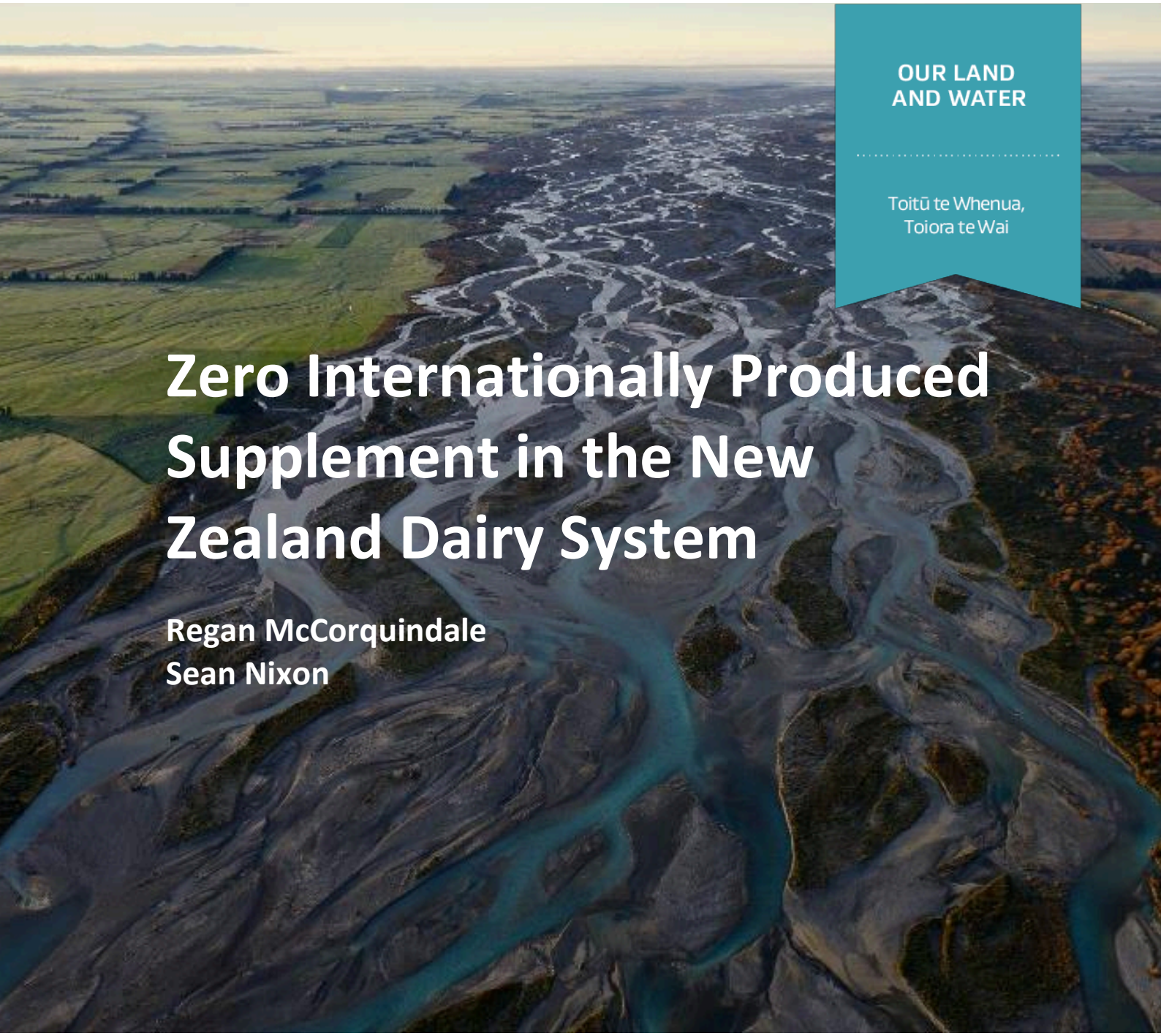
National Science Challenges



OUR LAND AND WATER

Toitū te Whenua, Toiora te Wai

Zero Internationally Produced Supplement in the New Zealand Dairy System

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Executive Summary

The aim of this project was to determine how the effects of removing all Internationally Produced Supplement (IPS), affects our New Zealand dairy farming systems with a productivity, profitability and sustainability lens. The small team of Sean Nixon, Agriconcepts and Regan McCorquindale, RECO, have paired up to determine how these supplements have influenced our industry in recent years.

Two Waikato dairy farms have been chosen and analysed in detail to determine how reliant these properties have become of IPS. The following scenarios were modelled to determine the overall effects. The base file being the current system farmed, Zero IPS (ZIPS), Substitution for New Zealand Produced Supplement (NZPS) and a lower stocking rate with ZIPS (LSR). At the individual farm level, Farm A and B would reduce total milk production by 13% and 24% respectively under the ZIPS scenario. The NZPS scenario total milk production has the potential to equal the base file pending the availability of supplement to the farmgate. The LSR scenario is also estimated to reduce production by 11% and 18% respectively between Farm A and B. Profitability was reduced significantly when farmed as a ZIPS scenario. Both farms report a predicted 27% and 50% reduction prior to substitution and a 12.8% and 25% reduction including the substitution for NZPS, the majority of this reduction being from an increase in the cost of local supplement. The LSR scenario also reduced profitability by 24% and 48% respectively. The only favourable metric of the ZIPS scenario is the environmental outcome, which for this project is only measuring Greenhouse Gas (GHG) as kg/hectare (ha) farmed. This metric was the second lowest out of the three different scenarios, measuring the lowest in the LSR, followed by ZIPS, NZPS and the base file.

The IPS data used for this project is from 1 June 2017 until 31 May 2021. New Zealand's IPS levels are constantly changing. Palm Kernel Expeller (PKE), the largest imported IPS by four times over Soybeans, has been decreasing over the last four seasons. Canola and wheat have also been on the decline, however, Maize Grain, Soybean and Dried Distillers Grain (DDG) have all increased in this four season timeframe (NZX, 2021).

The biggest challenge moving to a ZIPS dairy system in New Zealand is our availability of land to grow the alternative crops. The quantity of IPS averaged nationally in the 2020/21 season was 608kg/cow (NZX, 2021). The four year average is 612kg/cow/yr. This is from the accumulation of PKE, Maize Grain, Canola, Soybean, Wheat and DDG. Two approaches were taken in terms of substituting IPS throughout New Zealand. Maize silage was identified as the most appropriate substitute for the north island (CopRice, n.d.), barley and wheat grain for the south island (Vibart, 2017). Maize silage is grown in large quantities per hectare, averaging 21tDM/ha in the season ending May 2021 with a total of 55,000ha grown. Whereas, in the south island, barley, wheat and oats respectively cover 36,599ha and 7.27t/ha, 33,394ha and 10.1t/ha, and 2,242ha and (AIMI FAR, 2021).

Total supplement at a national level was gathered, however, distribution of this feed throughout the regions was unable to be obtained in this project. Substitution crops has been explored, however the biggest limitation remains the total area available and the ability to transport these feed types. Utilising the same feed conversion efficiency as the farms modelled, the production that has been achieved in recent years from the inclusion of IPS has equated to 207 million kilograms of milksolids. Total annualised production would reduce from 1.947 billion milksolids in the season ended May 2021 to 1.737 billion milksolids under the same climatic conditions. This equates to the milk production produced between the 2013/14

season. In the 2014/15 season for reference, 390kgDM/cow were imported to dairy farms (Ministry for Primary Industries, 2017).

Although the IPS data used for this project only considers the last four seasons, total IPS has reduced by 271 million kilograms (NZX, 2021), yet production has increased from less cows. This is an indication that our industry is becoming more efficient with feed, genetics, pastures, crops and the overarching management of these farms.

For production per hectare and per cow to remain the same as the season ended 31 May 2021, a total of 183,000ha would need to be retired from actively milked dairy platforms to yield the required tonnage of NZPS (New Zealand Dairy Statistics, 2021). Total dairy farmed land in the 2021 season was 1.7 million hectares so this would be a net reduction of 10.76%. The north island in certain areas has the ability to grow maize silage in larger yields/ha than the south island can grow in both barley and wheat grain/ha respectively. This leads to 76,000ha required in the north island to sustain their substitution on a 1:1kgDM basis, whereas the south island requires 104,000ha to achieve the same outcome. These substitution allocations do not take into account the nutritive value of the feed that is being substituted at a national scale. The Farmax modelling has taken the nutritive value into account on the specific farms modelled.

The challenge that the dairy industry continues to face is the huge reliance upon the transport and logistics industry to supply product to the farmgate within 24-48hrs of it being required for consistent feeding. A lot of the IPS that is fed within our systems is used through either an in-shed feed system or feed pad operation. If the product was not available to farm within these timeframes, the dairy cows diet would be inconsistent and this has flow-on effects for milk and reproductive performance (Queensland Government, 2018).

Dairy farmers are nimble and willing to change, however the industry has become very reliant on IPS and moving to a ZIPS system is not the immediate answer. Net production and profitability is likely to be too damaging to the businesses sustainability for the short to medium term. A sustainable dairy business will be able to reinvest returns to ensure the business adopts modern practices that are for the betterment of the environment.

Introduction

Internationally Produced Supplement (IPS) has played a major role in the New Zealand Dairy Industry. Increasing stocking rates up until recent years meant that more feed had to be introduced to maintain levels of dietary requirements. This study looks to disseminate what production has been gained in recent years from IPS and what suitable substitutes could be implemented that are produced on New Zealand soils. In the last decade there has been a lot of improvement to pasture species, different crops, methodology of growing these crops and genetic gain in our national dairy herd that means referencing farm systems the industry followed in the 1980's and 1990's, is no longer a fair comparison.

This project has worked with two Waikato dairy farmers to analyse their systems and determine,

- What is the net effect of total production lost removing all IPS and adjusting the system with no substitute and;
- how does the farm system change by removing IPS and introducing NZPS and our potential supply of such feed source.

The outcomes from these two objectives will be scaled up at a national level to see where the opportunity is to create an industry that is reliant on feed alternatives that are produced within our countries resource. This industry will be termed the 'substitute industry' from here forwards.

The substitute industry exists today as not all feed imported into a dairy farm has to be from IPS. Maize silage is often grown off farm at either run off blocks or cropping farms and sold to dairy farmers. Another example of this is buying baled or bulk grass silage from drystock blocks who produce this surplus to their own requirements. Lucerne offers a nutritive dense feed that can be either grazed in situ or harvested for bales or bulk that is contributing to this substitute industry (Barenbrug, n.d.).

Materials and Methods

This project has been completed as part of a desktop based study. The farm data are all from commercial dairy farmers who have made changes to their systems over the years that has been a result of using IPS.

The model used for the Waikato farms has been 'Farmax'. This is the most complete data set model that takes into consideration all aspects and flow-on effects from changes within the system.

Method

1) Two dairy farms were chosen within the Waikato region that farm with IPS.
2) They were sent the form which is attached as Appendix 1; which helped get the base file in Farmax as accurate as the current system.
3) All of the IPS was removed from the system and associated flow on effects had been adjusted.
4) A duplicate base file was created and all of the IPS was substituted for the NZPS and minor amendments required to ensure the model was still reflective of a practical system.
5) The final file was a lower stocking rate scenario that was still farmed with Zero IPS.

6) The IPS data was distributed nationally on a per cow basis. This was because regional specific IPS data was unable to be obtained.
7) Calculating the substitute NZPS has been scaled by applying the same per cow IPS requirement to the national herd average.
8) The total feed quantity was then divided by the average cropping yields from the 2021 harvest and each designated crop to arrive at the new revised cropping area.
9) Estimations were made on yields from cover and catch crops following the primary crop to build the total per hectare tonnage for the substitute industry.
10) The newly increased cropping yield is redistributed back to the national dairy herd to arrive at a new production level.
11) Opportunities and limitations have been discussed throughout.

Discussion

New Zealand's dairy farming industry has passed peak cow numbers (New Zealand Dairy Statistics, 2021). The industry now needs to turn its focus to 'more, from less'. Whether this refers to total cow numbers, less IPS, less synthetic nitrogen used, more efficient farms which require less labour, or just, less land. Dairy farms are already being converted into residential housing on town boundaries, others are selling titles off farm to reduce debt and others are converting dairy blocks to drystock for their own grazing and/or cropping requirements (New Zealand Herald, 2021).

Although the national dairy herd numbers are on the decline, New Zealand has just reached its highest milk production level in history, 1.947 billion milksolids for the 2020/21 season (DCANZ, 2022). This is a 2.7% lift on the season prior (New Zealand Dairy Statistics, 2021). Total cow numbers in this season were down 0.36% to 4.9 million cows (New Zealand Dairy Statistics, 2021). This brings the average per cow performance to 397kgMS.

The New Zealand Dairy Statistics documentation suggests that in the four most recent seasons, the per cow production has increased from 368, 382, 385 to 397kgMS/cow/yr. This is a 7.8% increase in the per cow production. The estimated 207 million milksolids that has come from IPS equates to 42kgMS/cow/yr. IPS has increased 56% at the farmgate since the 2014/15 season which has contributed towards the per cow production lift (Ministry for Primary Industries, 2017).

Table 1: Two Waikato Dairy Farms Modelled Through Farmax and the Three Different Scenarios without the use of IPS

Parameter	Farm A				Farm B			
	Base	ZIPS	Sub	LSR	Base	ZIPS	Sub	LSR
Number of Cows (peak lactation)	530	530	530	495	191	191	191	170
Stocking Rate (SR: cows/ha)	2.9	2.9	2.9	2.7	3.4	3.4	3.4	3
Comparative Stocking Rate (CSR)	84.5	91.5	86	86.8	84.1	95	84.3	90.8
Net Pasture Growth (t DM/ha)	15.3	15.3	15.3	15.3	16.6	15.7	16.8	14.8
Pasture Consumed (t DM/ha)	13	13	13	12.8	15.5	14.7	15.6	13.7
Total Feed Consumed (t DM/ha)	18.3	16.8	18.3	16.8	22.8	19.7	22.7	18.3
IPS Consumed (kgDM/cow)	441	0	*426*	0	740	0	*700*	0
Total Imported Feed/ Total Feed (%)	28	21.7	27.9	22.9	18.8	9.3	18.2	8.9
Annual Milksolid (MS) Production								
MS (kg/cow)	429	375	427	408	421	320	422	347
MS (kg/ha)	1250	1093	1244	1111	1436	1092	1438	1055
MS (as a % of Liveweight LW)	83.6	73.8	81.9	78.8	83.8	66.3	83.7	72.1
LW (kg/ha)	1496	1481	1518	1409	1717	1647	1718	1464
Feed Conversion Efficiency (kgDM: kgMS)	14.2	14.8	14.2	14.6	14.2	15.9	14.2	15.3
Days in Milk	286	286	286	286	266	267	266	265
Body Condition Score	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
Greenhouse Gas (kg/ Farm ha)	526	492	524	486	623	550	622	523
Operating Profit (NZ$/ha)	3330	2417	2901	2524	1584	780	1187	818

Fonterra's Final Farmgate milk price for the 2018/19 season which was $6.35kgMS has been applied to both the farms, however the cost structure used was different. Farm A cost structure was reflective of the same season, whereas Farm B has been compiled from the 2020/21 season. Therefore, comparisons between both properties operating profit/ha is not recommended, within farm comparison are acceptable. The values in red are NZPS/cow in substitution for the IPS.

Farm A

This dairy farm is 182ha effective of flat to medium rolling contour. The IPS is fed via a feed pad operation. IPS for this particular farm is PKE and DDG and is fed consistently throughout the year. The rates per cow vary throughout the season but is continual. Operating profit/ha remains the greatest in the current system compared with the other scenario's, with a ZIPS component. The substitute scenario has the potential to produce the same total production, however the cost and availability of the NZPS remains the biggest challenge. The environmental outcomes are most favourable in the LSR scenario and closely followed with ZIPS. Physically and financially, the ZIPS and LSR system do remain viable, although dependent on an individual farmers circumstances and financial obligations.

Farm B

This dairy farm is 56ha effective of gentle rolling contour. The introduction of IPS has been fed through an in-shed feed system with small quantities fed in trailers on the paddock under challenging climatic conditions. Similar to that of Farm A, the operating profit/ha is still the greatest under the current system with the inclusion of IPS. Following the same trend, the environmental outcomes remain most favourable in the LSR scenario, followed by ZIPS, Sub and the base system.

General Comments

The modelling above provides very crude outcomes for each respective system. If system changes to this nature were going to occur, many other factors would come into consideration which would change a lot of the above metrics. Breeding and future genetics, reducing liveweight per hectare and increasing feed conversion efficiency, calving date/s if the farm is seasonal or year round milk supply, building NZPS supplement reserves to ensure feeding can occur when its required, not when it is available for purchase. The Farmax model concluded that the two farms analysed, which are System 3 and 4 (DairyNZ, 2021), show a greater reduction than the forecasted national change under the ZIPS and LSR system. These properties have a greater reliance on IPS for their production outcomes compared with farms on a System 1 and 2. To build a better understanding of these implications, a national register of farms would need to be created to determine how many farms are in each production system. This will assist in understanding how a Zero IPS system affects the different production systems greater than others.

Substitute Requirements

With the quantities of IPS used in the New Zealand dairy system nowadays, it is not easily substituted by increasing the amount of area cropped. Productive pastoral land is on the decrease with aspects mentioned prior and now the increased plantation of pines for carbon farming (BakerAg, 2021). For the north island to replace the quantity of IPS on a kilogram of dry matter basis, there would need to be an additional 72,000ha of maize silage grown, this is additional to the 55,000ha that is currently grown annually of which 93% is grown in the north island. For the south island, 104,000ha. Proportionally the south island requires a far greater area as the total potential yield per hectare is 12tDM/ha vs. 24tDM/ha in the north island, different substitutes being considered and therefore large differences in annual tonnages. These are not a fair comparison as the maize silage grown in the north island to substitute the

IPS is a bulk feed of medium energy and low protein value, whereas the barley and wheat grain that can be grown in the south island is of high energy, medium protein and all three of the feed types would be used for different purposes within the production system.

If the New Zealand dairy system moved to this Zero IPS model and utilised NZPS for substitution, the challenge is access to product. NZPS can be effectively used within a farm system on an individual farm basis, but at scale, will fail to meet requirements. The fact our islands are separated poses a huge logistical challenge in that we cannot efficiently cart feed types from where it is grown, to where it is required.

Forecast Change to National Production

The forecast has been scaled at a regional level but with national assumptions because the distribution of feed within data sets has not been determined. The key assumption is that the per cow performance remains at the levels it is today, along with the same stocking rate. The area required for the substitution of supplement will have to come from within the industries current area. This means that the national herd will be reduced by 500,000 cows, dairying area reduced by 170,000ha and production by 207 million kilograms of milksolids. This drop is the equivalent of 10.37% of annual milksolid production. To maintain the same level of milk production nationwide, the per cow performance would need to increase from 397kgMS/cow to 442kgMS/cow, a 11.3% lift in performance. At present, the revised model only accounts for a 1:1 swap on the amount of IPS and no further improvements to the production system.

The metrics that work in favour of the ZIPS or LSR scenario are the Greenhouse Gas Emissions kg/ha (GHG) farmed. Both the farms modelled have the lowest GHG from the LSR scenario, closely followed by ZIPS, Sub and the Base systems. Therefore, using GHG as a metric of environmental sustainability, the theme of Zero IPS and lower stocking rates, is beneficial for a farms environmental outcomes.

Limitations

The broad scope of this project has led to large assumptions that require further investigation before implementation. The IPS feed has not only been distributed evenly within regions on a per cow basis but is assumed that it has been allocated to the national dairy herd. IPS can also be fed to replacement stock that until they have entered the lactating herd, haven't contributed towards the national milksolid production. IPS can also be fed to drystock to help with their liveweight gains which also hasn't been considered.

The other main consideration for the substitute industry is that the crops mentioned require large machinery to harvest. This reduces the availability of land that can be cropped. By default, land converted out of dairy for these crops is likely to be more efficient and productive land. The circa 180,000ha required for crop is required to be flat to gentle rolling contour.

Ultimately, without IPS, dairy cow numbers and farmed area can remain the same but the industries efficiency will decline at a rapid rate. Without reducing the dairy area and substituting for NZPS, the energy required for maintenance will remain the same, and the available energy left for milk production has declined. The challenge this also poses is that in a climate emergency, both in drought and excessive rainfall circumstances, there is not the ability to buy on the spot market to fill the deficit to the same degree that IPS offers. The

season finished May 31, 2022 is a great example for the Waikato region. Large quantities of PKE have been imported for farm systems to remain viable from an animal welfare view point, regardless of profitability and sustainability. The livestock are paramount. Without this availability, meat processors would be at capacity as farmers within region would be experiencing the same challenge and trying to reduce stock, unless adequate NZPS inventory was on hand.

Conclusion

The industry is a long way from being in a position to move to a Zero IPS farming system without experiencing the implications above. The national level of production and stocking rates has become too reliant on IPS to make rapid and drastic change. A sustainable Zero IPS system is also too heavily reliant on farmers converting from dairy production to cropping to increase supply of NZPS, and ultimately this is the decision of the land owner. If Zero IPS was forced upon the industry, rapid change to systems would be required to ensure animal welfare was maintained to the highest standard.

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Appendix

Appendix 1

Description	Unit	Additional Notes
Land Based		
Total Farm Area (ha)		
Total Effective Area (ha)		
Contour (flat, rolling, steep)		
Target Cover 1 June		
Annual Pasture Growth?		
June		
July		
August		
September		
October		
November		
December		
January		
February		
March		
April		
May		
Crops Grown (maize, turnips, chicory, plantain…)		
Nitrogen Used (kgN/ha and dates of appl.)		
Livestock		

Total Dairy Herd (incl in-calf heifers		
BW, PW of Dairy Herd		
Breed and Liveweight		
Heifer replacements reared		
Grazing stock off		Heifers (May to May)? Calves off? Winter Grazing?
Calving date		
Length of AB vs. Natural		
Dairy herd changing with culls and early dry offs.		E.g. 480 peak milk, 470 Dec, 450 Feb, 420 April, 220 dry 10th May, 200 milked 25th of May.
Heifers natural mated or AB		
Other stock on farm		
Bulls		

Production		
Annual Production	kgMS	
June		
July		
August		
September		
October		Cows in vat…
November		
December		
January		
February		Cows in vat…
March		
April		
May		

Supplements Used		
Total Quantities of		Approx. distribution of feed? E.g. DDG from December only at 0.4kg/cow… Kibbled maize for first 3 months. Total used, 40t…
PKE		
DDG		
Tapioca		
Soybean Meal		
Soyhull Pellets		
Kibbled Maize		
High Starch Pellets		
Canola Meal		
Biscuit Meal		
Molasses		
P8		
Maize Silage Bought		
Grass Silage Bought		
Hay Bales Bought		
Silage Bales Bought		
Cost Structure		
Animal Health/hd		
Breeding and Herd Improvement		
R&M		
Vehicles and Fuel		
Total Supplement Cost		
Pasture Conserved		
Nitrogen and Fertiliser		
Wages/ Labour		

Administration		
Weed and Pest Control		
Grazing off farm		
Freight		
Other		

Appendix 2 – Revised National Performance

	Area Farmed	Total Cows	SR	Total kgMS	kgMS/cow	IPS/cow	Total kg feed/region	Revised Area	Revised Total Cows	NZPS/cow	kgMS/cow	Revised Total kgMS
Northland	110,043	250,840	2.28	80,519,778	321	608	152,510,981	101,653	231,715	658	321	74,380,437.68
Auckland	38,376	94,757	2.47	34,870,728	368	608	57,612,507	35,450	87,533	658	368	32,211,961.77
Waikato	373,291	1,098,637	2.94	420,778,007	383	608	667,971,353	344,829	1,014,870	658	383	388,695,213.84
Bay of Plenty	64,785	183,229	2.83	66,695,505	364	608	111,403,481	59,845	169,259	658	364	61,610,215.24
Central Plateau	103,664	281,832	2.72	108,223,679	384	608	171,354,158	95,760	260,344	658	384	99,972,016.96
Western Uplands	18,471	48,566	2.63	14,472,707	298	608	29,528,208	17,063	44,863	658	298	13,369,215.71
East Coast	1,855	4,804	2.59	1,522,841	317	608	2,920,780	1,714	4,438	658	317	1,406,729.91
Hawkes Bay	15,587	44,203	2.84	16,399,479	371	608	26,875,696	14,399	40,833	658	371	15,149,078.35
Taranaki	167,167	465,977	2.79	194,312,592	417	608	283,314,283	154,421	430,448	658	417	179,496,963.35
Manawatu	80,322	215,788	2.69	86,746,633	402	608	131,198,888	74,198	199,335	658	402	80,132,517.63
Wairarapa	55,496	150,445	2.71	57,770,823	384	608	91,470,470	51,265	138,974	658	384	53,366,007.79
NORTH ISLAND	1,029,057	2,839,080		1,082,312,772		Total Feed	1,726,160,805	950,595	2,622,611			999,790,358.24
						Cropping Area at 22tDM/ha	78,462				Drop in NI Production	-7.62%
	Area Farmed	Total Cows	SR	Total kgMS	kgMS/cow	IPS/cow	Total kg feed/region	Revised Area	Revised Total Cows	NZPS/cow	kgMS/cow	Revised Total kgMS
Nelson/Marlborough	26,227	74,586	2.84	28,864,828	387	608	45,348,288	22,217.94	63,184.79	718	387	24,452,554
West Coast	69,158	150,787	2.18	50,362,959	334	608	91,678,496	58,586.52	127,737.72	718	334	42,664,484
Noth Canterbury	207,637	723,825	3.49	315,587,803	436	608	440,085,600	175,897.64	613,181.20	718	436	267,347,092
South Canterbury	72,798	247,156	3.40	107,018,573	433	608	150,270,848	61,670.11	209,375.77	718	433	90,659,728
Otago	91,748	272,966	2.98	110,824,065	406	608	165,963,328	77,723.41	231,240.45	718	406	93,883,513
Southland	216,889	595,667	2.75	252,562,720	424	608	362,165,536	183,735.38	504,613.42	718	424	213,956,015
SOUTH ISLAND	684,457	2,064,987		865,220,948			1,255,512,096	579,831	1,749,333.36			732,963,386
						Cropping Area Required at 12tDM/ha	104,626.01				Drop in SI Production	-15.29%
										Total Production	North Island	999,790,358
											South Island	732,963,386
											Total KgMS	1,732,753,745