agKnowledge
"The Independent Fertiliser Experts"

Autumn
2019

ISSUE 41

Fertiliser Review

CLOVER-BASED PASTURE FIRST?

One of the messages from a paper presented to the Pasture Summit in November 2018 by DairyNZ, is very clear. Graphically it looks like this (see Figure 1)

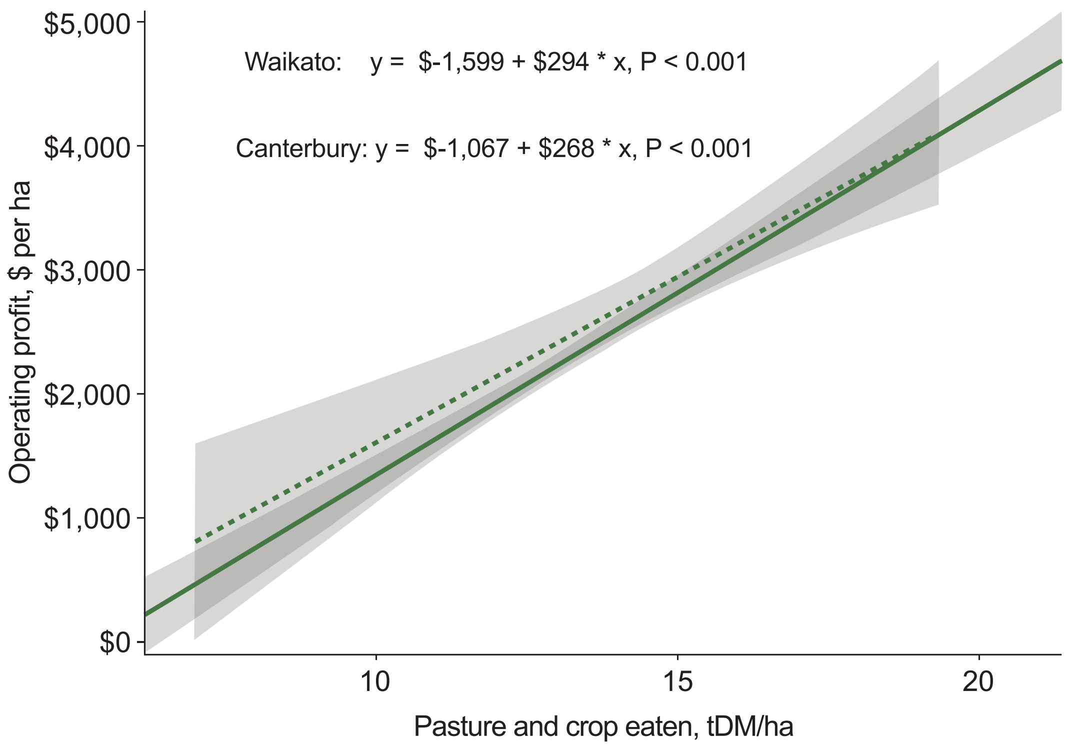

Figure 1 The relationship between pasture and crop eaten and operating profit.

Notes: Pasture and crop eaten means clover-based pasture and crop grown on the farm.

In words it sounds like:

"High pasture harvest, with low reliance on supplementary feed and effective cost control, are key attributes of financially-robust dairy businesses. These businesses may not be the most profitable during years of high milk price (3 out of the last 12 years); however, they are more capable of maintaining a positive cashflow through low milk price years (6/12), ensuring they are profitable and resilient to the increasing volatility in the sector."

This graph and these words are a modern-day expression of the old mantra: the international competitive advantage that the NZ pastoral industry enjoys is based on in situ, all-year around grazing of clover-based pasture. It is the reason why we can trade competitively on the international market even though we are half-a-world away from the market.

More explicitly: the marginal cost of a kg of white-clover/ryegrass DM is 4-5 cents. Nitrogen fed ryegrass costs 10 to 12 cents per kg DM, crops are 15-20 cent and supplements like maize and PKE are > 30 cents.

These messages are just as important for the dry-stock sector as they are for the dairy industry and therein lies a BIG BUT.

BIG BUT: We have lost the plot?

Time and time again we go onto farms and see poor pastures. I estimate that about 70% of the farmers who come to agKnowledge for advice in the last 10 years are farming at below optimal soil nutrient levels. One, or a number, of the 16 essential plant nutrients is missing. The most frequent limitations are potassium (K) and sulphur (S) but trace element problems like molybdenum (Mo) deficiency also occur. The consequential losses in pasture production can be large (10-20%) because the pasture can only grow as fast as the most limiting nutrient.

My routine when I go onto a farm is to ask the farmer to show me his/her best and worst pastures. Normally I am taken to the worst paddocks first after which, and with a hopeful grin, the farmer will show me the best pastures. And normally they are the best pastures in the context of that farm. But in the context of what a good clover-based pasture SHOULD look like, they are poor. Why have we lost the plot I wonder? I can think of several reasons:

Go back to the 1950s, 60s, 70s and 80s the then Department of Agriculture and subsequently the Ministry of Agriculture laid down literally hundreds of fertiliser field trials - trials looking at different fertilisers, different nutrients and different rates of different nutrients. I know from my own experience that farmers loved to look at these trials and I have no doubt they went back to their farms with a clear mental picture of what a good clover-based pasture looks like if there are no nutrient limitations. They had a mental 'benchmark' against which to assess and manage their own pastures. But we have not done this type of trial work for possibly 30 years. We now have a new generation of farmers who have not had the benefit of this experience.

Furthermore, over the last 20 years or so, dairy farmers in particular, have been using increasing amounts of nitrogen fertiliser and supplements. Their production was no longer entirely dependent of growing vigorous clover-based pasture. They probably did not even realize, or even care, that their pastures were no longer pulling their weight.

Other factors have come into play. In the 1980's the fertiliser industry was deregulated. One consequence has been the emergence of two large co-ops competing on market share. From my perspective the transition from co-op to corporate has been obvious and with this has been a shift in purpose away from technical support to sales and marketing.

There was a time when farmers could rely on sound technical support from their co-op but the feed-back I get these days from farmers is that this is no longer the case. I do wonder what basic training these young recruits into the fertiliser industry are offered, especially when it comes to the fine arts of visual pasture assessment and soil testing.

This problem is compounded by the environmental demands now placed on the fertiliser industry. These days a fertiliser rep probably knows far more about

Overseer and how to compile a nutrient budget than they do about growing good clover-based pasture.

Which brings me to my final point. Where do you go to learn about soil testing, soil fertility and pasture nutrition; what are the tell-tale signs in a clover-based pasture which can be so helpful when diagnosing soil fertility problems and more importantly ground proofing soil test results? The answer is nowhere!

The land based Universities, Massey and Lincoln, do not teach these skills anymore.

Bringing this to a personal level I think it is fair to say that my colleagues, Dr Roberts (Ravensdown), Mr Morton (now retired ex Ballance) and myself are the last ones standing with a background in agricultural science and with a skill set including soil fertility, soil testing, pasture nutrition and fertilisers.

These revelations are truly amazing for a country whose largest industry - the pastoral sector - depends on growing clover-based pasture!

The Tiller Talk Project

Given the above, agKnowledge Ltd and Dairy NZ have commenced a project with the objective of teaching dairy farmers how to 'read' pastures - visually assess pasture production, vigor and composition. This is part of DairyNZ's Tiller Talk project.

Large demonstration plots have been established on 14 sites throughout NZ. At each site there are 4-5 large plots (10 m x 10 m) with different treatments: 1) control (we have deliberately chosen sites, which are deficient in at least one major nutrient) 2) heaps of P 3) heaps of P and K 4) heaps of P, K and S and 5) heaps of all three nutrients plus a dose of lime or molybdenum on some South Island sites.

The intention is to show farmers what an ideal pasture looks like when there are no nutrient limitations and to teach them how to visually assess pastures in terms of vigor and composition. This is the same concept as condition scoring of cows, which is now widely used in the dairy sector.

Red Meat Profit Partnership (RMPP)

In parallel with the Tiller Talk Project, I have been running workshops (9 so far) for dry-stock farmers covering soil fertility 101. These workshops funded through the Beef & Lamb project (RMPP) have from my perspective been a lot of fun and very rewarding. The key is small groups (10 to12 farmers), informal, interactive and allowing for plenty of time for discussion and debate (2-3 hrs).

The messages are simple:

- Clover-based pastures provide the cheapest feed for ruminants.
- Clovers have a higher nutrient requirement than grasses
- Clover is the 'canary in mine' – if the clover content is poor then chances are that there is a nutrient limitation.
- Clover requires 16 nutrients and can only grow as fast as the most limiting nutrient.
- The ideal pasture contains 30-40% clover.
- The fertiliser policy should be directed to growing clover.

The workshops include time in the field learning the tell-tail signs which appear in the pasture, and especially in the clover component, if the soil fertility is not balanced.

FINE PARTICLE APPLICATION OF FERTILISERS

This topic keeps rearing its ugly head (see Fertiliser Review 40). This time it has arisen as part of the ongoing campaign by Greenpeace to denigrate the fertiliser industry (see article on Greenpeace in this issue).

Tony Wall (Stuff, September 2018) reports that the big fertiliser companies are "quashing environmentally friendly way of applying nitrogen." He is referring to what is called 'fine particle application' (FPA) – a process in which nitrogen fertiliser N is dissolved or suspended in water and then sprayed onto pasture.

Its proponents make many claims which boil down to two propositions: it increases the N use efficiency – more pasture grown per kg N applied and it is environmentally friendly – it reduces N leaching. Dr Bert Quin takes these arguments further claiming that the same benefits can arise from using prilled urea – a finer grade of granulated urea - without the need to fine grind the fertiliser N.

These benefits, it is claimed, arise for two reasons – the N is spread more evenly and/or the N is taken up directly by the plant.

There is much at stake given that NZ farmers are big users of fertiliser N and that N is one of the big four contaminants which affect water quality.

In that grand tradition of enlightenment science, the question arises: what is the evidence?

Three reviewers have trolled through trial data comparing the effects of granulated urea with FPA applied urea.

Morton and co-authors (2018) concluded that: "…there was insufficient experimental evidence to recommend the use of FPA fertilisers over the standard granular form of application." They were rigorous in their approach and only included results from properly designed, replicated and randomised trials. They excluded anecdotal evidence, data from unreplicated trials and trials which did not include an estimate of the errors inherent in such experimentation. Nine field trials meet this standard and formed the basis for their conclusion.

In 2014 I reviewed the literature for DairyNZ. I applied the same criteria as Morton and co-authors, in terms of trial selection, but my brief was wider: I looked at the national and international data comparing solid fertiliser (i.e granulated) with the many types of liquid fertiliser (i.e. pure solutions, organic based liquid fertiliser, slurries and suspensions including FPA).

I concluded from this body of research that the form of fertiliser (liquid, suspension, slurry or granular) has no effect on plant growth. More explicitly there was no evidence that foliar application of nutrients is more efficient or effective than the granulated equivalent. An analogy springs to mind: sugar cubes verses granulated sugar. For soluble materials like most N fertilisers the particle size is not a factor affecting its efficiency.

A third review was conducted by Mr Chris Crossly, funded by an organisation called Living Water. He reached a different conclusion. It is a matter of scientific process and integrity, and in no way churlish, to ask why and how?

Mr Crossly is, as far as I am aware, a farm consultant, not a scientist. In itself this is not fatal but track record and experience can be important when assessing competence and credibility.

The Crossley report has in turn been critically assessed by a scientist from AgResearch and dammed with faint praise. While suggesting there is "**some evidence** (emphasis added) that FPA has advantages" the report goes on to note the many limitations in the review. For example, that the report places a lot of weight on one trial – refered to as the Winton trial. The trial was poorly executed, there was no statistical analysis of the data and the results were ambiguous.

The Crossley report included research published by Dawar and co-workers and interestingly the AgResearch reviewer drew attention to this research suggesting that, because it was peer-reviewed and published, it should be given greater weighting.

In my review of this research, I noted that "The authors themselves are guarded in their conclusions: "Although some caution should be used in extrapolating these glasshouse-based results to the field applying urea in FPA form is likely to be a good management strategy….". To their credit they repeated their trial work in the field, albeit in small plots, and the important overall result based on the total N recovery is consistent with the main conclusion of this report that the NUE of urea is not enhanced using FPA."

Dr Quin was an early advocate for FPA. He now claims that he has developed a better system - called the 'ONESystem' - which is even better than FPA. He has reported data from two trials comparing the results from his ONESystem with granular urea. The results were ambiguous: it 'worked' in one trial but not in another. In any case these results were confounded: The trials compared granular urea with prilled (micro-granulated) urea to which a urease inhibitor was also added. Furthermore, overseas research has shown that at the same amount of N applied, prilled urea is no better or worse than granulated urea.

Thus there is no evidence to support the view that FPA results in more production per unit N applied. What about the claimed environmental benefits – it is claimed to reduce N leaching. Research completed at Ruakura some years ago using N-15 tracers, showed that there was little to no leaching of fertiliser N per se. Most of the N leached arises from the urine patch so changing the form of N fertiliser from granulated, to prilled to FPA will have no practical effect on N leaching.

So where does all this leave Dr Quin's claim that "establishment" scientists have their "minds in the mud" on this issue. If there is any truth in this it is because the establishment has had to put is head into the murky waters of "advertorial science" to divine the truth. As for Tony Wall's assertion that the "big fertiliser companies" are "quashing" this FPA technology, perhaps he has made the unforgivable journalistic error of not looking adequately at both sides of the story? Then again he may like to ponder the effectiveness of sugar lumps versus sugar crystals?

GREENPEACE VERSUS THE FERTILISER COMPANIES

In my opinion the biggest threat to the future of agriculture in New Zealand is extreme environmentalism – the sort that flows regularly from Greenpeace. It is not their environmental goals that I object too. Indeed I agree with many of them - I want clean water too! It is the ideology they espouse to achieve their goals that is the threat. Their recent campaign to ban nitrogen fertilisers is a case in point.

Their argument is straight forward: Fertiliser N grows more pasture; more pasture means more animals; more animals means intensification. Intensification means more environmental damage. Ipso facto – ban fertiliser N.

Regretfully their logic indicates a lack of knowledge and understanding of NZ clover-based pastoral systems.

Fertiliser N is not the problem - the N getting into waterways mostly comes from the leaching of N from urine patches (dairy cows can deposit 500-1000 kg N/ha in a urine patch), which is far too much for the soil/plant system to retain.

The N in the urine can come from fertiliser N applied to the soil or from clover N (i.e. fixed N from atmosphere). Just because clover N is 'natural' does not mean it does not get leached.

My estimate of the amount of clover N fixed annually in NZ pastures is about 1.1 b kg N. (About $1.5b worth of N). Compare this with fertiliser N - we use approximately 0.4 m tonne of N annually, i.e. about one third of the N fixed by clover from the atmosphere.

Now: if they banned fertiliser N the likely outcome is that more clover would grow, fixing more N, in which case the total amount of N in the pastoral system (soil/pasture/animal cycle) may not decline. i.e. the same amount of N would go through the urine-process and be subject to leaching.

Also, counter-intuitively, reducing the number of animals (i.e. the number of urinations per unit area and time) may not have a large effect on the rate of N leaching, because the fewer number of animals will likely be better fed and hence pass more urine N per animal.

So what is Greepeace on about – what is really motivating them with their misleading rhetoric? The answer can been divined from their video (“Why synthetic nitrogen sucks,”) which emphasises that urea is synthetic - ‘made in factories’ - whereas clover is a ‘product of nature’. The implication is that clover N, unlike synthetic N is benign. This is simply not true.

They claim that “we can grow all the food we need without synthetic N by adopting regenerative agriculture.” There are two problems with this claim. First, regenerative agriculture is organic farming dressed in drag (see Fertiliser Review No 40) and science has shown that the production from organic systems is about 60% compared with conventional agriculture. More pointedly, it is estimated that 40% of the worlds’ population depends on N fertiliser for their food. Which 40% of the worlds’ population do you want to starve to death?

The conundrum poses the question: Can we feed the world and have good environmental outcomes at the same time? I believe we can and that the solutions will be found in the application of sound, evidence-based solutions – the sort of things that science is so good at. Greenpeace in their campaign to ban N fertiliser have adopted the ideology of the Luddite’s. In my view there is no future in going backwards.

REACTIVE PHOSPHATE ROCK (RPR)

A farmer sought my advice: he was advised by a fertiliser company to apply an RPR fertiliser to his sizeable hill country farm. He wanted to know how it would ‘stack-up’, ‘cost-wise’ against superphosphate? He provided me with an analysis of the fertiliser, its cost, and the transport and spreading charges for the farm

The product was in fact an RPR/elemental S mix costing $505/tonne. It contained 9.6% phosphorus (P) and 7.2% elemental sulphur (S). He was advised to apply it at 244 kg/ha. This would have provided inputs of 23 kg P/ha and 17 kg S/ha annually.

For comparison 255 kg/ha of super (9.0% P and 10.5% S) would deliver similar inputs of P and S (i.e. the same amount of P (23 kg P/ha) and slightly more S (26 kg S/ha)). The cost of the super is $322/tonne. Thus, ex works, the cost of the RPR/elemental S mix is 1.5 times more than super, for the same amount of P and slightly less S.

Ah ha, said the salesman. But the P concentration in RPR is higher and therefore you do not need to cart and spread as much. Really! The cost of transport and spreading on this farm is $100/tonne. Thus, the RPR mix would cost $605/tonne on the ground and the super $422/tonne for the same amount of P and S. A ratio of 1.4 in favor of straight super.

We can of course refine these calculations by taking into account the value of the S in the products, noting that super contains 10.5% S and the RPR blend 7.2%. The current value of S is about $0.70/kg and hence the 72 kg S in a tonne of the RPR mix is worth about $50 and the 105 kg S in a tonne of super is worth $73. From there we can calculate that the P on the ground is costing $5.78/kg in the RPR mix and $3.87 in the super. Ratio 1.49

So, it does not matter how you do these sums the RPR mix is more expensive than the comparable super alternative. And it gets worse the more you think about it.

It is assumed in the calculations above that the P in the RPR is all plant available. The science shows that the best RPR (Sechura, which I understand is no longer imported into NZ) dissolves at about 30% per year. This creates a lag effect, which, strictly speaking, adds more cost to the RPR.

The farmer once presented with this information had a number of questions: “But I was told by the salesman that RPR has a liming effect” - you have not accounted for that. Yes and No. Yes, some RPRs have a liming effect but it is very small and of little practical value given the rates of application of RPR we typically use. In any case, the elemental S added to the RPR has an opposite effect - it acidifies the soil when it is oxidized to plant available sulphate S and this rate of acidification exactly neutralizes any liming effect from the RPR.

The farmer continued: “But I was told by the salesman that RPR was better for the environment” – it does not runoff into the water-ways like soluble P fertiliser. There has been one trial in NZ testing this hypothesis. It showed that the concentration of P in the runoff from plots receiving soluble P was higher than that from the RPR treated plots. But this effect only lasted about 60 days post application, thereafter the P concentrations in the runoff water were about the same.

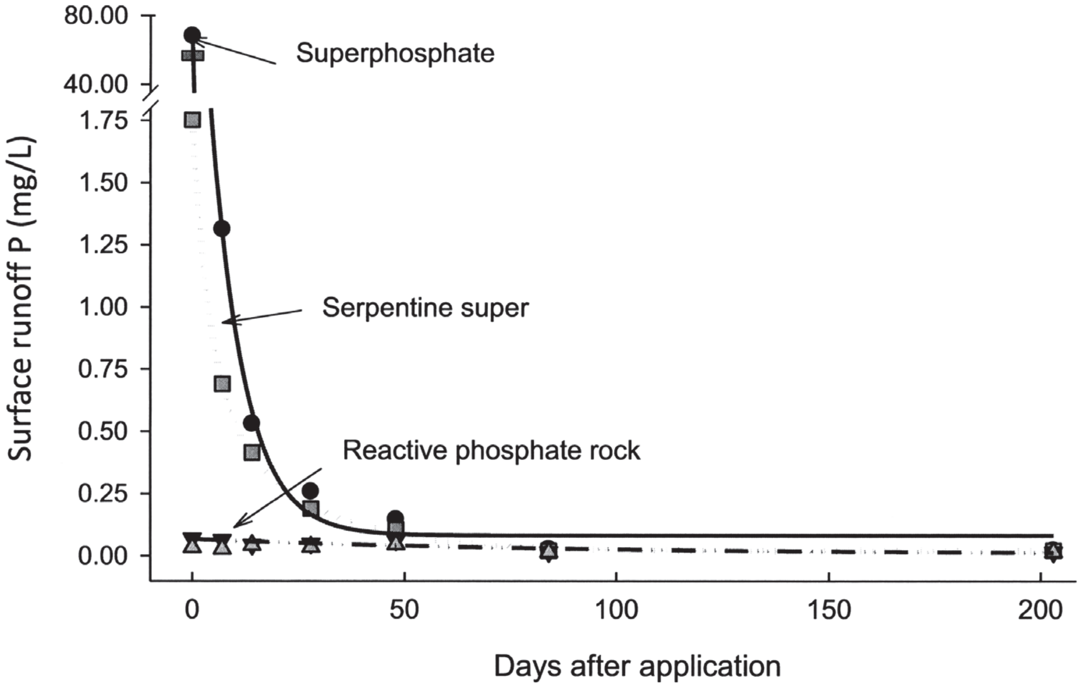

Figure 2 The relationship between surface runoff of P over time (days) from plots treated with fertiliser with a range in P solubility.

Some historical perspective is useful. RPRs were introduced into NZ agriculture in the mid-1980s and at that time it was assumed that they were as agronomically effective as super - a kg of total P in RPR was assumed to be equivalent to a kg of soluble P in super.

Since then much research has been done on the chemistry and agronomic effectiveness of RPRs. Indeed, when I was the Group Leader (Soil and Fertiliser) in the old MAF Research Division, about 50% of the science budget was directed towards research on RPRs. It was a major concern for farmers at the time, especially because subsidies were removed from fertiliser.

We now know as a result of this research that a kg of P in RPR is not as agronomically effective as a kg of P from super and that RPRs differ in their effectiveness. As noted above the best RPR, Sechura, dissolves at about 30% per year and the lag effect is 4-6 years. What this means is that you have to apply the best RPR for 4-6 years before you would build up sufficient RPR residues to meet the annual demand for plant available P. And remember; the worst RPR introduced into NZ at the time dissolved at about 10% per year.

My Advice?

Be wary of the claims made by those who sell fertilisers! If in doubt seek independent advice.

THE ETS AND THE ZERO CARBON BILL

Some food for thought; Mr Phil Journeaux, an agricultural economist who works with AgFirst, has been crunching the numbers. (The Journal of the NZ Institute of Primary Industry Management, December 2018). The average dairy farm (147 ha) produces 9.6 (range 3-19) tonnes of Green House Gas (GHG expressed in CO2 equivalents) emissions per hectare. The figure for the average Sheep & Beef farm is 3.1 (1.0-5.0). The range reflects the fact that all farms are different in terms of their GHG profile.

Applying standard modeling techniques he has estimated the effects of changes in farm systems on the likely changes in GHG emissions. Typically, they range from +/- 5 to 10%. In other words, applying current knowledge about farm systems is not going to ‘cut the mustard’ if the goal is to become carbon neutral.

Converting to forestry is the exception - it has big impacts on reducing GHG emissions but these come with a cost (Table 1)

Table 1. Impacts of forestry land use change on GHG emissions and EBIT

Proportion of area in forest (%)	Average dairy farm		Average Sheep & Beef farm	
	Change in GHG (%)	Change in EBIT (%)	Change in GHG (%)	Change in EBIT (%)
5	-6	-8	-18	-7
10	-14	-15	-33	-12
15	-22	-20	-49	-20
20	-30	-35	-64	-24
30	-45	-50	-93	-35

Looked at differently he has calculated the hectares of radiata forestry required to offset GHG emissions for an average dairy farm and sheep & beef farm.

Table 2. Hectares of radiata forestry required as an offset

	Offset (%)							
	5		10		50		100	
	Total[1]	Safe[2]	Total	Safe	Total	Safe	Total	Safe
147 ha dairy	3	12	6	24	28	118	56	235
627 ha sheep & beef	4	16	8	32	39	162	77	324

Notes: 1) Total assumes the trees will never be harvested.

2) Safe assumes to the amount of carbon remaining after harvest.

These numbers suggest that some modest cuts in GHG emissions of approximately 5% may be possible but anything greater than that will put most farmers under serious financial stress. At the extreme end it would annihilate dairy farming completely.

The NZ Institute of Economic Research (NZIER) has estimated the likely GDP growth rates for different 'Zero Carbon' scenarios and targets. Journeaux has extrapolated these annual growth rates out over the period 2017 to 2050. The results are staggering. Relative to 'doing nothing' he estimates that the best-case scenario has an opportunity cost of $700 billion and the worst case had an opportunity cost of $1.5 trillion.

As he put it in his correspondence with me: "Which seems to me to be a lot of money to reduce global CO_2 levels by 0.17%."