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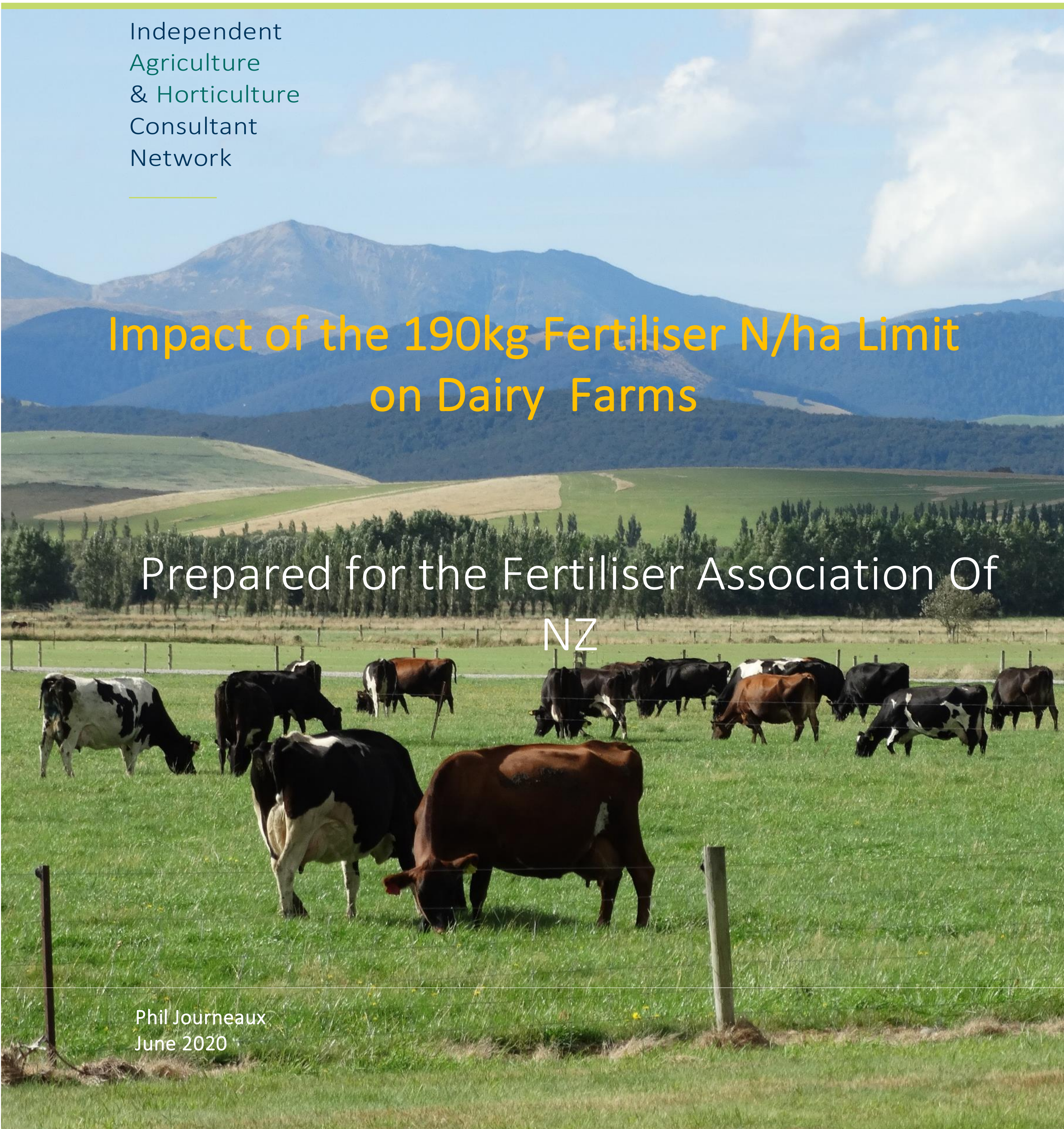

Impact of the 190kg Fertiliser N/ha Limit on Dairy Farms

Prepared for the Fertiliser Association Of NZ

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TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

This analysis investigates some of the implications of restricting dairy farms to a limit of 190 kg N/ha via synthetic nitrogen fertilisers.

The analysis shows that all of the upper quartile farms (based on kg N/ha applied) are above the 190 kg/ha limit. In addition to this, irrigated dairy farms, as illustrated by the Canterbury figures, show that only the bottom quartile farms are below the 190 kg/ha limit. This is because nitrogen fertiliser is an integral component of irrigated farms, in ensuring sufficient pasture dry matter is grown to make the system economic.

The financial cost of the limit is difficult to readily estimate, as there are no models of the upper quartile farms readily available to estimate this. Modelling using Farmax and OverseerFM based on an <u>average</u> Canterbury irrigated dairy farm, applying 234 kg N/ha, and then restricting this down to 190kg N/ha, resulted in a 13.9% reduction in EDITDA, and a 6.6% reduction in nitrate leaching.

Estimating the number of dairy farms likely to be affected by the restriction is also difficult to estimate due to the lack of good statistics. Assuming the quartile analysis at face value would indicate around 35% of dairy farms will be affected.

For sheep & beef farms the issue is not directly relevant; few if any such farms get close to the 190kg N/ha limit, and for those farms that do (e.g. South Island mixed finishing farms), the majority of nitrogen fertiliser usage is for arable purposes, which is exempt from the limit.

The limit throws up a number of issues which will need to be considered:

- Fertiliser nitrogen is but one of three main sources of nitrogen within the farm system. If there is a compensatory increase in the use of supplementary feed, then the total amount of nitrogen within the system may well not alter, and hence no change in nitrate leaching would be achieved
- Similarly, if nitrogen fertiliser input is reduced, there will be some compensatory increase in the amount of nitrogen fixed by legumes (i.e. clovers)
- It remains to be seen if forage crops grown either on farm or by specialist farmers is classified as either “pastoral” or “arable”. In many instances these crops require in excess of 190kg N/ha to be grown.
- Organic nitrogen fertilisers are exempt from the application limit. While nitrate leaching from these fertiliser is minimal as a result of direct application, once mineralised they contribute to the total nitrogen pool within the farm system, and hence directly to nitrate leaching.

2.0 BACKGROUND

On May 28, 2020, the government announced a range of regulations pertaining to the agricultural sector outlining restrictions or actions necessary to improve water quality. One such regulation was to limit the application of synthetic nitrogen fertiliser, on pastoral farms, to a maximum of 190 kg N per hectare. The rationale for the 190 kg limit is not readily apparent, and no analysis on this is available.

The purpose of this report is to analyse the implications of this measure.

3.0 NITROGEN USE ON DAIRY FARMS

Nitrogen fertiliser usage on dairy farms, by quartile is summarised below[1].

Table 1: Fertiliser nitrogen application by quartile for the main dairying areas, 2017/18 (kgN/ha)

	Q1	Q2	Q3	Q4	Mean
Northland	36	92	127	192	102
Waikato/Bay of Plenty	61	116	158	222	138
Taranaki	71	122	161	242	155
Canterbury	104	224	265	309	222
Southland	113	174	193	230	185

Table 2: Fertiliser nitrogen application by quartile for the main dairying areas, Average 2013/14 – 2017/18 (kgN/ha)

	Q1	Q2	Q3	Q4	Mean
Northland	35	98	138	208	112
Waikato/BoP	56	110	148	213	128
Taranaki	75	130	173	240	148
Canterbury	132	230	267	320	234
Southland	110	171	196	230	171

As can be seen from these tables, all of the upper quartile farms in all regions are in excess of 190kgN/ha

For irrigated dairy farms, as illustrated by Canterbury, only the bottom quartile is under 190 kg N/ha. The reason for this is that for irrigated dairy farms, nitrogen fertiliser is a significant component of the farming system to ensure the profitability of the system give the (generally) high cost of irrigating water. This can be illustrated (as outlined in a recent report[2]); in dryland conditions average pasture growth is 5-6 tonnes dry matter (DM) per hectare. The addition of water usually doubles this to 11-12 tonnes DM/ha. The further addition of nitrogen fertiliser boosts this further to 16-20 tonnes/DM (depending on the amount of nitrogen applied). This addition of nitrogen fertiliser ensures that the whole system is profitable.

Restricting synthetic fertiliser to 190 kg N/ha will therefore impact more severely on irrigated farms, as discussed below.

3.1 Impact at a Farm Level

To fully analyse the impacts across each region would require models of the Q4 farms to be developed in both Farmax and OverseerFM. Currently these models don't exist – while they definitely could be constructed, this would take some time and effort.

The analysis discussed below pertains to the Canterbury irrigated dairy model constructed by AgFirst. This is an average model for Canterbury, based on Dairy Statistics and discussion with local consultants as to the farm system operated.

[1] Derived from Dairybase
[2] The value of Nitrogen Fertiliser to the NZ Economy. Journeaux P, et al 2019.

Table 3: Canterbury dairy farm parameters

	Canterbury
Effective Area (ha)	231
Cows Wintered (hd)	791
Milksolids Production (kgMS)	321,434
Kg N/ha	234

The reason for using this model is that the average synthetic nitrogen fertiliser application is above the 190kg limit, and hence can be used to illustrate the impacts of the 190kg N/ha limit.

In the analysis the average fertiliser N application was reduced down to 190kg N/ha, under two scenarios:

(i) In the first scenario, total milksolids were simply reduced down to match the new level of pasture growth

(ii) In the second scenario, cow numbers were reduced (by 7%) and per cow production held, such that the farm was feasible under the reduced pasture grown. This is a more likely scenario as it gives a better economic return.

The information from each scenario was then run through OverseerFM to determine the change in nitrogen leached. The results are:

Table 4: Impact of reducing nitrogen fertiliser input, Canterbury Irrigated dairy model

		190 kg N/ha			
	Base (234 kg N/ha)	Scenario 1: Reduce Milksolids	% Difference	Scenario 2: Reduce Cows	% Difference
Effective area (ha)	231	231		231	
Cows wintered	791	791	0%	736	-7%
Total Milksolids (kg MS)	321,484	298,704	-7.1%	297,994	-7.3%
EBITDA ($)*	$774,462	$654,459	-15.5%	$666,819	-13.9%
N Leached (kg N/ha)	76	74	-2.6%	71	-6.6%

*EBITDA is based on a $6.26/kg MS payout, being the 10-year average Fonterra payout (2010/11 – 2019/20)

As can be seen from Table 4, under the “reduce cows” scenario the impact of reducing nitrogen fertiliser input from 234kgN/ha down to 190 kg N/ha is a 13.9% reduction in EBITDA and a 6.6% reduction in N leached.

Note: EBITDA is the residual sum from gross farm income less operating and fixed costs, and is required to meet debt servicing, depreciation, tax, capital replacement, drawings, and further farm development.

Obviously, the impact will vary depending on the degree of reduction required; the impact on a farm currently applying (say) 200kg fertiliser N per hectare would be much less than a farm applying (say) 250-300 kg N/ha.

3.2 Number of Farms Affected

Estimating the number of farms affected is difficult, for two reasons:

(i) The quartile analysis shown above is from a sample of farms, based on the amount of nitrogen fertiliser applied (as kg N/ha). While the upper quartile within the sample is above the 190kg limit, it does not necessarily flow that 25% of all farms are above this limit.

(ii) It also depends on the distribution within each quartile. For example, the figures shown in table 1 and 2 are the averages for those quartiles; some of the farms within the top quartile may be under 190kg N/ha, and similarly, some of the farms within the 3rd quartile may be over 190 kg N/ha.

But taking the quartile figures at face value, then:

(i) All Q4 dairy farms are over the 190kg N/ha level. There are 11,372 dairy farms in New Zealand[3], so 25% of this = 2,843

(ii) The Q2 and Q3 farms in Canterbury are above the 190kg level, which equates to 600 farms

(iii) The Southland Q3 farms are just over the 190 kg level, so assuming 50% are above 190kg, this equates to 123 farms

(iv) An estimated 40% of the farms in Otago are irrigated along very similar lines to Canterbury. This would give 89 farms in Q2 and Q3 above the 190kg level

Summarising this gives:

Table 5: Number of dairy farms above the 190kg N/ha level

New Zealand Q4	2,843
Canterbury Q2 & Q3	600
Southland Q2	123
Otago	89
Total	3,655
Percentage of total NZ dairy farms	32.1%

There are also a number of irrigated dairy farms throughout the rest of New Zealand, especially in Nelson/Marlborough, Wellington, Horizons, and Hawke's Bay. It is not possible to differentiate the number from the available statistics, but (a) many of these farms are very likely to be using greater than 190 kg fertiliser N/ha, which (b) would mean the national total could be around the 35% mark.

[3] Dairy Statistics 2017/18

4.0 NITROGEN USE ON SHEEP & BEEF FARMS

Analysis[4] has shown that the amount of nitrogen fertiliser applied on sheep & beef farms is significantly less than that for dairy farms, and few, if any, are breaching the 190kg N/ha level. The exception to this is Class 8 South Island mixed finishing farms, where nitrogen fertiliser applications on the cropping component of the farm can be quite high.

Table 6: Fertiliser Nitrogen application on sheep & beef farms (kg N/ha0

	Q4	Mean
South Island High country	7	1.5
South Island Hill country	11	4.7
North Island Hard Hill country	20	6.8
North Island Hill country	31	11.1
North Island Intensive finishing	60	18.8
South Island Finishing breeding	53	16.8
South Island Intensive finishing	39	16.7
South Island Mixed finishing	267	119.1
All Class Average	34	13.6

Source: Beef + Lamb NZ Economic Service. 5-year average 2013/14 – 2017/18

Much of the nitrogen fertiliser usage on sheep & beef farms is as an input to forage cropping, and even if the nitrogen fertiliser input into the crop is greater than 190 kg/ha, it is very unlikely to push the farm as a whole over this level. For the South Island mixed finishing farms, 87% of the fertiliser nitrogen is used for cropping purposes, very largely cereals and small seeds, and fertiliser nitrogen input into such “arable” purposes is exempt from the 190 kg limit.

5.0 OTHER ISSUES

5.1 Sources of Nitrogen

There are three main sources of nitrogen into a pastoral farming system in New Zealand:

(i) Fertiliser nitrogen
(ii) Nitrogen (as protein) in supplementary feedstuffs
(iii) Nitrogen fixed by legumes (e.g. clover)

The main driver of nitrate leaching is from animal urine; animals are part of the nitrogen cycle, and it is the total amount of nitrogen within the cycle which is important rather than any one source. While there is some nitrate leaching direct from fertiliser nitrogen applications, particularly if applied at individual heavy rates, this can be minimised via small regular applications. The main aspect of nitrogen leaching from nitrogen fertiliser therefore is via animals grazing; the nitrogen fertiliser increases pasture growth, which is eaten by animals, with the excess nitrogen then excreted as urine, from which the nitrate then leaches.
If the amount of forage available on the farm is reduced as a result of a limit on nitrogen fertiliser, then the next best option (in an economic sense) is to use supplementary feed to “plug the gap”. Whether or not to use supplement is essentially a marginal cost versus marginal benefit calculation, but not withstanding this, it is (a) a ready option, and (b) means that the

[4] Farm Level Cost of a Carbon Tax on Nitrogen Fertiliser. P Journeaux, 2020

total amount of nitrogen operating within the cycle on a farm would be maintained, such that there is no reduction in nitrate leaching.

5.2 Clover Fixation of Nitrogen

Nitrogen fixation by legumes is/can be an important source of nitrogen in grazed pasture, and much of New Zealand pastures are a ryegrass/white clover mix, where the clover provides (a) a high quality forage, and (b) fixes atmospheric nitrogen which is then available as a pasture nutrient.

There is a strong relationship between the amount of nitrogen fixed by clovers within a pasture, and the amount of nitrogen fertiliser applied; as the amount of nitrogen fertiliser increases, it suppresses the fixation of nitrogen by clovers (mainly via a shading out of the clover by the grasses), and conversely, as nitrogen fertiliser input is reduced, clover fixation increases. This is illustrated below.

Table 7: Relationship between fertiliser and clover nitrogen fixation[5]

Fertiliser N (kg/ha)	0	220	360
Clover nitrogen (kg/ha)	210	170	70

This shows a strong correlation between the two, of -0.93, with a R^2 of 0.87.

This means that if nitrogen fertiliser application is decreased, clover nitrogen fixation will make up some, but not necessarily all, of the difference. In other words, the total amount of nitrogen within the farm system will not shift that much.

5.3 Forage versus Arable Crops

Within the regulations announced, arable (and vegetable) crops are exempt from the 190 kg N/ha limit, for reasons of food security.

The inference from this is that forage crops grown on pastoral farms, would also come within the 190kg limit. Presumably, this would be added to the overall farm figure rather than be counted on its own.

The issue that arises is that the nitrogen fertiliser input can be quite high for many of these crops. A case in point is maize grown for silage, which is a major feature on many farms, especially in the top half of the North Island (The 2017 Ag Stats show a total of 41,268 ha grown, of which 28,389 ha was grown north of Taupo).

Maize removes 10kg N per tonne of dry matter product. With average yields of 20-25 tonnes DM/ha, it means that farmers need to apply 200-250kg n/ha simply to replace what the crop removes. In a number of cases this may be sufficient to push the farm as a whole over the 190kg limit, in which case the farmer may well look to contract in maize silage instead. Which leads to another issue. Many farms grow 100% of maize (for silage), which is contracted to supply dairy farms. Do these farms qualify as ‘arable” or as “pastoral”? If the classification is

[5] Cited in: The value of N-fixation to pastoral agriculture in New Zealand, Walker T. 1995. Agronomy Society of New Zealand Special Publication No. 11 / Grassland Research and Practice Series No.6

"pastoral" then this would lead to a significant disruption in supplementary feed supplies to dairy farms, and very likely to be substituted by importing other such feedstuffs.

5.4 Organic Nitrogen Fertilisers

The restriction on nitrogen fertiliser application only applies to synthetic (inorganic) nitrogen fertiliser. Nitrogen fertiliser from organic sources, such as compost and animal manures, are exempt.

The main advantage of organic fertilisers is their slow release; the nitrogen within the fertiliser has to be broken down, by soil microbes, into an inorganic form before the plants can take it up. This means that any direct leaching of nitrates from the application of the fertiliser is minimal. The disadvantage is often the cost, and the slow release nature means they can't be readily used tactically.

Once the nitrogen is in the inorganic form, it becomes part of the total nitrogen cycle within the farm and contributes to nitrate leaching the same as any other source of nitrogen.

A key source of organic nitrogen on every dairy farm is, of course, the dairy shed effluent. Many Regional Councils restrict effluent applications to a maximum of 150kg N/ha equivalent. But there is nothing stopping dairy farmers (other than some capital and operating cost) in using effluent as a top-up above the 190 kg synthetic N/ha limit.

5.5 Dairy Goats/Sheep – Cut and Carry

Most dairy goat and dairy sheep farms operate a "cut and carry" system, whereby the pasture is mechanically harvested in the field, and then feed to the animals in a covered barn.

In this situation, many farms are harvesting between 12 and 15 tonnes of dry matter per hectare. This dry matter usually has a nitrogen content of 3-3.2% (corresponding to 18%+ crude protein). To replace this nitrogen into the soil, i.e. maintain this level of harvesting, would require a fertiliser N input of between 360-480 kg N/ha/year.

Inasmuch as the 190kg limit applies, this will force such farms to significantly increase the amount of bought-in feed, at 2-3 times the cost.

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