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Technologies to transform environmental woes to wealth

Submission: Low emissions economy - Biozest

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Introduction

Indigo has developed a technology (Biozest) that will significantly reduce emissions from agriculture by increasing pasture fed milk and meat production. Biozest can be seamlessly integrated into New Zealand's existing farming systems to reduce emissions and increase productivity.

Indigo has identified an acute inefficiency in the ruminant biological digestive system resulting in 75% of pasture protein being wasted as urea and methane. We have increased ruminant efficiency resulting in a 30% increase in milk and meat production. As a result of reducing this inefficiency we have proven the waste (urea and methane) can be reduced by up to 48%.

We are proposing a Public Private Partnership as a potential pathway to ensure New Zealand can benefit from this technology immediately.

This is a commerce based model that is risk averse. An opportunity based on proven technology. This is a model to increase New Zealand's wealth, abate liabilities, capitalise on national and international benefits and sustain future technology development. We can be a wealthy country very quickly and consolidate our clean green and pasture-fed meat and milk brands.

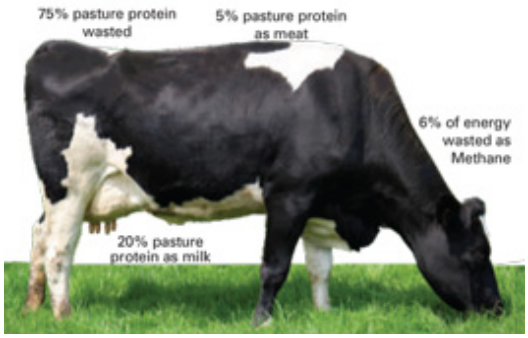
We would like to ensure that technologies such as Biozest, which is available for use on farms right now, are objectively and independently assessed alongside other, previously proposed, solutions.

We want to ensure the agriculture sector is aware of the benefits of adopting low emissions technologies and we would like to provide evidence that will ensure the Productivity Commission's report is able to debunk the myth that reducing emissions will cause economic harm.

We would also like to see a clear pathway for research, collaboration and implementation of emissions reduction technologies so that New Zealand can immediately benefit both environmentally and economically.

The Challenge

Ruminant digestion is a highly inefficient system. Ruminants do not efficiently convert pasture to milk or meat. Farmers commit significant resources to producing pasture but, rather than being converted to milk or meat, much of this passes through stock resulting in waste including urea and methane.



One approach to reducing methane emissions has been to attempt to identify compounds that inhibit methanogens. Trying to remove or inhibit one component of a complex digestive system in grass-fed farming and without side effects has so far been unsuccessful.

Another approach to reducing emissions has been to improve, or supplement, feed.

Grain fed milk and meat producers already have a commercially available technology to reduce greenhouse gas. (https://www.dsm.com/markets/anh/en_US/products/products-eubiotics/products-eubiotics-crina/crina-ruminants.html, https://www.ncbi.nlm.nih.gov/pubmed/26229078) This supplement must be consumed continuously or at very specific rates that makes this type of technology impractical in New Zealand's grass fed systems. But, grain-fed farmers can begin taking concrete steps to address emissions and it is inevitable that European and American farmers are going to lobby for farming to be included in the global emission reduction initiatives. This will give grain fed farming a commercial advantage. This could make our farmers liable for an emissions cost of $830 million per annum (as estimated by Federated Farmers)[1].

We cannot place our economy and farmers in such a vulnerable position.

We need to act now.

Our Opportunity

Ruminant metabolic inefficiency has a significant impact on farm productivity and the emission of greenhouse gases (nitrous oxide and methane). Ruminant animals are inefficient utilisers of dietary nitrogen. Ruminants on average convert 24.7% (range 13.7% to 39.8%) of feed nitrogen into milk or meat. 75% of feed nitrogen is wasted as urine or dung urea[2]. Cattle typically lose 6% of their ingested energy as eructated methane[2].

Increasing the efficiency of conversion of pasture protein into milk or meat instead of urea or methane will deliver higher productivity and abate greenhouse liabilities. A small lift in the percentage of feed nitrogen converted to milk or meat can deliver a substantial increase in farm productivity. For example, a feed nitrogen conversion increase of 2.5% (from 25% to 27.5%) can deliver a 10% increase in farm productivity ((2.5/25) X 100 = 10%).

Nitrous oxide (from urea) has 310 times the global warming potential of carbon dioxide[3]. Therefore, a small reduction in urea excretion can significantly decrease farmers' greenhouse gas liability. Methane has 21 times the global warming potential of carbon dioxide[3]. A small reduction in methane eructation can also significantly decrease farm greenhouse gas liabilities.

Ruminant production systems are inefficient because of an imbalance in nutrient and energy supply resulting in the asynchronous release of nitrogen from pasture protein and energy from carbohydrates for microbial fermentation in the rumen[4].

There are two possible - processes for increasing the capture of pasture protein during microbial fermentation instead of being wasted as urea and methane: One strategy is to increase the amount of readily available energy during the early part of fermentation. The readily available energy in pasture comes mainly from soluble carbohydrates (soluble sugars)[4]. The fermentation of these soluble carbohydrates is less methanogenic than the fermentation of cell wall carbohydrates[6]. The second strategy for improving microbial efficiency in ruminant animals is to protect pasture proteins by reducing the rate at which they become degraded to ammonia in the rumen[4].

Phenylpropanoids in plants and pasture can protect proteins from rapid degradation and improve the efficiency of conversion of pasture protein to animal protein (meat and milk)[4]. Plants produce phenylpropanoids such as anthocyanins, flavonoids, isoflavonoids, flavones, lignin, suberin, coumestrol and other oils[5].

One group of phenylpropanoids, isoflavonoids, strengthens the defence system against pest and disease damage[8] thus improving plant health**.** Scientific evidence also substantiates farmers' assertions that phenylpropanoids improve animal health[5]. Phenylpropanoids have a range of functions[5]:

- anthocyanins: prevent physiological disorders and reduce cold damage,
- aromatic oils: increase the bouquet in flowers,
- flavonoids: improve flavour,

- isoflavonoids: strengthen the defence system against pest and disease damage,
- isoflavonoids, flavones and anthocyanins: help the plant take up nutrients for growth,
- lignin and suberin: harden the cell against physical, pest and disease damages.,
- coumestrol and other oils: help the plant repair damaged cells.

Phenylpropanoids can therefore improve pasture productivity by reducing pest, disease and environmental (drought, waterlogging, wind, cold, salinity and light) stress[5]. Phenylpropanoids also act as signals to soil microbes involved in nutrient procurement[6]. Phenylpropanoids secreted by plant roots act as signals to attract nitrogen fixing bacteria[7]. Phenylpropanoids promote development of mycorrhiza fungi that are crucial for phosphate uptake, nutrient availability through chelation and mineralization of soil calcium, iron and phosphates[6]**.**

Phenylpropanoids have a beneficial effect in rumen fermentation, microbial populations, performance in meat and milk production, feed conversion efficiency and methane inhibition[8]. The increased phenylpropanoid content in pasture increases the content of conjugated linoleic acids, the health promoting fatty acids in milk and meat[8].

In addition to improving the conversion of pasture protein to milk and meat, the higher content of phenylpropanoids in pasture can shift the type of nitrogen excreted in urine and dung from a soluble form to an insoluble form of nitrogen[8]. This has a beneficial effect on nitrogen cycling and reduction of leaching.

Based on this knowledge we have developed a technology branded Biozest.

The Solution

"Improved nutritional management of these ruminant animals, e.g., through supplementation, is expected to lead to increased productivity and will generally reduce methane emissions per unit of product"[9].

The paper referenced above was published in 1991 and is a summary of discussion at an EPA sponsored workshop, February 1989 and a workshop conducted under the auspices of IPPC in December 1989. The concept of reducing emissions via improved nutritional management is not new. The knowledge gained and the development of science in this area in the 25 years since the publication of this paper has enabled us to develop the Biozest technology.

To quote page 19/20 of the Productivity Commission Issues Paper:

However, a low-cost technology that delivers dramatic reductions in biological emissions appears far off, and may not emerge. While a methane vaccine could reduce CH4 emissions by up to 40%, no successful trials of such a vaccine have so far occurred (PCE, 2016). The process from initial concept of a technology to commercialisation is typically long and complex. Even once a technology proves technically effective, scientists and farmers must consider its cost-effectiveness, impact on farm productivity, risk of facing consumer resistance, and how easily it can be integrated into New Zealand's farming system (PCE, 2016).

Biozest is a low cost technology with a high return on investment. Biozest improves the growth, resilience and quality of pasture. In turn, when Biozest treated pasture is grazed, it improves the digestive function of ruminants. Trials on New Zealand dairy, sheep and beef farms have proven that Biozest treated pasture is more easily converted to valuable meat and milk instead of polluting waste products such as urea and greenhouse gases.

Biozest increases productivity and, as a safe pasture spray (approved by MPI/ACVM), has no direct or negative impact on farm animals. Biozest can be seamlessly integrated into New Zealand's existing farming systems to reduce emissions and increase productivity.

Biozest helps pasture naturally resist stress or damage and deliver higher pasture quality and yield. Biozest works by eliciting and sustaining plant defence and stress tolerance systems which drive production of a range of bioactive molecules (phenylpropanoids) and soluble sugars.

However, the most important feature of Biozest is that when Biozest treated pasture is consumed by ruminants it increases the efficiency of ruminant digestion. As a result, more pasture protein is converted to milk or meat rather than being wasted in urine, manure and greenhouse gases.

Biozest is an alpha market tested technology that has been farm proven in New Zealand to increase milk/meat production by 30% and reduce urea excretion by 24 to 48%.

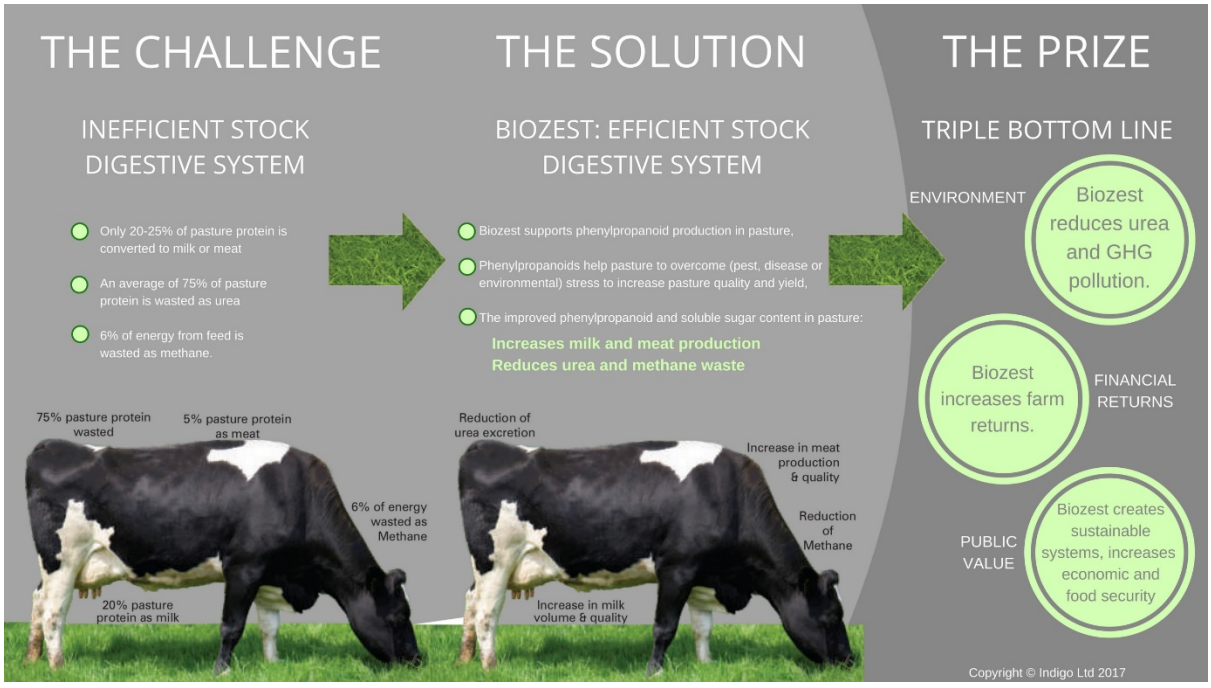
Key Benefits

1. Increase in milk and meat production, increased profitability per hectare ($300/ha),

2. Reduction of urea loading and greenhouse emissions (up to 48%),

3. Supports New Zealand's clean green image and sustainable farming (brand value).

4. Increases brand value of Pasture Fed milk & meat (increased content of conjugated linoleic acids)



Environmental Benefits

Biozest:
- Improves pasture resilience, quality and productivity (climate resilience),
- Improves digestive function in all ruminants (animal health value),

- Increases milk and meat production by 30%,(higher productivity at reduced footprint)
- Reduces polluting waste by-products such as urea and methane (up to 48%) (abates greenhouse gas and environmental liability).

-reduced leaching of nutrients from urine and dung[8](increased recycling of nutrients),

-improves nutrient uptake and rhizobial nitrogen fixation[6,7](economic and ecological management of soil fertility management).

The science that enabled the invention of Biozest is now mature; therefore, we have comprehensive trial data and the science to substantiate all claims regarding improvements in productivity and reductions in emissions.

Trial work includes large scale (commercial scale or real-world condition) trials carried out on entire herds or farms (e.g. milk production trials, dry stock farm trials) as well as controlled, smaller scale, split block/paddock trials (e.g. pasture productivity trials).

Biozest has been proven in trials to:

- Increase pasture productivity (Kg dry matter/hectare) (by 89-127%),
- Increase pasture palatability (kg dry matter consumed) (by more than 10%),
- Improve pasture performance in stress conditions (frost, drought and waterlogging),
- Lift soluble sugar production to improve ruminant digestion (by 18%),
- Improve stock condition (stud bulls returned an additional $1645 per bull at sale),
- Increase dairy cow productivity: increased milk volume and milk solids,
- Increase dairy goat productivity: an additional 31% of milk volume and 33% of milk solids over a full milking season,
- Reduce the environmental impact of dairy farming. Both dairy cows (24-36% reduction) and dairy goats (36% reduction) excreted lower levels of urea in urine to help cut nitrate leaching and greenhouse gas emissions. In addition, the urea excreted is expected to be in a less leachable form[7].

Trial summaries and data can be viewed here: http://www.indigobiotech.com/biozest-trial-results.html

Economic Benefits

A Low Emissions Economy Can Increase our Wealth.

Many Countries have increased GDP while reducing carbon emissions (http://www.wri.org/blog/2016/04/roads-decoupling-21-countries-are-reducing-carbon-emissions-while-growing-GDP).

The financial benefits to farmers and growers coupled with the environmental benefits will trigger an economic repercussion multiplier effect.

There are multiple beneficiaries:

1. **NZ Farmers**: improve productivity, efficiency and, therefore, profitability.

2. Improves **NZ Competitive edge** and enhances NZ's Clean Green brand: Improve efficiency to regain competitive edge over grain fed animals (currently rapidly moving ahead in efficiency) while retaining 'brand' and market preference for pasture fed meat/dairy.
3. **Greenhouse gas**: New Zealand has a realistic chance of achieving future targets. The technology will enable farmers to turn what was perceived as liability to wealth.
4. Farming returns: low returns are impacting both farmers and the wider industry e.g. **fertilizer companies** which have been forced to lower fertilizer prices and may have reduced profit margins – especially if appropriate limits on N application are introduced. Fertilizer companies have an opportunity to derive revenue from a new technology and reduce the pain of a downturn in their traditional business.
5. **Indigo Limited**: Indigo has developed the technology and it is now ready for commercialization. Collaboration among stake holders in the agricultural sector including research entities will allow the benefits of this technology to be fully realized and further development of additional technologies.
6. **Research**: there are opportunities for CRIs to carry out additional research into areas that are beyond Indigo's capabilities and are in the public good arena. There is an opportunity for NZ to earn carbon credits instead of farming being a liability.
7. **100% Pure – Clean Green New Zealand** – incredibly valuable in terms of both tourism dollars and export earnings from products trading on this brand. Acknowledged to be under threat. We can take immediate steps to protect our clean green status.
8. **Pasture fed milk & meat**. The increased phenylpropanoid content in pasture increases the content of conjugated linoleic acids, the health promoting fatty acids in milk and meat[7].

There is an economic repercussion multiplier effect - even more so than stated above as other technologies are drawn into play e.g. C-Dax (pasture measurements, spraying etc), Farmax or Overseer (data input and analysis to assist decision making). Further adoption of technology of this type will also help drive precision agriculture as the collection of detailed data is encouraged and becomes the norm.

If a model such as a public private partnership is employed, the NZ government stands to gain carbon credits if it is able to implement this technology to reduce emissions overseas and abate the $1 billion carbon emission liability our farmers face. It is probable surplus carbon credits will be generated within our own economy.

The agriculture sector need not be negatively impacted by a move towards a low emissions economy.

Low emissions farming may be easily implemented, increase productivity and increase farmers returns.

If we transition towards a lower emissions future, the primary industry can be reassured, ahead of any regulatory changes, that productivity and economic returns can actually be enhanced by adopting emissions mitigation technologies, such as Biozest, that address inefficiencies, reduce waste, increase productivity and increase returns.

If New Zealand is able to achieve large scale implementation and continued innovation of a range of emissions mitigation technologies there may be opportunities to implement technologies offshore and gain additional carbon credits as well as export earnings from the sale of technologies or products overseas. Inclusion of agriculture in the low emission transitioning process is likely to drive further innovation.

The Pathway

While we have proven the productivity benefits of Biozest and the reduction in urea discharge, precisely measuring the extent of greenhouse gas reduction falls into the realm of 'public good' science and requires collaboration with our CRIs. The CRI's are well equipped to precisely measure the reduction in pastoral greenhouse gas so that New Zealand can claim the due carbon credits.

Independent review of technologies.

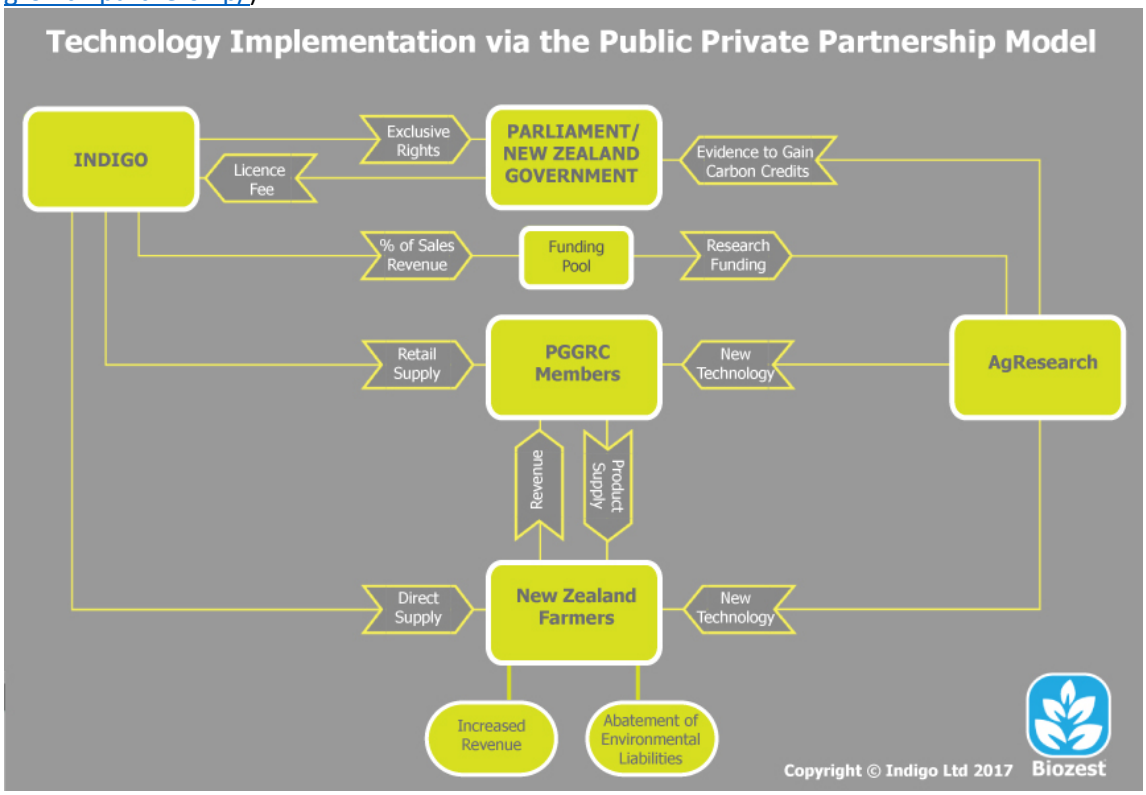
New Zealand must openly and independently assess promising technologies to ensure the agriculture sector has access to the best available technologies quickly.

Public Private Partnership

Due to the scale and urgency of the problem, New Zealand must be open to employing established models, which have been successful in other countries and in other areas of work for public good, such as public private partnership. Other models may also be appropriate but the implementation pathway for technologies developed outside of the CRIs and government funding streams is not clear and may be impeding innovation.

The PPP model is often used to drive projects forward when the scale and urgency of a problem requires a government to seek solutions from private industry. The PPP model has been used successfully in the Nordic region to finance and implement climate related projects: https://norden.diva-portal.org/smash/get/diva2:915864/FULLTEXT01.pdf .

MPI already employs a form of the PPP model: "The Primary Growth Partnership is a joint venture between government and industry" (https://www.mpi.govt.nz/funding-and-programmes/primary-growth-partnership/).



A public private partnership will support wider uptake of the technology and improve the wealth of our farmers and our nation. We can reach the critical mass to make real impact quickly and transparently.

In the model we propose, if applied to the Biozest technology, our government can purchase the exclusive rights to the technology.

In return the government can receive a set margin from sales. This money can be invested by the government in AgResearch to precisely quantify the reduction in (global) pastoral greenhouse gas so that the Government also earns carbon credits. As the combined revenue grows AgResearch could gain funding security based on this income stream. The increased R&D will further improve our farm based economy.

Our farmers will be able to increase their revenue significantly, abate their greenhouse gas liability and reduce the ecological impact of pastoral farming on soil and water. Because Biozest also improves pasture productivity, farmers' reliance on supplementary feed will be reduced, consolidating the pasture fed brand. The members of Greenhouse Gas Research Consortium also can participate in the benefits: Biozest sales through their rural distributor businesses will offer another revenue stream.

This is a commerce based model that is risk averse. A wealth creation opportunity based on proven technology. This is a model to increase New Zealand's wealth, abate liabilities, capitalise on national and international benefits and sustain future technology development. We can be a wealthy country very quickly and consolidate our clean green brand.

Conclusion

We have the technology to address emissions from agriculture.

Reducing emissions will not have a negative economic impact.

Reducing emissions can increase productivity and will have wide reaching, positive, economic repercussions.

The model for implementation exists and is already employed by MPI.

The science that enabled the invention of Biozest is now mature; therefore, we have comprehensive trial data and the science to substantiate all claims regarding improvements in productivity and reductions in emissions.

We now need clear pathway for research, collaboration and implementation of emissions reduction technologies so that New Zealand can immediately benefit both environmentally and economically.

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