult wether populations change in a linear manner between the population at the start of the year and the start of the next year. In practice, farmers are likely to cull rams prior to mating each year (remove old/unsound rams) and purchase new rams between December and February.

On the other hand, replacement wethers are likely to come from the wether hoggets and increases in wether numbers should occur in October when wether hoggets become two tooths or are sold.

Breeding rams are assumed to weigh 40% more than adult ewes. This suggests that if the average ewe liveweight is 60 kg (see MAF POL 0910-11532) then the average ram liveweight is 84 kg. This seems appropriate both for rams being purchased as two-tooths and for flock rams, since rams are typically maintained at or around their purchase weight so they do not become too heavy for mating (George Cruickshank, pers comm). However, the sheep input sheets suggest that rams are growing at 50 g/d, meaning a ram would increase in weight by 18.25 kg per year. This is unrealistic as farmers maintain their rams in "working condition". Cruickshank (2005) surveyed the Wairarapa Romney Improvement Group (4% of the NZ sheep flock) and found that rams lasted an average of 3.9 years. So an individual two tooth ram purchased at 84 kg growing at 50 g/day would be an unlikely 157 kg when it was culled four years later. It would be more accurate for rams to be purchased at 84 kg and to maintain their weight thereafter. In the 2007/08 season the carcass weights from rams averaged 30.3 kg (MAF slaughter statistics). Using a dressing out of 40.8% (as per ewes), the liveweight of these cull rams would have been 74.3 kg. Since many of these rams would be culled on age and condition and would be lighter than the flock rams, a liveweight of 84 kg for working flock rams seems reasonable. In addition as the adult rams make up only a small proportion of the flock, the effect of any changes in weight are likely to have an insignificant effect on the model relative to the errors around some of the other measures.

Recommendations

- *That wether numbers are adjusted in October when wether hoggets enter the wether flock.*
- *That ram liveweight gains are reduced to 0 g/d growth.*
- *That rams are culled at the end of February*

3.0 Beef

As in the sheep model, the data used in the beef model comes from the census data and the national slaughter statistics. However, unlike the sheep model, the beef model is complicated by the fact that beef production comes from the progeny of beef breeding cows as well as surplus calves and older stock from dairy farms. Beef from beef and dairy origin is not differentiated at slaughter. Moreover the steers and heifers category covers animals up to three years of age and animal age is not distinguished at slaughter. This makes verification and cross checking very difficult and potentially results in mismatches between the slaughter data and the census data. This will be made worse if there are inconsistencies in how farmers fill in the census forms. This can also cause issues over time in that for example changes in dairy cow slaughter numbers and carcass weights affects the calculation of beef cow liveweights when in reality the two are unrelated. Another example is that the age at which cows are first run with the bull has decreased over time and this means that the R3 heifer group on farms has disappeared as these animals are now just part of the mixed aged cow herd. Issues such as a better way of determining beef cow liveweight need to be addressed. In addition, there may need to be some structural changes to the model – for example, steers need to be slaughtered at an older age and this will require the addition of another age category. Also heifers appear to be entering the herd earlier so an age category needs to be removed for these animals.

3.1 Beef cow liveweight

Currently, there is very little published data on the weights of beef breeding cows. Information on the number and carcass weight of adult cows slaughtered is available from national slaughter statistics but these include both adult dairy cows and adult beef cows. To obtain an estimate of the weights of beef breeding cows the model currently uses the following procedure. "The number of beef cows slaughtered is assumed to be 25% of the total beef breeding cow herd and other adult cows slaughtered were assumed to be dairy cows. The carcass weight of dairy cattle slaughtered is estimated using the adult dairy cow weight and a killing out percentage of 40%. The total weight of dairy cattle slaughtered (number × carcass weight) is then deducted from the national total carcass weight of slaughtered adult cows. This figure is then divided by the estimated number of beef cows slaughtered to obtain an estimate of the carcass weight of adult beef cows. Liveweights were then obtained by assuming a killing out percentage of 45%". This "average" liveweight of adult breeding beef cows applies for the whole year and no within year pattern of liveweight change is assumed. This method of estimating the weights of beef breeding cows is potentially subject to large errors due to errors in estimating killing out percentage, breeding cow replacement rates and in the estimation of dairy cows liveweights". This method of calculating beef cow liveweight is heavily influenced by changes made to dairy cow numbers, dairy cow weights and dairy cow dressing out percentages.

Recent work in another contract (MAF POL 0919-11532) has shown that the estimate of 455 kg for beef cow liveweight used in the model for 2009/10 is light and compares with 568 kg for recent unpublished data, 541 kg from survey data from 12 farms in 2009 and 2010, 568 kg calculated for breeding cows on Landcorp farms and 537 kg for breeding cows on M&WNZ survey farms. This report suggests that a figure of 547 kg should be used for beef cow liveweight in 2009/10.

There has been a change in cow liveweight over time. Landcorp Farming Ltd have made available the carcass weights on 96,176 cull beef cows slaughtered between 1997/98 and 2008/09 and which show a linear increase in beef cow liveweights of 8.5 kg/year. This means that national beef cow liveweights are likely to have increased from 402 kg in 1990/91 to 547 kg in 2009/10. These compare with figures presently used in the model of 378 kg (1990/91) and 451 kg (2009/10). In future, beef cow liveweights could be calculated using carcass weight data from approximately 16,000 cows slaughtered annually by Landcorp Farming Ltd and M&WNZ survey farms.

Recommendation

- *That average beef cow liveweight in the model be changed to 402 kg in 1990/91, increasing at 8.5 kg/year to 547 kg in 2009/10.*

3.2 Calving dates

The model assumes all breeding cows and replacement breeding females calve on the 1st of September. However, the majority of calves on M&WNZ survey farms are actually born in September (Table 4). Calving tends to be later on the harder farm classes (1-3) but there is no difference between the islands. This results in a mean calving date of the 20th September. This also means that the cattle age classes in the model should occur on the 20th September. A later calving date will mean faster growth rates, reduced lifetime feed intakes and methane emissions.

Recommendation

- *That the mean calving date for beef cows be shifted from the 1st to 20th September.*

Table 4: Estimated calving dates in 2007/08 for M&WNZ survey farms

Farm class	Bull out date	Estimated calving date[1]	No cows
1	2/12/2006	28/9/2007	3500
2	27/11/2006	23/09/2007	4872
3	2/12/2006	28/09/2007	8928
4	20/11/2006	16/09/2007	9918
5	6/11/2006	2/09/2007	1880
6	15/11/2006	11/09/2007	3567
7	15/11/2006	11/09/2007	270
8	30/11/2006	26/09/2007	162
SI		21/9/2007	
NI		20/9/2007	
Mean		20/9/2007	

[1]Estimated mean calving date using bull out date assumes a 21 day cycle, equal number of cows cycling each day of the cycle, a 70% conception rate and a 282 day gestation. Overall mean is weighted by number of cows in each farm class.

3.3 Culling of beef cows

The model currently culls beef cows at the end of February. Although the national slaughter statistics indicate that 50.7% of cows are slaughtered by the end of March (Table 5) there is no separation of beef and dairy cows. Better data to verify beef cow killing date is available from M&WNZ survey farms which also found 50.9% of beef cows were killed by the end of March (Table 6). This suggests that beef cows in the inventory model are slaughtered a month too soon.

Timing of beef cow slaughter is related to specific farm events e.g. pregnancy testing, weaning and pasture supply. The timing of these triggers will vary by region. The farm survey data (Table 6) suggests it varies by region and farm type. For example, cows from class 5 farms make up the majority of the cows killed September to January. These cows are also heavier (241.4 kg carcass weight) than other farm classes supplying large numbers of cattle at other times of the year. These differences in weight and timing are likely to impact on feed intake and are further reasons for examining a model based on farm type for sheep and beef.

Table 5: National dairy and beef cow kill

Inspected Numbers (000s)	2004/05	2005/06	2006/07	2007/08	2008/09	%	Cumulative
July	57	36	39	33	33	5.4	5.4
August	37	26	29	18	24	3.7	9.0
September	35	25	28	13	23	3.5	12.5
October	34	26	31	17	34	3.9	16.4
November	33	30	40	24	39	4.5	21.0
December	38	32	33	24	38	4.6	25.5
January	31	27	30	32	37	4.5	30.0
February	58	33	38	66	74	7.1	37.1
March	109	103	112	70	113	**13.6**	**50.7**
April	137	103	110	124	173	**17.9**	68.6
May	157	156	152	138	165	**21.1**	89.7
June	68	68	62	80	79	**10.3**	100.0
Total	**792**	**665**	**706**	**639**	**833**		

Table 6: Pattern of beef cow kills by farm type in 2007/08 (M&WNZ survey farms)

	Farm Class										
Month	1	2	3	4	5	6	7	8	Total	%	Cum
Jul	42	6	108	103	77	2	14		352	4.1	4.1
Aug			10	38	174	1			223	2.6	6.7
Sept	6		2	20	232	1			261	3.1	9.7
Oct	31	2	24	59	254	3			373	4.4	14.1
Nov	22	34	109	51	235	72	2	43	568	6.7	20.7
Dec	28	43	107	90	226	13	8	19	574	6.3	27.4
Jan	5	59	205	81	294	22	10	50	726	8.5	35.8
Feb	15	49	148	173	84	1	2	39	511	6	41.7
Mar	32	22	148	391	111	32	5		791	8.7	**50.9**
Apr	49	106	555	714	50	161	10		1645	**19.3**	70.0
May	34	104	664	691	57	174	2		1729	**20.3**	90.1
Jun	120	136	176	298	29	91			850	10.0	100
Total	384	561	2256	2709	1823	574	53	151	8511		

Recommendation

- *That average slaughter date for beef cows is shifted from the end of February to the end of March*

3.4 Replacement rates and age of heifer mating

The model assumes the breeding cow population is 75% adult cows, with 25% of heifers mated as 2 year olds and calving for the first time at 3 years of age. Yet M&WNZ survey farms report 17% 2-3 year old heifers to mixed aged cows with a range from 13 to 23% at the 30th June (Table 7).

Table 7: Average numbers of mixed aged breeding cows and 2-3 year old heifers by farm class from M&WNZ survey farms at June 2008

Farm Class	MA cows	2-3 yr heifers	% heifers	1990
1	175	27	13.4	18.0
2	116	20	14.7	18.0
3	124	36	23.3	23.6
4	58	14	20.5	22.8
5	20	3	16.7	20.8
6	41	7	14.6	16.0
7	6	1	14.6	
8	6	0	14.3	
Total	547	112	17.0	20.1
Model	1184411	355330	25%	

In reality, many farmers run their yearling heifers with a bull (Table 8). From the farm survey data, most of the farmers surveyed ran their two year old heifers with a bull but there was no indication of how many of these actually calved. What tends to happens is that farmers keep more heifer calves than they need (hence the figure of 25% replacements), mate them as yearlings and then cull those that don't get in calf at 18 months of age as local trade heifers. However, it is likely that there has been a significant change over time, as in 1990 the mating of heifers at two years of age would have been rare, with heifer mating at 3 years of age the norm. In 1990/91 there were no heifers recorded as run with the bull on the survey farms.

Table 8: Age of heifer mating on M&WNZ survey farms (2007/08)

Farm class	1-2yr old heifers	2-3 yr heifers
1	27	29
2	20	22
3	36	10
4	14	11
5	3	4
6	7	11
7	1	2
8	0	4

Recommendation

- *That 25% of beef heifer replacements are retained as breeding animals, with a 2% annual death rate. In March/April (as rising 2 year olds) dry animals slaughtered (after pregnancy testing) so that after allowing for deaths between March and October, 17% of heifers enter the beef breeding herd as calving heifers.*

3.5 Deaths

The model assumes a 2% per annum death rate for all stock. The death rate of cows on M&WNZ survey farms averages 2.7% and ranges from 0.8 to 5.0% with losses being highest on hard hill country in the North Island and High Country in the South Island. These farms also have highest proportions of breeding cows. The death rate of calves averages 5.6% and ranges from 1.5% through to 20%. The death rate in calves is highest on intensive properties on both islands (at 11.5 and 20%). This is probably a result that includes artificially reared calves of dairy origin and deaths of calves prior to weaning because of better recording systems. The death rate for older cattle (other than cows) on M&WNZ survey farms is 1%. The model assumes a constant death rate across the year. In reality, culling and deaths are more likely to occur at certain times of the year especially in the breeding animals. For example, more cows are likely to die around calving because of the increased physiological and metabolic risks associated with calving.

Recommendation

- *That cow death rates are increased to 2.7 % and that 50% of these deaths occur in the month of calving. Death rates in younger stock needs to be looked at further in the context of the model and after the suggested changes to replacements rates, slaughter dates and age structures are addressed (Sections 3.4, 3.7 and 3.8).*

3.6 Replacement breeding bulls

The model assumes that the production of additional breeding bulls happens evenly through out the year. But calves will still be born at the normal time, stay in the system and are purchased at the annual bull sales which occur in June/July each year. Bulls are typically culled for faults (e.g. feet problems) in the month after mating.

Recommendation

- *Surplus bulls are culled at the end of February. Any increases in bull numbers occur through increasing the number of bull calves kept for replacements and introduced into the herd prior to mating*

3.7 Slaughter animals

The relative proportion of heifers, steers and bulls in the non-breeding categories of the inventory model are obtained from annual census data and MAF slaughter statistics. The numbers of bulls, heifers and steers within each age group is calculated by multiplying the number killed by the number of years present. The slaughter statistics do not differentiate carcasses on age and the model assumes that all animals are killed at two years of age. If the age of slaughter is incorrect then the age structure of the animals on farm will also be incorrect. This will affect the estimated growth rates and the total feed required by that stock class.

3.7.1 Heifers. The model assumes that heifers are killed at two years of age (i.e. on the 1st September based on current calving date). When the national slaughter statistics are examined, heifers appear to be killed throughout the year with a slight decline in numbers during the late winter/early spring months (July to October). Half of the heifers are killed by mid January (Table 9) and at an average carcass weight 230.4 kg. Yet on the M&WNZ survey farms, 50% of the heifers killed off sheep and beef farms are killed by October (i.e. at 2 years of age; Table 10) rather than mid January as in the National Statistics. The difference is likely to be due to the heifers from the dairy industry which are not separated out in the slaughter statistics and contribute to the beef kill.

The proportion killed at various ages varied by farm type with from 0% - 84% killed by 20 months. R2 heifers tend to be killed from January - June and R3 heifers tend to be killed November to January (Table 10).

Table 9: Monthly heifer slaughter (MAF slaughter statistics)

	Year						
Inspected Numbers $^{00's}$	**2004/05**	**2005/06**	**2006/07**	**2007/08**	**2008/09**	**%**	**cumulative**
July	48	37	40	36	43	8.1	8.1
Aug	34	37	36	33	31	6.8	14.9
Sept	30	36	33	32	28	6.3	21.1
October	33	39	39	37	40	7.3	28.5
November	44	47	51	47	47	9.1	37.6
December	44	42	40	41	45	8.4	**46.0**
January	40	37	39	43	41	7.9	**53.9**
February	44	35	37	40	42	7.9	61.8
March	48	46	47	37	46	9.2	71.0
April	47	39	39	46	47	8.7	79.7
May	53	54	49	53	53	10.4	90.1
June	45	52	42	56	54	9.9	100
Total	**509**	**500**	**493**	**500**	**516**		

Table 10: Timing of slaughter of R2 and R3 heifers on M&WNZ survey farms (2007/08)

		Farm Class										
Age	Month	1	2	4	5	6	7	8	Total	% age	% tot	Cum
R2	Jul	0	0	19	9	21	0	0	49	1.4	0.4	0.4
	Aug	**36**	0	0	0	10	29	0	75	2.1	0.7	1.1
	Sept	0	0	20	10	20	0	0	50	1.4	0.4	1.5
	Oct	7	6	0	8	31	31	0	83	2.3	0.7	2.2
	Nov	0	2	12	0	44	6	0	64	1.8	0.6	2.8
	Dec	11	0	57	63	6	10	0	147	4.1	1.3	4.1
	Jan	10	**185**	104	41	**173**	0	0	534	14.9	4.7	8.8
	Feb	23	2	**233**	69	99	1	0	427	11.9	3.7	12.5
	Mar	26	70	**234**	**148**	30	**57**	0	590	16.5	5.2	17.6
	Apr	**42**	67	154	23	**130**	**69**	0	506	14.1	4.4	22.1
	May	**45**	**102**	121	**113**	**107**	7	0	561	15.7	4.9	27.0
	Jun	**42**	13	135	75	**124**	**58**	0	490	13.7	4.3	31.3
	Total	242	447	1089	559	795	268	0	3576			
R3	Jul	0	4	269	77	34	**14**	0	427	5.5	3.7	35.0
	Aug	6	0	**323**	174	51	0	0	651	8.3	5.7	40.7
	Sept	0	12	200	**232**	62	0	0	537	6.9	4.7	45.4
	Oct	**57**	2	111	**254**	57	0	0	531	6.8	4.6	**50.0**
	Nov	0	14	259	**235**	**236**	2	**43**	891	11.4	7.8	57.8
	Dec	0	3	**442**	**226**	**163**	8	**19**	1001	12.8	8.7	66.5
	Jan	0	27	**375**	**294**	62	**10**	**50**	954	12.2	8.3	74.9
	Feb	17	6	157	84	41	2	**39**	420	5.4	3.7	78.5
	Mar	**53**	**88**	**326**	111	83	5	0	725	9.3	6.3	84.9
	Apr	**44**	16	198	50	65	**10**	0	515	6.6	4.5	89.4
	May	36	**75**	228	57	**147**	2	0	753	9.6	6.6	96.0
	Jun	11	**105**	153	29	117	0	0	462	5.9	4.0	100
	Total	224	352	3041	1823	1118	53	101	7817			
Grand	Total	466	829	4130	2382	1913	321	101	11923			
% Sold 20 months		52	56	14	26	24	42	84	0		31.4	

Recommendation

- *Sell heifers at the end of October at 2 years of age (i.e. no change after adjustment for calving date).*

3.7.2 Bulls

The MAF national slaughter statistics from 2003/04 to 2008/09 give an average bull carcass weight of 306.4 kg. None of the data sets identify a slaughter bull class over two years of age. Bulls tend to be farmed on the better farm classes, which along with faster growth rates mean that most bulls are killed as R2s rather than R3s. In both the slaughter statistics (Table 11) and the data from the M&WNZ survey farms (Table 12) the majority of bulls are killed from November to February with 50% killed by the end of January rather than on the 1st of September as the model predicts. This means bulls are killed at around 18 months of age (assuming they are August born and originate from the dairy industry). This pattern is consistent across years (Table 12). This suggests that bulls are killed earlier than the model predicts and that the feed requirements for bulls is over-estimated. In addition, 41.6% of the bulls are killed off farm class 5 (North Island Intensive) and a further 27.5% are from farm class 4 (North Island hill; Table 12) meaning that over 73% of all bulls are produced in the North Island.

Table 11: Bull kill 2004/05 – 2008/09 (MAF slaughter statistics)

Inspected Numbers(000s)	2004/05	2005/06	2006/2007	2007/08	2008/09	%	Cuml %	Cwt
July	30	19	18	20	20	3.9	3.9	300.9
August	10	8	8	5	10	1.6	5.5	302.6
September	8	10	9	7	7	1.5	7.0	310.5
October	21	26	28	21	25	4.6	11.6	320.2
November	44	**63**	**70**	**61**	**64**	**11.4**	23.0	323.6
December	**89**	**65**	**69**	**68**	**60**	**13.1**	36.0	320.9
January	**94**	**82**	**81**	**93**	**74**	**15.9**	**51.9**	**313.2**
February	**85**	**61**	**64**	**82**	**72**	**13.6**	65.5	304.9
March	**62**	**62**	**56**	51	43	10.2	75.8	296.3
April	42	33	42	49	34	7.4	83.9	289.2
May	45	54	37	50	41	8.5	91.7	290.9
June	46	49	45	47	34	8.3	100	294.0
Total	**577**	**531**	**526**	**553**	**485**			**306.4**

Table 12: Pattern of bull kill by farm class (M&WNZ survey farms)

	Farm Class										
	1	2	3	4	5	6	7	8	Total	% Total	Cumul
Jul	13	29	**121**	432	448	57	1	1	1102	4.6	4.6
Aug	0	8	22	59	87	19	1	7	203	0.9	5.5
Sept	0	3	29	140	131	1	0	2	306	1.3	6.8
Oct	2	4	41	274	243	41	7	87	697	2.9	9.7
Nov	1	29	62	625	**1531**	386	17	**197**	2848	**12.0**	21.7
Dec	4	50	48	825	**1291**	352	10	**140**	2720	**11.4**	33.1
Jan	0	40	98	**1032**	**1993**	**565**	1	**156**	3885	**16.3**	**50.2**
Feb	3	**118**	**126**	**1005**	**1489**	**489**	45	**206**	3485	**14.6**	64.6
Mar	0	67	38	696	765	423	**78**	112	3481	9.2	73.8
Apr	1	**105**	87	557	922	374	**60**	68	2179	9.1	82.9
May	0	27	**123**	528	891	121	**77**	123	2174	7.9	90.8
Jun	19	**197**	**125**	347	**1231**	139	40	**180**	1890	9.6	101.4
Total	43	677	920	6550	11022	2967	337	1279			
%	0.2	2.8	3.9	27.5	**46.3**	12.5	1.4	5.4			

Recommendation

- *That bulls are killed at an average of 18 months of age (as opposed to two year of age).*

3.7.3 Steers

The MAF national slaughter statistics for 2004/05 to 2008/09 give an average steer carcass weight of 309.7 kg. There is a relatively even pattern of kill across the year with a small depression from July to October which varies according to year (Table 13). This results in 55% of the steers being killed by the end of February. The overall picture from the survey farms is similar with a depression from July to October and peak from January through to May (Table 14). Neither of these matches the inventory model where the average steer is slaughtered at 2 years of age on the 1st of September. On average, only 16% of steers are killed under 2 years of age. This varies with farm class with those farms on more productive country in the South Island killing their steers earlier at a slightly lighter carcass weight. The M&WNZ survey farms have 51.2% of steers killed by the end of December (at 28 months of age).

Table 13: Steer kill 2004/05 to 2008/09. (MAF slaughter statistics)

	Year						
Inspected Numbers(000s)	**2004/05**	**2005/06**	**2006/07**	**2007/08**	**2008/09**	**%**	**Cum**
July	42	32	37	40	42	6.4	6.4
August	24	25	30	28	29	4.9	11.3
September	20	27	26	27	23	4.5	15.8
October	26	34	36	35	41	5.6	21.4
November	43	60	62	58	59	7.7	29.1
December	57	60	58	58	56	8.4	37.5
January	56	60	59	71	52	8.4	**45.9**
February	72	54	57	69	60	8.9	**54.8**
March	71	73	70	58	60	9.5	64.3
April	58	51	56	69	55	8.2	72.5
May	68	81	57	69	65	9.6	82.1
June	61	64	59	66	63	9.1	91.2
Total	**596**	**621**	**607**	**648**	**605**		

Table 14: Steer kill by farm class (M&WNZ survey farms)

Age	Month	Farm Class 1	2	3	4	5	6	7	8	Total	% within yr	% Total 2 yr
R2	Jul	0	0	0	0	7	9	6	0	22	0.9	0.2
	Aug	36	0	0	0	1	0	0	0	37	1.5	0.4
	Sept	0	0	0	0	0	0	8	0	8	3.3	0.5
	Oct	7	6	0	0	0	0	0	**101**	114	4.7	1.3
	Nov	0	2	0	65	13	66	2	0	148	6.2	2.3
	Dec	11	0	0	37	37	48	7	0	140	5.8	3.2
	Jan	10	**185**	0	52	17	0	0	0	264	10.9	5.1
	Feb	23	2	0	62	54	65	2	0	208	8.6	6.5
	Mar	26	70	0	49	23	74	49	0	291	**12.0**	8.5
	Apr	**42**	67	0	72	44	**152**	35	0	412	**17.0**	11.4
	May	**45**	**102**	1	**113**	**62**	**104**	**63**	0	490	**20.2**	14.8
	Jun	**42**	13	13	**130**	0	44	47	0	289	**11.9**	16.8
	Total	242	447	14	580	258	562	219	101			
	%	10.0	18.4	0.6	23.9	10.6	23.2	9.0	4.2			
R3	Jul	21	85	118	246	122	22	4	23	441	3.7	19.8
	Aug	49	29	26	268	80	2	2	29	485	4.0	23.1
	Sept	77	5	17	215	194	37	0	21	566	4.7	27.1
	Oct	31	68	17	242	62	57	2	5	484	4.0	30.5
	Nov	83	**140**	163	295	**323**	**185**	21	7	1217	**10.1**	38.9
	Dec	**106**	**192**	119	412	**305**	**180**	9	0	1323	**11.0**	**48.0**
	Jan	54	**121**	**243**	**654**	**274**	87	16	1	1450	**12.1**	**58.1**
	Feb	16	**112**	**365**	**780**	**288**	150	39	0	1750	**14.6**	70.2
	Mar	2	32	111	435	211	110		0	991	8.2	77.1
	Apr	2	60	168	493	132	**184**	40	6	1085	9.0	84.6
	May	89	66	105	**682**	74	85	62	0	1163	9.7	92.6
	Jun	7	63	108	570	185	130	0	1	1064	8.9	100
	Total	537	973	1560	5292	2250	1229	285	93			
	%	4.4	8	12.8	43.3	18.4	10.1	2.3	0.8			
Grand Total		779	1420	1574	5872	2508	1781	504	194	14442		
% sold 1-1.5		31.1	31.5	0.9	9.9	10.3	31.4	43.5	52.1	16.6		

Recommendation

- *That the average age at slaughter of 24 months for steers be changed from 1st September to 1st February (28 months of age after adjusting calving date).*

3.8 Number in each age group

The model calculates the proportion of stock in each age category in the following manner. The total number of beef animals is taken from the agricultural census on the 30th June each year. The number of beef cows and replacement heifers are subtracted from the total number to give the number of animals destined for slaughter. The number in each sex category is calculated from the proportion of slaughter animals in each sex category. The total number in each sex category is then divided by the number of years between birth and slaughter. This then gives the number of animals in each age and sex cohort.

Changes to the age of slaughter for heifers, steers and bulls will affect growth rates and on farm age groupings. Age groupings need to allow for a constant death rate so in turn there need to be more animals in younger age groups to allow for deaths. Currently, the best method of getting the classes of cattle nationally is to take the proportions killed from the national slaughter statistics and then allocate this to the age groups based on the differences in ages at kill (e.g. have to carry more steers to allow for older animals) after allowing for deaths at the younger ages. Cattle growth rates will have to be adjusted to allow for these differences.

In the long term, a better method of determining the different populations is needed. Information on population numbers coming from dairy, lifestyle blocks and sheep and beef properties would provide insight into where the discrepancies are arising and allow for better corrections in the future.

Currently, the numbers of animals being killed and the number of non breeding animals do not reconcile (Table 15). However, changes in replacements rates, age at slaughter and age at which heifers enter the herd may improve the reconciliation of numbers.

Table 15: Comparison of numbers modeled and available for slaughter with annual slaughter numbers (2003-2008)

	Heifers		Steers		Bulls	
	On farm	Killed	On farm	Killed	On farm	Killed
2003	375	514	403	583	529	698
2004	356	509	404	596	483	577
2005	374	500	438	621	423	531
2006	373	493	463	607	396	526
2007	382	500	471	648	408	553
2008	355	516	460	605	393	485
Total	2215	3032	2639	3660	2632	3370

4.0 Deer

Data on the farmed deer populations and the data on the proportions in each sex and age category are obtained from agricultural census data. Compared to dairy, sheep and beef there is less detailed data available. However, the contribution of deer to the model has decreased in recent years as deer numbers have dropped relative to the other stock categories and now only make up a very small component of the emissions. While more information on different stock classes would improve the model, the reality is that it will have little effect on the total methane output.

4.1 Proportions of each population

For the year ended June 30th 2008 the model has the following proportions: breeding hinds (0.4), hinds >1 (0.19), hinds 1-2 (0.10), stags <1 (0.19), stags 1-2 (0.03), stags 2-3 (0.02) and mixed age breeding stags (0.06).

The results from the M&WNZ survey farms are similar (Table 16). In the year ended June 30th 2008 the majority of deer were in the South Island high country so any change in this farm class will affect the pattern for the whole country. Deer data is collected from mixed livestock farms within the 560 farms surveyed by the M&WNZ Economic Service survey. None of these were specialist deer properties. However, a further 20 North Island and 20 South Island specialist deer properties have been surveyed separately by the Meat and Wool Economic Service.

The main difference between specialist and the mixed farms was that the specialist farms had a larger proportion of older stags that were basically kept for velvet. In 1990/91 on average farms carried fewer deer and a higher proportion of the herd were hinds. It appears that in 1990, there was a wider geographical spread of deer. This is not surprising as in the 1980's deer herds were built up to take advantage of taxation benefits. In more recent years, deer have been farmed on their productive merits and are more likely to be farmed in areas where seasonal feed production has a better fit with deer feed requirements.

From the carcass weights from the specialist deer farms it appears there has been little change in carcass weights within stock classes since 2003 (Table 17). However, according to the model, average carcass weights have increased since 1990. The deer industry is particularly volatile and this discrepancy may be due to changes in the stock classes being killed (e.g. more mature stags being slaughtered) rather than changes within stock classes. The data available on age classes being killed is very limited. Better data separating out slaughter animals into stags and hinds and 1 and 2 year old animals would be beneficial but any effects are likely to be minor because of the size of the population.

Table 16: Deer numbers by farm class (M&WNZ survey data 2007-2008)

	Hinds			Stag					%
Class	MA	Weaner	1.5yr	Weaner	1.5yr	2.5yr	MA	Total	2007/08
1	87	32	16	28	22	7	3	195	46.0
2	13	5	4	5	1	1	1	30	7.1
3	18	10	7	3	1	0	1	40	9.4
4	8	4	2	3	1	2	0	20	4.7
5	0	0	0	0	0	0	0	0	0
6	16	9	8	19	4	1	0	57	13.4
7	3	7	0	5	0	0	0	15	3.5
8	0	17	0	17	0	0	0	34	8.0
Total	155	91	41	88	31	12	6		
% 2007/08	36.6	21.5	9.7	20.8	7.3	2.8	1.4		
% 1990/91	43.7	17.8	10.2	17.3	9.6	0	1.5		
Model %	40	19	10	19	3	2	6		
Specialist deer %	39.5	20.6	7.3	20.6	3.7	7.6	10		

Table 17: Deer carcass weights (kg) from specialist deer producers (M&WNZ survey data report)

		Year				
		2003	2004	2005	2006	2007
NI	cull hinds	52	52	52	53	54
	3+ stags	100	100	100	101	101
	2 stag	69	69	69	70	71
	yearling stag	55	55	55	56	57
SI	cull hinds	52	52	52	52	52
	2 stag	65	65	65	65	65
	yearling stag	57	55	56	55	55

The liveweights of growing stags and hinds are calculated from carcass weights in MAF slaughter stats and a dressing out % of 55% (Simone Hoskin, personal communication). On the other hand, the liveweights of mature stags and hinds are taken from liveweight data published by Fennessy et al (1981). This allows for a baseline (1989) figure of 110 kg for hinds and 150 kg for stags. The model then automatically updates these weights each year by the same percentage change as recorded in the slaughter statistics for growing stags/hinds. No within year pattern of liveweight change is assumed.

However, the data of Fennessy et al (1981) actually suggests that the weight of a mature breeding hind is 95 kg rather than the 110 kg used in the model. This will have a large impact on the feed requirements for the breeding herds. Data collected on mixed age red deer hinds between 1984 and 1989 indicated an average hind liveweight of 94 kg (Barrell, 1989). Moreover, the cull hind carcass weights from the M&WNZ survey (Table 20) and a dressing out of 55% indicate a mature hind liveweight of 94 kg. Hind liveweights may not have changed over the years because of the trend towards using maintaining the genetic integrity of red deer herds and using wapiti and elk x stags as terminal sires over red hinds to increase growth rates and carcass weights of progeny. This will not impact on hind liveweights.

The data of Fennessy et al (1981) suggests an increase in the weight of breeding stag over its lifetime with the animal not reaching 150 kg until about three years of age. The number of breeding stags is a very small proportion of the population so changing this weight will have little effect.

Recommendation

- *That the baseline liveweight of hinds be reduced from 110 kg to 95 kg.*

4.2 Calving date

The model currently assumes a mean calving date in December. This compares with 17th Nov for M&WNZ survey farms in 2007/2008. Calving date is also likely to have advanced over time as in 1990/1991 the estimated mean calving date on these farms was 25th November (Table 18). There was no difference between the two islands and calving date is heavily influenced by the calving date in the South Island high country as this farm class has the largest numbers of deer. The shift is likely to be due to a gradual selection against hinds that calve late.

Table 18: Calculated calving dates by farm class for M&WNZ survey farms

Farm	2007/2008		1990/91	
Class	Stag out	Calving date[1]	Stag out	Calving date[1]
1	13/3	17/11	21/3	25/11
2	28/3	2/12	27/3	1/12
3	13/3	17/11	25/3	29/11
4	17/3	21/11	20/3	24/11
5			20/3	24/11
6	11/3	15/11	19/3	23/11
7	1/3	5/11	12/3	16/11
8			1/3	5/11
Mean		**17/11**		**25/11**

[1]Estimated mean calving date from stag out date and assuming an 18 day oestrus cycle, equal number of hinds cycling each day of the cycle, a 70% conception rate and a 249 day gestation. .

Recommendation

- *Change calving date to 17th of November in 2007/08 and adjust previous dates to fit the changes occurring since 1990/91.*

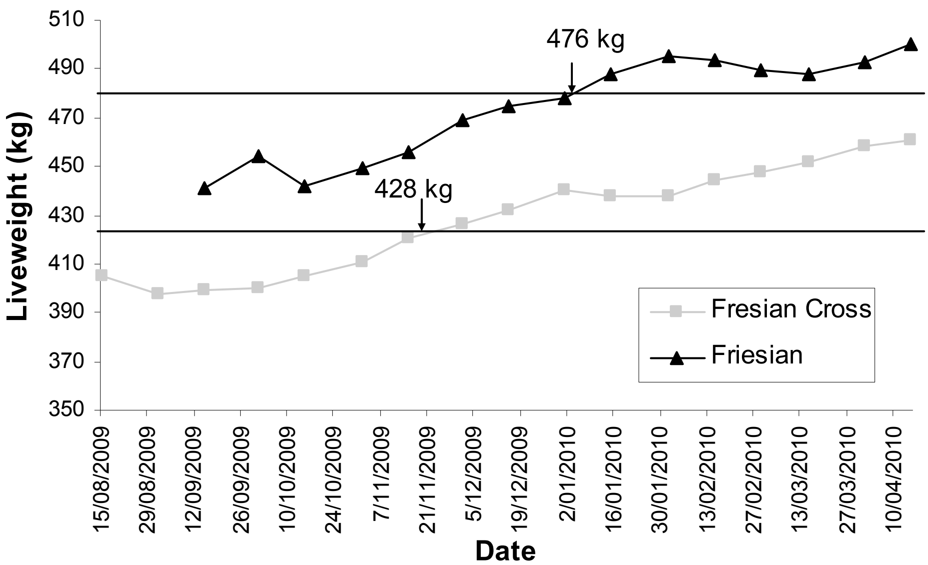
5.0 Dairy

Dairy cows have a significant impact on methane output. In 1990, dairy cattle made up 23.4% of the emissions from farm animals in New Zealand and dairy animals have increased from 3,199,730 in 1990 to 5,578,440 in 2009. Thus the figure used for dairy cow liveweight has a huge impact on methane output.

5.1. Cow liveweight

Currently, the average weight of a dairy cow is entered directly into the model. The data is obtained from the LIC Dairy Statistics which provides survey data on the weights of dairy cows by age and breed. Data is lodged with LIC from progeny tested herds (weighed by Agri-quality staff) and from weights farmers lodge with LIC's MINDA service. Most weights are recorded in Oct/Nov (Bill Montgomerie, per comm.). The weight of an "average" dairy cow is calculated by taking into account the proportion of each breed in the national herd and the age structure of the national herd. It is assumed that there is no within year liveweight change. However, given the liveweight change that occurs in dairy cows through lactation it is easy to see how the timing of a single weight might under or over estimate the average cow liveweight over the year. With modern rotary weighing systems this sort of cow data is available on a daily basis throughout lactation. For example, Landcorp Ltd. have supplied cow liveweight data from 11 herds (9 Crossbred and 2 Friesian) comprising 9225 animals during 2009/10 (Fig 3). These are mean weights from the morning and afternoon milkings. The 7265 crossbred cows averages 428 kg – this is 11 kg lighter than the 439 kg used by LIC in the model. The 1960 Friesian cows (476 kg) are closer to that used in by LIC (477 kg). By comparison, the model uses a figure of 446 kg after correction for the percentages of Friesian, crossbred and Jersey cows in the national herd.

Figure 3: Monthly dairy cow liveweight from 9 cross bred herds containing 9225 milking cows in total - includes pregnancy weight (Landcorp, personal comm..)



Dairy heifer birth weights are assumed by the model to be 9% of cow bodyweight (Clark et al., 2003 – page 15) but this may be an overestimate of dairy heifer birthweights. There is virtually no data on calf birthweights, but Muir et al. (2004) reported a liveweight of 38.7 kg for 65 Friesian bull calves weighed within 24 hours of birth on 4 Waikato farms in August 2000. Whilst the Friesian dams were not weighed, LIC Dairy Statistics give an average weight of 446 kg for Holstein-Friesian cows in 2000/2001. These bull calves would have weighed around 8.7% of their cow bodyweight. Since heifer calves are likely to be 2 kg lighter than bull calves, heifer calf birthweight is likely to be around 8.2% of cow bodyweight. However, it is unlikely that such small discrepancies will have an impact on national methane output.

The model assumes that heifers reach 90% of the average cow weight at first calving (i.e. at 2 years of age). LIC data (Table 19) suggests that as two year olds, heifers are 86% of the average weight of all the cows in the herd and 82.5% of the cows three years and older. Moreover, the same data suggests that cows continue to increase in weight until 5 or 6 years of age. Lower liveweight targets for younger cows will affect the requirements for maintenance and growth. In addition, as two years olds, crossbred heifers appear to be lighter relative to their older herd mates than are Friesians. This means that average feed and maintenance requirements will reduce over time if the proportion of crossbred cows increases over time.

Table 19: Effect of age on cow liveweight for the 2006/07 season (LIC data)

	Friesian		Crossbred		Jersey	
Age	%	Weight	%	Weight	%	Weight
2	18.7	409	20.4	369	17.8	320
3	15.1	443	17.5	423	16.3	367
4	14.4	468	15.9	451	15.3	384
5	13.9	489	13.7	471	13.8	398
6	11.1	505	10.6	485	11.4	404
7	8.2	488	7.6	476	8.6	413
8	6.3	496	5.5	477	6.4	419
Overall		463		438		378
2yr weight as a % of older herd mates		88.3		84.2	.3	84.7

Recommendation

- *To look more closely at dairy cow growth rates and liveweight profiles using across breed/region data from LIC and other sources.*

5.2 Deaths

Currently, the dairy model assumes no deaths and assigns a lower milk production per cow to make up for the difference. The only published data on dairy cow deaths is from LIC's Monitoring Fertility Project (Xu and Burton, 2003) which surveyed 98,231 cows and found mortality averaged 2.1% over 3 years. It is likely that there is wealth of information available on MINDA as to when cows die and when cows are culled. But obtaining this information will provide challenges as it is likely to be regarded as commercial IP. As with other breeding animals it is likely that more deaths occur around calving than at any other time.

Recommendation

- *To incorporate a death rate 2.1% - half of which occurs in August.*

5.3 Calf milk

The annual milk yield per cow is calculated from data on the total amount of milk processed and the number of milking dairy animals. Yet whole milk is also fed to calves on dairy farms. Thomson and Muir (2004) surveyed dairy farmers and found that for every 100 milking cows, 24.6% heifers and 7.2% bull calves were reared. These were each fed an average of 316 litres of colostrum, penicillin milk or vat milk. Given that the remaining bobby calves are supposed to be fed colostum for 4 days (at 4 lites/day), the total amount of colostrums/penicillin milk/whole milk used from each cow for feeding calves is 107 litres. To put this in context, Fonterra estimates that the average cow produces 52 litres of colostrum and 15 litres of mastitis milk, so there is around 67 litres of milk/cow which is unsuitable for standard milk collection.

The model assumes that approximately 40% of beef calves are supplied by the dairy industry. This is likely to change over time and could be back-estimated from the change in bull kill.

Recommendation

- *That 107 litres of milk be added to the first half of the annual lactation of each cow to allow for the milk fed to calves.*

5.4 Calving date

Table 20 suggests that a 1st August calving is too early and that an overall average is 13th August. Calving date varies between regions and thus the median calving date will have varied over time due to the relative weightings of the amount of dairying in each region. The importance of dairying to the greenhouse gas calculation means calving date should be adjusted on a regional basis

Table 20: Median date of calving by region

			Year				
Region	**03/04**	**04/05**	**05/06**	**06/07**	**07/08**	**Mean**	**%**
Northland	6/8	7/8	9/8	6/8	5/8	6/8	8.7
Auckland	9/8	9/8	10/8	9/8	8/8	9/8	36.7
BOP/East Coast	9/8	8/8	10/8	9/8	8/8	8/8	9.7
Taranaki	16/8	15/8	16/8	14/8	16/8	15/8	16.3
Wellington/HB	18/8	16/8	19/8	16/8	19/8	17/8	9.5
South Island	27/8	26/8	26/8	24/8	25/8	25/8	19
Mean						**13/8**	

From LIC annual reports, mean is weighted by number of dairy farms in each region

Recommendation

- *The average calving date should be 13th August and that it is set by region as this will take into account changes in the amount of dairying in each region over time.*

5.5 Bull numbers and liveweights

In the dairy industry about 70% are mated using artificial insemination (LIC Annual reports). Those that fail to hold to AI are mated to a back up bull. Replacement heifers tend to be kept from the cows that get pregnant to AI as this semen is from top dairy bulls. This means that the calves from the back up bulls are a by-product with limited value and are sold as bobby calves or as bull calves to the beef industry. The business of the dairy industry is producing milk so bulls for mating bulls are selected on ease of calving and price. This differs from the beef industry where the calf is the main product and bull selection is more critical and bulls tend to be more highly valued. So many dairy bulls are leased or bought immediately prior to mating. They are then returned or sold to slaughter immediately after mating so these bulls are more likely to be counted as part of a beef operation either as stud beef bulls or as part of the bull beef numbers rather than as dairy breeding bulls.

Because bulls on dairy farms are functional and their weight simply maintained to avoid lameness issues with heavy bulls on gravel races they tend to be held at a constant liveweight. Moreover, any growth will have occurred prior to their arrival on the dairy farm and be included in the slaughter bull growth rate.

Recommendations

- *Cull surplus bulls in January after mating. Any increases in bull numbers will occur through an increase in the number of bull calves kept and these will be introduced into the herd prior to mating.*
- *Bulls have a 0 g/d growth rate.*

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Beef and Lamb NZ (formerly Meat and Wool NZ) provided access to their survey data collected across a range of farm types. This provided a valuable resource and their assistance is gratefully acknowledged.

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Appendix 1: Farm description for Meat and Wool Economic Service sheep and beef survey farms in 2008/2009

	Category	Farm No.	Farm size	su				Land %		
				Sheep	Cattle	Deer	/ha	Flat	Rolling	Steep
1	SI High	20	10902	8658	2372	333	1.1	9.0	7.5	83.5
2	SI Hill	42	1767	4244	1818	53	4.0	19.8	15.1	65.1
3	NI Hard	72	1058	4195	2229	66	8.7	4.1	18.0	77.9
4	NI Hill	171	459	2165	1693	35	10.2	9.0	42.0	49.0
5	NI Intensive	94	301	1292	1486		10.1	36.4	48.6	15.0
6	SI Finish/breed	87	490	2659	1057	92	9.3	44.0	34.3	21.7
7	SI Intensive Finish	45	256	2358	274	20	12.5	58.9	38.4	2.7
8	SI Mixed Finish	27	359	1427	679	45	7.5	82.0	16.9	1.0