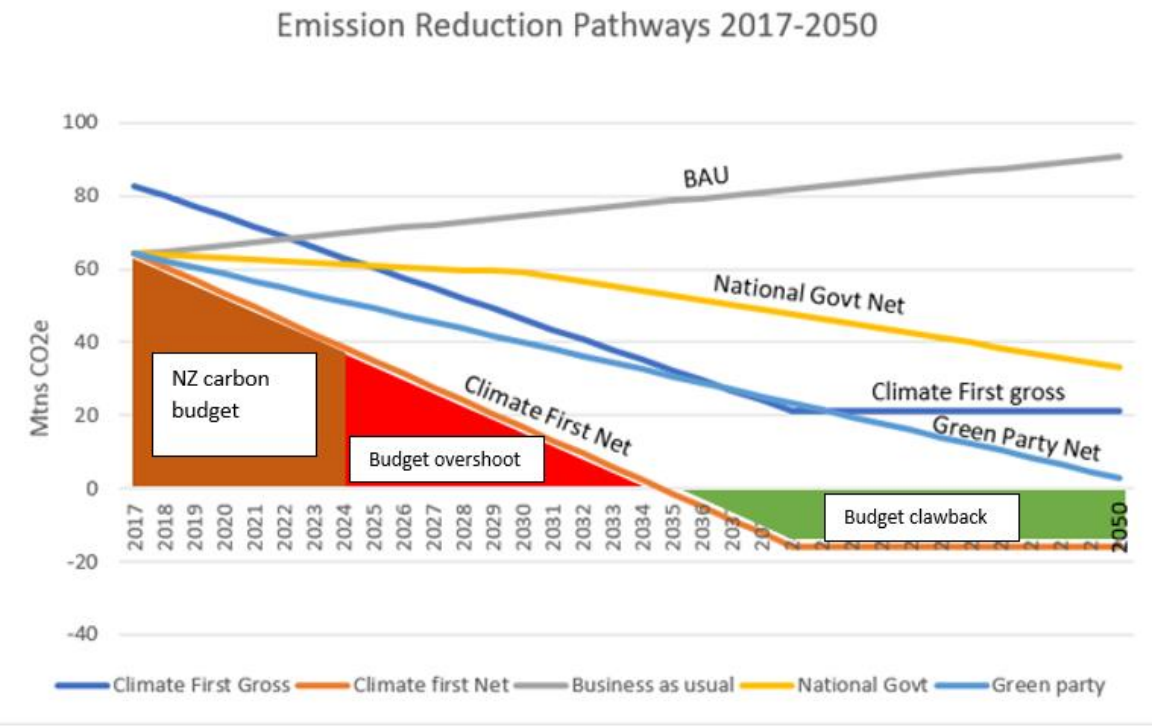
The Afforested Dairy Farm -2017 Proposal

Summary.

For New Zealand to achieve the Climate First emissions reduction pathway (Chart 1) and ensure that we did our fair share to reduce world emissions enough to stop a 2-degree temperature rise, the dairy industry, which produces a quarter of NZ emissions, must obviously play a big part.

Chart 1. The Required Emission Reduction Pathway. (RERP)



We investigate how this could be done, following the principle that dairy, in making 25% of NZ's emissions, must make 25% of the cuts.

We conclude that if the average dairy farm planted approximately 10 ha of its 146 ha in cypress trees in 2018, a further 10 ha in 2025 and a final 10 ha in 2033, (20.5% of the farm), the cumulative effect of the reduced stock emissions from fewer animals, plus the CO2 sequestered by the trees would be to keep that farm close to the Climate First RERP, and thus avoid paying carbon tax at $100 per tonne. The farm emissions would reduce from 1541 tonnes in 2017 down to 481 tonnes in 2050.

The Proposal

New Zealand's emission growth since 1990 is the second worst in the OECD[1] and much of the blame for this lies with the expansion of agriculture emissions which made up 48.4 % of our emissions in 2013[2]. Because there are no obvious ways to reduce these emissions, agriculture has been left out of

the ETS, however this is only putting off solving our problem. Climate First, in advocating a rapid reduction path down to -15.9 Mtns in 2039 must offer a solution.

We begin by establishing a Required Emission Reduction Pathway (RERP) for NZ[3] (Chart 1 above) which would keep us within our carbon budget. Then, following the principle that the burden of reduction must be fairly and equally shared by all sectors of the economy, we arrive at an RERP for each sector, based on 2013 figures and projections from The Second biennial report[4]. This is shown in Table 1.

Table 1. Reductions required by each sector in proportion to emissions

Sector reduction portions of the pathway						
year	Total	Agri	Energy	transport	Ind Proc.	Waste
	Gross	48.40%	22.70%	16.72%	6.20%	6.20%
	Mtns	red. 1.35	red.0.63	0.47	red. 0.15	red. 0.15
		Mtn/yr	Mtn/yr	Mtn/yr	Mtn/yr	Mtn/yr
2017	82.8	40.1	18.81	13.86	5.1	5.1
2018	80	38.74	18.18	13.39	5	5
2019	77.2	37.39	17.55	12.92	4.8	4.8
2020	74.4	36.03	16.92	12.45	4.6	4.6
2021	71.6	34.68	16.29	11.98	4.4	4.4
2022	68.8	33.32	15.66	11.51	4.3	4.3
2023	66	31.96	15.03	11.04	4.1	4.1
2024	63.2	30.61	14.4	10.57	3.9	3.9
2025	60.4	29.25	13.77	10.1	3.7	3.7
2026	57.6	27.90	13.14	9.63	3.6	3.6
2027	54.8	26.54	12.51	9.16	3.4	3.4
2028	52	25.18	11.88	8.69	3.2	3.2
2029	49.2	23.83	11.25	8.22	3.1	3.1
2030	46.4	22.47	10.62	7.75	2.9	2.9
2031	43.6	21.12	9.99	7.28	2.7	2.7
2032	40.8	19.76	9.36	6.81	2.5	2.5
2033	38	18.40	8.73	6.34	2.4	2.4
2034	35.2	17.05	8.1	5.87	2.2	2.2
2035	32.4	15.69	7.47	5.4	2	2
2036	29.6	14.34	6.84	4.93	1.8	1.8
2037	26.8	12.98	6.21	4.46	1.7	1.7
2038	24	11.62	5.58	3.99	1.5	1.5
2039	21.2	10.26	4.95	3.52	1.3	1.3

This means that the agriculture sector, which emitted 48.4% of NZ emissions needs to make 48.4 % of the reductions. The same applies to the transport sector which emitted 16.7% and would make 16.7% of NZ reductions. Historical and projected emissions are shown in table 2.

Table 2. NZ Historical and projected emissions.

Sector	1990		2013		2030 (projected)	
	emissions	%	emissions	%	emissions	%
Agriculture	34.3 Mtns	51.5	39.2 Mtns	48.4	42 Mtns	48.8
Energy	15.2	22.8	18.81	22.7	18.1	21
Transport	8.8	13.2	13.86	16.7	14	16.2
Ind Process	3.3	4.9	5	6.2	6.6	7.6
Waste	5	7.5	5	6.2	5.3	6.2
Total	66.7	100	81	100	86	100

Now dairy, whose on-farm emissions represent 46% of agriculture emissions[5], must make 46% of agriculture cuts. That means reducing from 18.45 Mtns in 2017 down to 4.72 Mtns in 2039[6], then staying constant at that level through to 2050 when dairy will have done its share of helping NZ to meet its allowed carbon budget of 660 Mtns between 2011 and 2050[7].

Assuming that no technological miracle is imminent, there are only two ways to achieve this: reduce stock numbers, and plant trees on-farm to sequester CO2. This proposal therefore, investigates

1.What reductions would be required

2.How many hectares of the farm would need to be afforested

3.How the farm profit would be affected with a Carbon Tax of $100 per tonne of CO2e

The revolutionary aspect of the proposal being put forward by Climate First, compared to all other ideas, is **that instead of a farmer being liable to pay carbon tax on all farm emissions, payment is only liable for emissions above the RERP. On the other hand, emissions below the pathway would gain carbon credits or cash pay outs each year.** Thus, instead of punishing a farmer for emissions, they would be given an incentive to meet the pathway and by that, help NZ to become a post-carbon country by 2035.

Table 3 shows the profit earned by an average "business as usual" farm which planted no trees and continued to graze all of its 146 ha.

Explanation of Table 3.

Column B is the agriculture emissions reduction pathway which needs to be followed for NZ to become a post-carbon country in time.

Column C is the pathway that the dairy industry in NZ as a whole needs to follow, assuming that dairy represents 46 % of agriculture emissions.

Column D shows the annual emissions allowed for the average dairy farm of 419 ha. This is calculated by dividing total allowable dairy emissions by the number of dairy farms in NZ.

Column E represents the annual emissions from the average herd.

Table 3. Profit outlook for a "business as usual" farm

A	B	C	D	E	F	G	H	A
bau calcs for 2017 proposal								
	Ag sector	Diary	Av. farm	Emissions	Diff from	cost to	return	Profit
	RERP	RERP at	RERP	from stock	RERP	pay at CT	from	after CT
		46% of Ag.	div. 11,970			$100 tn	146 ha.	
2017	40.1	18.45	1541.35	1541	-0.35	0	96,309	96,309
2018	38.8	17.83	1489.21	1541	51.79	5178.60	96,309	91,130.40
2019	37.4	17.20	1437.07	1541	103.93	10392.55	96,309	85,916.45
2020	36.1	16.58	1384.94	1541	156.06	15606.49	96,309	80,702.51
2021	34.7	15.95	1332.80	1541	208.20	20820.43	96,309	75,488.57
2022	33.4	15.33	1280.66	1541	260.34	26034.38	96,309	70,274.62
2023	32.0	14.71	1228.52	1541	312.48	31248.32	96,309	65,060.68
2024	30.7	14.08	1176.38	1541	364.62	36462.26	96,309	59,846.74
2025	29.3	13.46	1124.24	1541	416.76	41676.21	96,309	54,632.79
2026	28.0	12.83	1072.10	1541	468.90	46890.15	96,309	49,418.85
2027	26.6	12.21	1019.96	1541	521.04	52104.09	96,309	44,204.91
2028	25.3	11.58	967.82	1541	573.18	57318.04	96,309	38,990.96
2029	23.9	10.96	915.68	1541	625.32	62531.98	96,309	33,777.02
2030	22.6	10.34	863.54	1541	677.46	67745.92	96,309	28,563.08
2031	21.2	9.71	811.40	1541	729.60	72959.87	96,309	23,349.13
2032	19.9	9.09	759.26	1541	781.74	78173.81	96,309	18,135.19
2033	18.5	8.46	707.12	1541	833.88	83387.75	96,309	12,921.25
2034	17.2	7.84	654.98	1541	886.02	88601.70	96,309	7,707.30
2035	15.8	7.22	602.84	1541	938.16	93815.64	96,309	2,493.36
2036	14.5	6.59	550.70	1541	990.30	99029.58	96,309	-2,720.58
2037	13.1	5.97	498.56	1541	1042.44	104243.53	96,309	-7,934.53
2038	11.8	5.34	446.43	1541	1094.57	109457.47	96,309	-13,148.47
2039	10.4	4.72	394.29	1541	1146.71	114671.41	96,309	-18,362.41
2040	10.4	4.72	394.32	1541	1146.68	114668.09	96,309	-18,359.09
2041	10.4	4.72	394.32	1541	1146.68	114668.00	96,309	-18,359.00
2042	10.4	4.72	394.32	1541	1146.68	114668.00	96,309	-18,359.00
2043	10.4	4.72	394.32	1541	1146.68	114668.00	96,309	-18,359.00
2044	10.4	4.72	394.32	1541	1146.68	114668.00	96,309	-18,359.00
2045	10.4	4.72	394.32	1541	1146.68	114668.00	96,309	-18,359.00
2046	10.4	4.72	394.32	1541	1146.68	114668.00	96,309	-18,359.00
2047	10.4	4.72	394.32	1541	1146.68	114668.00	96,309	-18,359.00
2048	10.4	4.72	394.32	1541	1146.68	114668.00	96,309	-18,359.00
2049	10.4	4.72	394.32	1541	1146.68	114668.00	96,309	-18,359.00
2050	10.4	4.72	394.32	1541	1146.68	114668.00	96,309	-18,359.00
								694,808

Column F shows how this farm, with constant annual emissions, would gradually diverge from the pathway down.

Column G shows the annual and increasing cost of paying the carbon tax of $100 for being above the RERP.

Column H represents the annual profits from grazing the full 146 ha. This is calculated from the average milk solids output of the average farm multiplied by the average milk solid price of the last 20 years, inflation adjusted ($6.10 per Kg) (See assumptions box)

Column I is the final net profit assuming a profit of 10% of the gross profit. (see assumptions box). Note that accumulated profits over 22 years would be $972,295, or $44,195 per year, far below current rates.

Scenario one.

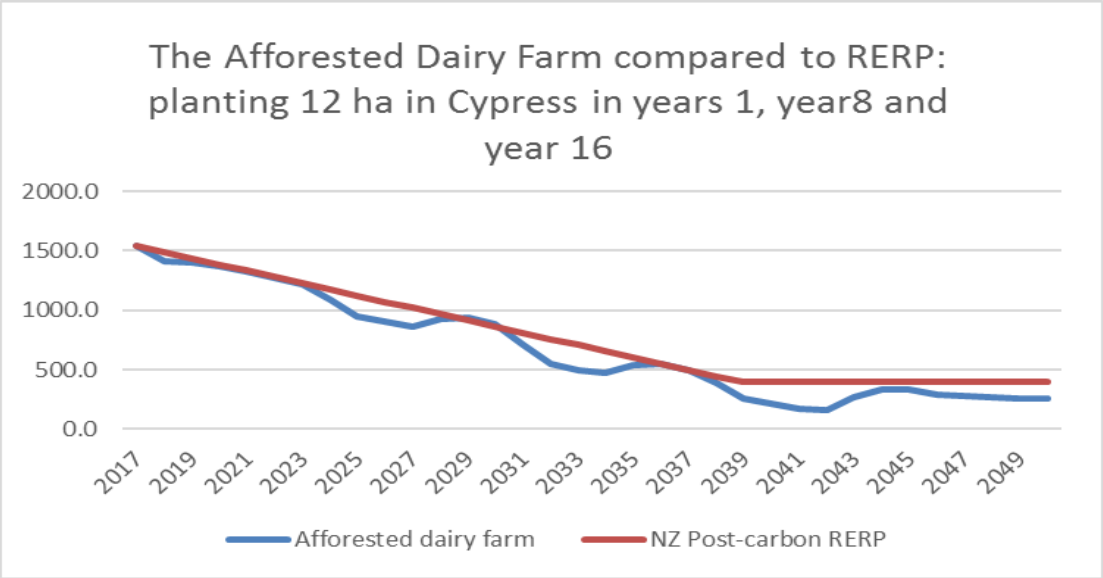
A dairy farm plants 12 ha in cypress trees in 2018, another 12 ha in 2025 and a further 12 ha in 2033. This would mean 8%, 16% and eventually 24% of the average farm of 146 ha. This would reduce herd numbers by 34, 68 and eventually 102, with their associated emissions. Thus, the reduction in herd emissions and the sequestration from the trees planted would keep this farm on the RERP and ensure no carbon tax of $100 per tonne was paid.

Table 4 shows the profit outlook for a dairy farm which afforested 12 ha in cypress trees.

In year 1, another 12 in year 8 and a further 12 in year 16 (2018, 2025 and 2031)

ADF calculations may 2017 proposal 12plus 12plus 12													
year	emissions	Dairy	em.146	seq 1 ha	seq 1 ha	seq 12 ha	seq 12 ha	seq 12 ha	total seq	diff adf	CT at $100	farm	total profit
	total	farm RERP	134, 122	lookup	lookup	cypress	plus 8 yr	plus 16 yr		and rerp		profit	inc CT
	farm		then 110	cumulative	annual		cypress	cypress				at $659/ha	
2017	1541.4	1541.4	1541.35	0	0	0	0	0	0	0.0	0	96214	96214
2018	1414.7	1489.2	1414.66	0	0	0	0	0	0	-74.6	-7455.395	88306	95761.4
2019	1406.3	1437.1	1414.66	0.7	0.7	8.4	0	0	8.4	-30.8	-3081.452	88306	91387.45
2020	1370.3	1384.9	1414.66	4.4	3.7	44.4	0	0	44.4	-14.7	-1467.509	88306	89773.51
2021	1324.7	1332.8	1414.66	11.9	7.5	90	0	0	90	-8.1	-813.5656	88306	89119.57
2022	1271.9	1280.7	1414.66	23.8	11.9	142.8	0	0	142.8	-8.8	-879.6224	88306	89185.62
2023	1219.1	1228.5	1414.66	40.1	16.3	195.6	0	0	195.6	-9.5	-945.6792	88306	89251.68
2024	1093.1	1176.4	1414.66	66.9	26.8	321.6	0	0	321.6	-83.3	-8331.736	88306	96637.74
2025	949.6	1124.2	1287.97	95.1	28.2	338.4	0	0	338.4	-174.7	-17466.79	80398	97864.79
2026	904.0	1072.1	1287.97	126.4	31.3	375.6	8.4	0	384	-168.1	-16812.85	80398	97210.85
2027	859.6	1020.0	1287.97	158.4	32	384	44.4	0	428.4	-160.4	-16038.91	80398	96436.91
2028	928.0	967.8	1287.97	180.9	22.5	270	90	0	360	-39.8	-3984.963	80398	84382.96
2029	934.0	915.7	1287.97	198.5	17.6	211.2	142.8	0	354	18.3	1828.98	80398	78569.02
2030	882.4	863.5	1287.97	216	17.5	210	195.6	0	405.6	18.8	1882.923	80398	78515.08
2031	707.2	811.4	1287.97	237.6	21.6	259.2	321.6	0	580.8	-104.2	-10423.13	80398	90821.13
2032	553.8	759.3	1287.97	260	22.4	268.8	338.4	0	607.2	-205.4	-20544.19	72490	93034.19
2033	497.4	707.1	1161.02	284	24	288	375.6	0	663.6	-209.7	-20970.25	72490	93460.25
2034	472.2	655.0	1161.02	308.7	24.7	296.4	384	8.4	688.8	-182.8	-18276.3	72490	90766.3
2035	543.0	602.8	1161.02	334	25.3	303.6	270	44.4	618	-59.8	-5982.361	72490	78472.36
2036	551.4	550.7	1161.02	359.7	25.7	308.4	211.2	90	609.6	0.7	71.58229	72490	72418.42
2037	496.2	498.6	1161.02	385.7	26	312	210	142.8	664.8	-2.3	-234.4745	72490	72724.47
2038	391.8	446.4	1161.02	411.9	26.2	314.4	259.2	195.6	769.2	-54.6	-5460.531	72490	77950.53
2039	256.2	394.3	1161.02	438.1	26.2	314.4	268.8	321.6	904.8	-138.1	-13806.59	72490	86296.59
2040	219.0	394.3	1161.02	464.4	26.3	315.6	288	338.4	942	-175.3	-17529.91	72490	90019.91
2041	174.6	394.3	1161.02	490.6	26.2	314.4	296.4	375.6	986.4	-219.7	-21970	72490	94460
2042	161.4	394.3	1161.02	516.6	26	312	303.6	384	999.6	-232.9	-23290	72490	95780
2043	271.8	394.3	1161.02	542.5	25.9	310.8	308.4	270	889.2	-122.5	-12250	72490	84740
2044	330.6	394.3	1161.02	568.1	25.6	307.2	312	211.2	830.4	-63.7	-6370	72490	78860
2045	331.8	394.3	1161.02	593.5	25.4	304.8	314.4	210	829.2	-62.5	-6250	72490	78740
2046	286.2	394.3	1161.02	618.6	25.1	301.2	314.4	259.2	874.8	-108.1	-10810	72490	83300
2047	279.0	394.3	1161.02	643.4	24.8	297.6	315.6	268.8	882	-115.3	-11530	72490	84020
2048	265.8	394.3	1161.02	667.8	24.4	292.8	314.4	288	895.2	-128.5	-12850	72490	85340
2049	263.4	394.3	1161.02	691.9	24.1	289.2	312	296.4	897.6	-130.9	-13090	72490	85580
2050	261.0	394.3	1161.02	715.7	23.8	285.6	310.8	303.6	900	-133.3	-13330	72490	85820

Chart 2. Comparison of Afforested dairy farm emissions with the required pathway

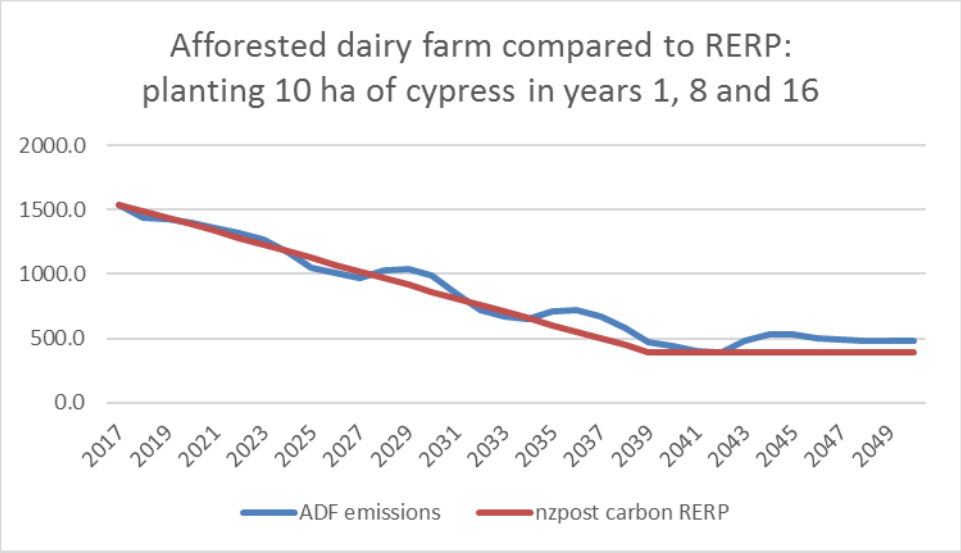


Conclusion to scenario 1.

The number of trees planted is too high, because the farm is below the RERP. Being below should prove unnecessary as there are expected to be methods of reducing cow emissions either by breeding, reducing intensification, reducing fertiliser use, farming organically or by other biological or chemical processes. The farm profit reduces from $96, 214 in 2017 to $85,620 in 2050, averaging $87,348 per year.

Scenario 2. Planting 10 ha per year every 8 years

year	total farm emisions	Dairy farm RERP	emissions 146, 136 126, then 116ha	seq 1 ha lookup cumulative	seq 1 ha lookup annual	seq 10 ha	seq 10 ha plus 8 yr	seq 10 ha plus 16 yr	total seq	diff rerp and farm emissions	CT at $100	profit at 659/ha	farm profit
2017	1541.4	1541.4	1541.4	0	0	0	0	0	0	0.0	0	96214	96214
2018	1435.8	1489.2	1435.8	0	0	0	0	0	0	-53.4	-5341.4	89624	94965.4
2019	1428.8	1437.1	1435.8	0.7	0.7	7	0	0	7	-8.3	-827.5	89624	90451.5
2020	1398.8	1384.9	1435.8	4.4	3.7	37	0	0	37	13.9	1386.5	89624	88237.5
2021	1360.8	1332.8	1435.8	11.9	7.5	75	0	0	75	28.0	2800.4	89624	86823.6
2022	1316.8	1280.7	1435.8	23.8	11.9	119	0	0	119	36.1	3614.4	89624	86009.6
2023	1272.8	1228.5	1435.8	40.1	16.3	163	0	0	163	44.3	4428.3	89624	85195.7
2024	1167.8	1176.4	1435.8	66.9	26.8	268	0	0	268	-8.6	-857.7	89624	90481.7
2025	1048.2	1124.2	1330.2	95.1	28.2	282	0	0	282	-76.0	-7603.8	83034	90637.8
2026	1010.2	1072.1	1330.2	126.4	31.3	313	7	0	320	-61.9	-6189.8	83034	89223.8
2027	973.2	1020.0	1330.2	158.4	32	320	37	0	357	-46.8	-4675.9	83034	87709.9
2028	1030.2	967.8	1330.2	180.9	22.5	225	75	0	300	62.4	6238.0	83034	76796.0
2029	1035.2	915.7	1330.2	198.5	17.6	176	119	0	295	119.5	11952.0	83034	71082.0
2030	992.2	863.5	1330.2	216	17.5	175	163	0	338	128.7	12865.9	83034	70168.1
2031	846.2	811.4	1330.2	237.6	21.6	216	268	0	484	34.8	3479.9	83034	79554.1
2032	718.7	759.3	1224.7	260	22.4	224	282	0	506	-40.6	-4056.2	83034	87090.2
2033	671.7	707.1	1224.7	284	24	240	313	7	553	-35.4	-3542.2	83034	86576.2
2034	650.7	655.0	1224.7	308.7	24.7	247	320	37	574	-4.3	-428.3	76444	76872.3
2035	709.7	602.8	1224.7	334	25.3	253	225	75	515	106.9	10685.6	76444	65758.4
2036	716.7	550.7	1224.7	359.7	25.7	257	176	119	508	166.0	16599.6	76444	59844.4
2037	670.7	498.6	1224.7	385.7	26	260	175	163	554	172.1	17213.5	76444	59230.5
2038	583.7	446.4	1224.7	411.9	26.2	262	216	268	641	137.3	13727.5	76444	62716.5
2039	470.7	394.3	1224.7	438.1	26.2	262	224	282	754	76.4	7641.4	76444	68802.6
2040	439.7	394.3	1224.7	464.4	26.3	263	240	313	785	45.4	4538.1	76444	71905.9
2041	402.7	394.3	1224.7	490.6	26.2	262	247	320	822	8.4	838.0	76444	75606.0
2042	391.7	394.3	1224.7	516.6	26	260	253	225	833	-2.6	-262.0	76444	76706.0
2043	483.7	394.3	1224.7	542.5	25.9	259	257	176	741	89.4	8938.0	76444	67506.0
2044	532.7	394.3	1224.7	568.1	25.6	256	260	175	692	138.4	13838.0	76444	62606.0
2045	533.7	394.3	1224.7	593.5	25.4	254	262	216	691	139.4	13938.0	76444	62506.0
2046	495.7	394.3	1224.7	618.6	25.1	251	262	224	729	101.4	10138.0	76444	66306.0
2047	489.7	394.3	1224.7	643.4	24.8	248	263	240	735	95.4	9538.0	76444	66906.0
2048	478.7	394.3	1224.7	667.8	24.4	244	262	247	746	84.4	8438.0	76444	68006.0
2049	476.7	394.3	1224.7	691.9	24.1	241	260	253	748	82.4	8238.0	76444	68206.0
2050	481.7	394.3	1224.7	715	23.1	231	259	257	743	87.4	8738.0	76444	67706.0
	471.7	394.3	1224.7	739	24	240	256	260	753	77.4	7738.0	76444	68706.0
	480.7	394.3	1224.7	762	23	230	254	262	744	86.4	8638.0	76444	67806.0
	485.7	394.3	1224.7	784.6	22.6	226	251	260	739	91.4	9138.0	76444	67306.0



Conclusion to scenario 2: 10 ha planted every eight years

With future improvements in emissions intensity, this planting proposal should work. Profits however drop from $96214 down to $67,306 in 2050, averaging $82, 894 per year.

Assumptions made in this analysis

1. Average dairy farm 146 ha (LIC/NZDairy 2014)
2. Average number of cows 419 (LIC/NZDairy 2014)
3. Dairy farms in NZ 11,970 (LIC/NZDairy 2014)
4. Av. emissions per Kg Milk Solids 10.57kg CO2e (Duchemin[8], Ledgard et al.[9])
5. Av. emissions per herd 1,541.35 Tns (Foote et al. 2012. dairy = 16.9 Mtns)
6. Average emissions per ha. 10.55 Tn (#5 / #1)
7. Av. MS per herd157,885 (LIC/NZDairy 2014)
8. Av. price /Kg MS over 20 yrs inflation adj. $6.10 (LIC/NZDairy 2014)
9. Gross profit for av. dairy farm $963,098 (#7 X #8)
10. Net profit at 10% of gross $96,309
11. Net profit per ha. $659 (#10/#1)

Objections, questions and considerations

How would NZ fund the payouts to farmers below the RERP?

When you compare the amount paid out by government over 22 years with the amount received by the ADF (columns G and K), the difference is $52,344 or $2,379 per year pay out. If all 11,970 farms did this it would cost the government $28.476 million per year. This could be easily covered by the profit from carbon taxes elsewhere, for example the tax income from a $100 CT on the country's 3.2 million light passenger vehicles would be $800 million.

If all farms entered the scheme, would dairy farming, as a whole, meet the RERP?

The ADF would be permitted to make cumulative emissions over 22 years of 18,526 to stay on the path (Column D). Its cattle would emit 27,118 Tns (column E), less amount sequestered by the trees of 9115 Tns (Column J), giving total farm emissions of 18,003 Tns, which is pretty close!

Isn't each farm different, some emitting more per animal than others?

This analysis is only looking at the average farm and the situation is certainly far more complex. What we have shown is that the mechanisms we suggest would work and are feasible – a far cry from the current hopeless system where dairy farms escape from making their fair contribution to the national emissions reduction effort, causing unproductive animosity between farmers and city dwellers. The ADF proposal offers farmers a carrot rather than a stick.

Wouldn't it be expensive to fence and plant the trees?

The government could help with this in several ways. The large increase in planting nationally would result in economies of scale in growing and supplying trees. Some more of the $800 per year from petrol tax could be made available. National Forest Service could be introduced for all citizens, similar to national military service which still exists in many countries under military threat; and the threat of climate change is just as deadly. A period of NFS or stipulated number of trees planted per person, would be a requirement of all citizens in order for them to receive the Universal Citzens'Income (proposed elsewhere in our policy). An added benefit would be contact between farmers and city dwellers leading to a more cohesive society and a better understanding and appreciation of the natural world for urbanites. It would give all citizens a stake in the countryside.

Isn't it a waste to plant our most fertile land in forestry?

No, the trees would grow really fast. In order to meet the climate change goal, stock numbers need to be reduced, which means a smaller acreage of pasture anyway. Trees could be planted along waterways which would slow farm runoff into streams, improving water quality. They could also be planted on the least fertile parts of the farm. The fact that trees would be in small blocks rather than in vast plantations makes them safer from forest fires, which could increase with global warming. Blocks isolated from other blocks would also be less disease prone. The blocks could be easily kept possum free. Having trees in the dairy landscape would improve local aesthetics, breaking up endless empty paddocks.

Conclusion

This proposal addresses the biggest barrier to the emissions reduction in this country, dairy farm emissions. New Zealand has a unique emissions profile among OECD countries with its large proportion of agricultural production, and various excuses have been given for failing to act to curb emissions from agriculture. By thinking laterally and trying to bring farmers on board in the shared battle to reduce emissions in time we think we have stumbled upon a ground-breaking opportunity for New Zealand to lead the world.

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