# Can Generating Gas and Electricity be the Solution to New Zealand Dairy Effluent Management?

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## *Executive Summary:*

This paper explores the options available to manage effluent within the New Zealand Dairy Industry.

It also clearly investigates why Anaerobic Digestion is not suitable at its current levels of technology to be an option for commercial dairy farms in New Zealand.

- Only 20 percent of the available effluent is collected in the Cowshed
- High costs of substrate such as Maize silage
- Lack of time and skills to manage the running of an AD plant
- Nutrient levels are still maintained using this system

Then it provides some practical, innovative solutions to manage the effluent.

Using 3 key options for integrated management

- Bio Crude manufactured using Algae
- Dung Beetles
- Precision Farming technology

It also challenges those within the industry to support change, and take action to implement the above solutions for the benefit of all those within the industry.

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## *Preface*

Upon deciding on this topic I thought finding a solution would be easier than first expected. I thought a trip to the heart of Europe, the base of the Methane Bio digestion, would solve the problem easily and that a bulk implementation of Anaerobic Digestion (AD) plants would solve the issue and contribute to the supply of electricity. However there were a number of factors that I was either unaware of or hadn't factored in. My basic knowledge of AD plants was that the effluent is put into a capped or airtight pond or tank, collect off the methane, and then somehow convert into electricity. As you can see from this it was very crude and really lacked a lot of detail.

The initial learning I had was the understanding of just how much biomass you actually need to run an AD plant and to produce sufficient amounts of methane.

I do believe that there is an opportunity within Metro areas like Auckland and Christchurch to use this technology. If we could get all the organic waste from the Councils and the waste from food manufacturers you would be able to get something working on an industrial scale that would become economically viable. I witnessed this operating very successfully in both Europe and North America, with a working farm in Massachusetts maintaining an income stream collecting all the Metro waste and running through their AD Plant. Without the waste the plant was uneconomical and unviable.

This was my first indication that things may not be as easy as I first thought. That plant had a capital cost of $3 million and was subsidised under a State scheme to the sum of 50%. They believed without the income from the waste and the 50% investment from the State the financials of the AD plant just wouldn't be worth doing.

Then I thought maybe this was only a situation that impacted on North America, and specific to the capital costs in this region.

I headed down to Brazil where a Sugar-cane bi-product is used to run AD plants. Grounds from Coffee manufacturing are also used but again it seemed clear that this method would not be sustainable under a NZ Dairying model and it would not eliminate the nitrogen content within the effluent.

Feeling a bit perplexed about what I was now starting to see it was becoming clear that I may have to change my initial thoughts and start looking further afield into the area of algae or maybe even microbes. However before then I had to head to Europe, the home of the Biogas revolution and see if I could find an alternative or more innovative solution.

After meeting with a number of highly advanced companies, visiting a number of plants and bio gas sites, I was still really disappointed, and thought I would head to the Biogas international conference and once and for all get some clear direction on the value of AD plants to NZ. During this conference I managed to get a meeting for an hour with the CEO of the International Biogas and Bio-energy Centre of Competence who assured me under current levels of innovation and technology that Bio Gas was not suitable for un-housed New Zealand Dairy systems. There were homemade un-housed systems working around the world but they were not economical. Knowing what I knew about the current electricity situation in New Zealand I could now clearly see that it was not going to work in its current state.

This paper is about what I found including:

- an overview of how Biogas works and why it's not suitable;
- some exciting opportunities that I have uncovered and why I think they are more superior and;
- How they could be used on a commercial dairy farm in NZ.

## *Introduction:*

I believe every New Zealand farmer out there has a desire to leave the land and their farm in a more sustainable condition than when they either brought it or acquired it off their family. This is both from an environmental and commercial perspective.

New Zealand Agriculture is market leading in many areas but the sector that gets the most attention and is the largest exporter is the dairy Industry. Having worked in the industry, raised my children on dairy farms and been part of this industry for a long time now I have seen the development of the exports markets, watched the Dairyboard go and seen the rise of Fonterra. I have also witnessed the growth of corporate farming, the increase in herd size and production, and also a movement to condemn dairying, for their use of resources and perceived money at all cost mentality, and let's not forget "dirty dairying".

It is because of this movement and the lack of unbiased debate that is happening on this topic that I have chosen to try and find some answers or maybe a solution. I think the only reason farmers aren't adopting better methods to manage the effluent is because of a lack of practical solutions that are better than the current methods. I decided that part of my topic was to scour the globe looking for alternative solutions, something that could change this perception, but it had to be simple, scalable and easily implemented by an industry looking for answers.

What I found very quickly was that one of the things that make us the most efficient Dairy producing nation also is one of our biggest problems to overcome. Our grass based system has meant that we have lead the world in our ability to free range our cows in a clean environment but it also meant that we have a nutrient matter that we also have to deal with. Unlike the majority of the world's dairying nations we don't house our cows so we have lesser control over our nutrient management.

This report is opinions, and options that I have learnt while on my journey, it is not a silver bullet but something I think if we have the right people on board, and take an open minded look at what else we can do with our effluent it potentially could be successful. As with lots of these reports sometimes they create more questions than they offer solutions but if we can find one small gem then we can be on our way to an industry wide solution.

## Investigation of Anaerobic Digestion

### What is Biogas?

Biogas is created by the breakdown of organic matter or material during a fermentation process that creates Methane and Carbon dioxide that can be collected and used as a source of energy. This occurs naturally within landfills and can be created using Anaerobic Digestion Plants.

### How does and an Anaerobic Digestion Plant (AD) Work?

An AD plant is an air tight system, either pond or tank, that is oxygen-free and is fed on organic matter, such as effluent, energy crops or food waste. A biological process occurs while this organic matter breaks down which produces methane gas, commonly known as biogas, along with an odour-reduced effluent. Microbes break down manure into biogas and a nutrient-rich effluent.

Photo of AD Plant in Germany

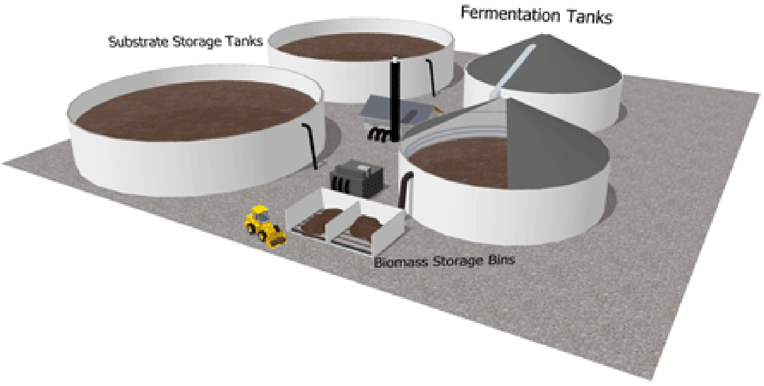
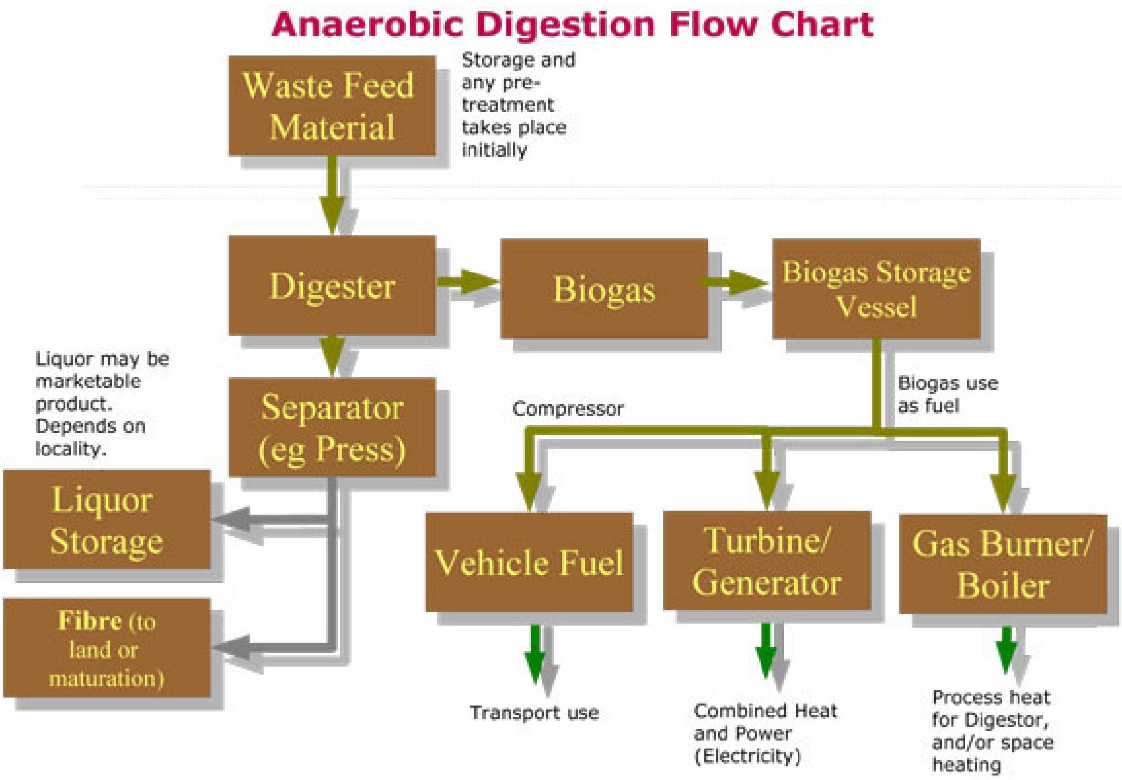



Diagram of AD operation

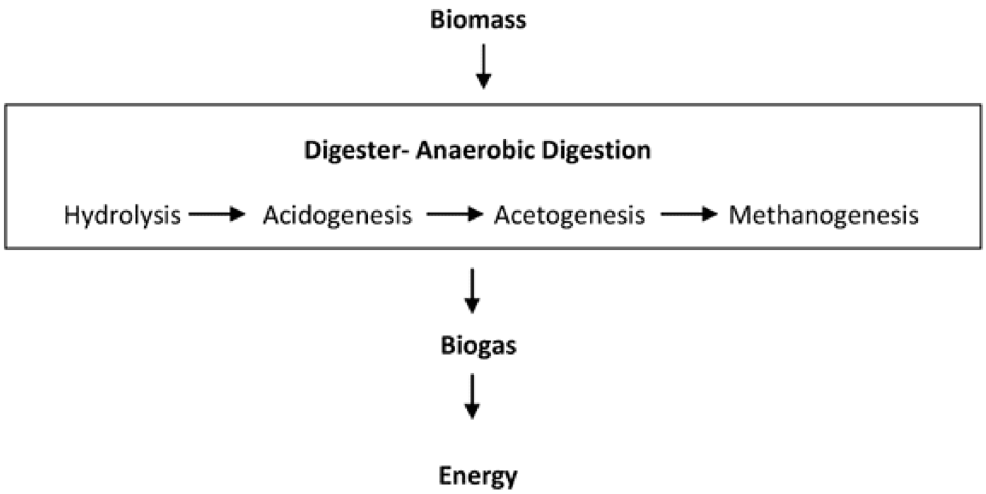
Steps for Anaerobic Digestion – Best described by Michael Biarnes of e-inst.com in his article Bio-Mass to Bio-Gas

"*There are four fundamental steps of anaerobic digestion that include hydrolysis, acidogenesis, acetogenesis, and methanogenesis. Throughout this entire process, large organic polymers that make up Biomass are broken down into smaller molecules by chemicals and microorganisms. Upon completion of the anaerobic digestion process, the Biomass is converted into Biogas, namely carbon dioxide and methane, as well as digestate and wastewater.*




Source: Anaerobic Flow Diagram

### Anaerobic Digester—Fundamental Steps




### Hydrolysis

*In general, hydrolysis is a chemical reaction in which the breakdown of water occurs to form H+ cations and OH- anions. Hydrolysis is often used to break down larger polymers, often in the presence of an acidic catalyst. In anaerobic digestion, hydrolysis is the essential first step, as*

*Biomass is normally comprised of very large organic polymers, which are otherwise unusable. Through hydrolysis, these large polymers, namely proteins, fats and carbohydrates, are broken down into smaller molecules such as amino acids, fatty acids, and simple sugars. While some of the products of hydrolysis, including hydrogen and acetate, may be used by methanogens later in the anaerobic digestion process, the majority of the molecules, which are still relatively large, must be further broken down in the process of acidogenesis so that they may be used to create methane.*

### *Acidogenesis*

*Acidogenesis is the next step of anaerobic digestion in which acidogenic microorganisms further break down the Biomass products after hydrolysis. These fermentative bacteria produce an acidic environment in the digestive tank while creating ammonia, $H_2$, $CO_2$, $H_2S$, shorter volatile fatty acids, carbonic acids, alcohols, as well as trace amounts of other byproducts. While acidogenic bacteria further breaks down the organic matter, it is still too large and unusable for the ultimate goal of methane production, so the biomass must next undergo the process of acetogenesis.*

### *Acetogenesis*

*In general, acetogenesis is the creation of acetate, a derivative of acetic acid, from carbon and energy sources by acetogens. These microorganisms catabolize many of the products created in acidogenesis into acetic acid, $CO_2$ and $H_2$. Acetogens break down the Biomass to a point to which Methanogens can utilize much of the remaining material to create Methane as a Biofuel.*

### *Methanogenesis*

*Methanogenesis constitutes the final stage of anaerobic digestion in which methanogens create methane from the final products of acetogenesis as well as from some of the intermediate products from hydrolysis and acidogenesis. There are two general pathways involving the use of acetic acid and carbon dioxide, the two main products of the first three steps of anaerobic digestion, to create methane in methanogenesis:*

$CO_2 + 4\ H_2 \rightarrow CH_4 + 2H_2O$

$CH_3COOH \rightarrow CH_4 + CO_2$

*While $CO_2$ can be converted into methane and water through the reaction, the main mechanism to create methane in methanogenesis is the path involving acetic acid. This path creates methane and $CO_2$, the two main products of anaerobic digestion".*

So you can see that it is actually quite an in-depth scientific process that creates a lot of volatility and requires a fair amount of know-how.

Anaerobic digesters were originally designed for operation using sewage and manure. Unfortunately this is not the most economical use of an AD. The problem is that by the time the sewage or manure is collected most of the goodness has been consumed inside the gut. Therefore most AD plants use more than just manure; they use either high sugar crops such as maize or silage, or other specific energy crops in conjunction with the sewage or manure. In a Dairy based system, where dairy effluent is the main source of energy, using maize silage significantly increases the production of gas. Manure based systems are cheap but they do not produce anywhere as much gas. It is understood that adding 30% substrate of maize silage to the system will increase the gas production by over 10 times.

This is initially where we begin to see the flaws associated with the use of AD's in New Zealand, where the cost of substrates such as Maize silage would be in the region of $400 per/ton. Compare this with the €35 cost in Germany and the situation looks very different.

Also, the fact that New Zealand uses a grass based system essentially means that our cows only produce 20% of the effluent in the cowshed where it is collected and the rest is either on stock races or in the paddock. As such the input source is very limited.

Once the different sources are mixed, water is added if required and then it moves into the digester. Within the digester the bacteria bubble away consuming the sugar, protein, fats, and carbohydrates. The mixture must be monitored to ensure it is all maintained at the most efficient state to produce the most biogas.

This is the next area of the process where I see problems for the mass adoption of AD plants in New Zealand. All the plants that I visited required a skilled operator to monitor and regularly sample the feedstock quality, the bacteria performance within the digester and the outgoing gas quality. If these aren't monitored you will have a poor performing digester not creating good quality gas or you could blow your digester apart and leak highly toxic gas and greenhouse gas straight into the atmosphere. I don't think many Dairy farmers would currently have the skills or the inclination to sit at a computer and have an alarm systems going off while they monitored their digesters, when many would get better financial performance from spending more time on their business. I know this debate is not just an economical one; however I feel New Zealand doesn't need the Health and Safety issues associated with this system. Not to mention the global reputational damage that the risk of explosion to an AD Plant and impact to the environment that this would have.

This leads on to the next step which is the Methane product and the digestate remaining. During this process I was hoping to find a system that would eliminate the nutrient levels within the effluent, therefore developing a system that would lower the nutrient pressure on the land, as well as either breaking even financially or creating another income stream. Unfortunately during the anaerobic process there is very little if any nutrient loss so all the nitrogen and phosphate are still in the digestate. This of course would make a wonderful fertiliser if it could be utilised by the farmer or neighbors. The waste water also needs to be managed so, from a management perspective, we are back at square one with regard to managing effluent, and it may be easier and more controlled to continue to spread it on the paddock as in traditional methods, however there would be a reduction in the odour created from the digestate.

To debate these options further I spent some time with Harro Brons, the International Sales Manager for German company WEL TEC BIOPOWER and we discussed trying to develop an option that would work for the New Zealand grass based production system

This is what he came up with as a potential option:

*"As a starting point, we take a current 1000 cow dairy farm on 400 ha, pasture based (avg 2.5 cow per ha). This kind of farm has little to no control on nutrients/nitrogen put on the land, as the cows are walking around.*

*The cows are walking long distances every day, which has a negative effect on the milk production. One result of little nutrients control and management is that less energy is present in the grass for milk production.*

*We can take the above example and turn it in to the following:*

*We increase the number of cows from 1000 to 1200, so a 1200 cow dairy farm. We built a 600 cow herd home/stable, based on a 12 hour rotation (so 600 cows inside for 12 hours, then the other 600 cows inside for 12 hours)*

*We split the 400 ha in 3 sections:*

*Section 1* *200 ha for the outside 600 cows (avg of 3 cows per ha)*

*Section 2* *105 ha for growing feedstock for the herd home/stable (grass, maize or high energy crops)*

*Section 3* *95 ha around waterways/lakes/rivers etc for growing miscanthus (elephant grass) to supply the bio energy plant.*

*By taking the 40% of the cows from the land and growing a non-fertilizer crop around the waterways we are able to reduce the nitrogen run-off/leaching by close to 50%.*

*And by putting the 600 cows inside we are able to achieve an increase of 5% in the milk production.*

*So in short, we can milk/farm more cows on the same farm, increase the milk production, and look after the environment by decreasing the nitrogen problem by 50%.*

*Furthermore, the farm can be self-sufficient in their energy, heat and fertilizer needs."*

As you can see from this example it is more environmentally sound but there are some issues associated with this system.

My thoughts are under our current Resource Management Systems consent would be required to keep the cows inside. There would be a large increase in staffing costs and cropping and cartage costs. Yes there maybe some increase in Milk production, but if irrigation is required to grow crops there will still be considerable requirement for electricity. The cost associated with purchase of the AD plant and building and maintenance on the Herd Home would also need to be taken into consideration.

Elephant Grass

*Source: MPI Website*

Also Elephant Grass is classified by the Ministry for Primary Industry as a pest.

## *Financials:*

This is an area where I see the AD Plant in New Zealand will really struggle. Currently in most areas of the globe that I toured there is a big push on renewable generation. Therefore there are green electricity tariffs which subsidises the value of every kilowatt hour (kWh) exported to the grid or in some cases just produced and consumed. In the UK examples of this are Renewable Feed-In Tariff and the Renewable Heat incentives. There are also especially large capital build subsidies most in the vicinity of 50% of total costs. Most AD's that I visited had a capital cost of between $750,000 - $3 million.

Even in some of these cases these projects are still exceptionally marginal and more require an attitude of “making a difference”, than commercial viability. Very recently there have been changes to the green policies within Germany and this has seen a huge drop in the potential of biogas and AD plants. It is believed that less than 200 plants will be built this year where as in the past there has been 1000's built to take advantage of the ‘green' financial climate.

In New Zealand we are also finding a lowering in demand of electricity, therefore we are seeing the export price of any produced electricity dropping accordingly. The most efficient use of any on-farm generation opportunity (solar, wind or micro-hydro) is to ensure you consume all the electricity yourself therefore lowering costs further by covering the retail cost of the electricity rather than earning wholesale market pricing.

Once again this only taking into account the capital cost and return on investment, the costs of operating, feeding and managing AD plants is very costly and time consuming.

I struggled to get people to discuss their financials around these options; however those that have contracts to take in Metro waste or food waste were happier to discuss. While those who were using crops appeared to be a little less helpful. I will let you draw your own conclusions on this.

There is a vast amount to read online about the different opinions on the commercial viability of AD plants and I would encourage anyone interested to read through them, however my stance is that I don't think it stacks up for a New Zealand model in its current state. I would be looking for some innovation changes in the future to reconsider this as an option.

A back to back corporate farm, which had 15,000 cows or more un-housed with all cowsheds feeding into the one area and using metro organic or food waste as a substrate, may be viable in the long term, but that doesn't represent many farmers in NZ currently.

Wel Tec Plant, Germany

At this point, as far as my original topic is concerned, my conclusion is that creating Gas and Electricity is not the solution to New Zealand's dairy effluent management issues.

It would be a very short topic if I finished here, but with a passion and drive to make a difference to dairy effluent management in New Zealand I decided to take another direction, one I believe merits closer consideration and I think could be adopted to change the perception of how dairy farmers are viewed in terms of managing cow waste.

### *If not Biogas then what next?*

Bio – Crude:

I believe that there is the potential in New Zealand to use dairy effluent to grow algae that can be turned in to Bio – Crude or synthetic crude oil. The technology has been developed by the Department of Agricultural and Biological Engineering, at the University of Illinois, using pig manure and preliminary results have proved to be successful.

I believe that we can develop on-farm effluent ponds that will allow for the growth of the algae while also managing the manure created in our current New Zealand Dairy production systems.

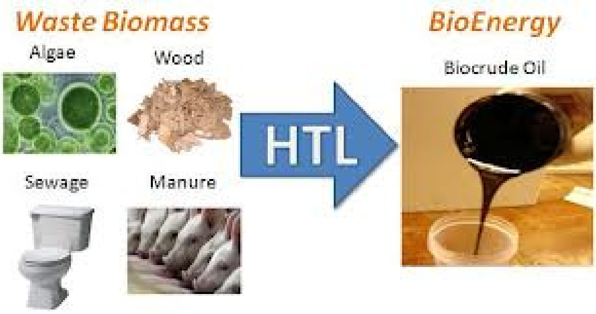



Image University of Illinois

### *So how could it work?*

Algae are plants that are can be either microscopic through to very large, such as seaweed. Algae can be grown in either sea or waste water, including dairy effluent.

The best thing about algae in this system is that it feeds off the nutrients in the waste, which treats and purifies the water. Basically the algae grows using basic photosynthesis, using sunlight, $CO_2$ and other nutrients, including Nitrogen and Phosphorous, into a useable biomass. There are also algae that can grow in the dark or in colder temperatures by using the sugars and carbohydrate present in the manure, however this requires further investigation.

Based on this I believe algae production could be the most promising long term solution to the dairy effluent , as well as providing the opportunity to make NZ more self sufficient with regards to fuel. Imagine the day when we can run Fonterra tankers on an Algae derived bio diesel. This is possible and what an amazing marketing story.

### *Algae have many associated benefits:*

- It stores energy in the form of oil, and it does this more efficiently than any other natural or manmade process.
- It grows fast: microalgae plants can double their numbers within hours can be harvested daily if required, and have bio fuel potential far greater than other bio-fuel crops.
- It stores energy in the form of oils and carbohydrates so can produce large amounts of bio fuels comparatively easily. The bigger the pond the more algae to create more fuel, the more return on investment.
- Algae consume the nasties that we are trying to manage - $CO_2$, nitrogen and phosphorus – and releases large amounts of oxygen into the atmosphere.

Hand full of Algae
*Source: Algae basics.com*

Not a bad story so far, but how will it work on farm?

Changing our current effluent pond systems, making them shallower and bigger, and using a waterwheel or pump to aerate the water would provide a better algae growing environment. There would be no other requirement on farm initially.

We would also have to consider regional collection facilities initially. Some corporate operations would have the scale to produce their own bio-crude on Farm but small operations would be collected as if it was milk or bobby calves and paid accordingly. Focusing on areas such as Waikato, Northland, Taranaki, Canterbury, West Coast and Southland where we could base the processing plants would be useful.

Then, using current NZ technology, through the use of pressure and heat we can create the bio-crude oil. Solray Energy has developed the Super Critical Water Reactor (SCWR) technology to convert algae and other biomass sources into crude bio-oil. In it the water-algae mixture is heated under pressure until the complex organic molecules break down into simple hydrocarbons, which then separate out as bio-crude.

The technology also has great potential to degrade toxic organic compounds to harmless residues. A major break-through is the development of a continuously-fed reactor system which is significantly more energy efficient. This technology is currently available and could be easily scaled to deal with the large numbers of dairy farms nationally.

A co-operative model similar to that of the old "DairyMeats" would mean everyone would benefit from the technology, and then the co-operative would be tasked to continue improving and driving the technology. I'm sure companies like Z Energy would be interested in purchasing this product if it was successfully implemented.

This algae technology was being trialed in human sewage by NIWA prior to the Christchurch earthquake. Of course dealing with sewage from 300,000 is slightly different from managing the effluent from 300 – 1000 cows but basically the theory is the same.

During the Bromley trial in Christchurch, they used a low-cost gravity harvesting method.

*Photos and information kindly supplied by Chris Bathurst from Solray Energy.*

Ivar and Sophie, two engineers at Solvent Rescue, showing algae oil samples. On far left the high rate ponds growing algae. Ivar is holding crude oil made from the Algae. Sophie in holding Petrol Distilled from the crude oil.

The Construction Engineers, Ross Beal and Chris Austin holding samples of Oil while behind them the end of the high rate ponds and the simple algae harvesters.

Inside the reactor shed showing the reactor tubes where Algae is converted to crude oil hydrocarbon at high pressure and moderate temperature

### *Where to from here?*

I'm currently in discussions with a couple of farming organisations that are undergoing a number of new farm conversions, and I think the next step needs to be a full commercial trial to prove that it works on farm not just in a bath tub trial. Putting in a trial site at the beginning of a new conversion will give us some insight into the cost to retrofit and allow a low cost trial option.

My goal is to have something that farmers can walk round and see working. To get confidence that it can work before having to invest in the technology. Funding from government, organisations such as Dairy NZ and Fonterra or any other company committed to the long term global success of NZ agriculture would be required to progress these new technologies.

Okay so now we have dealt with about 20 percent of the problem, even though, in my opinion, it is the most challenging from a public perception point of view…how do we deal with some of the rest?

## *Dealing with the waste in the paddock:*

### *Dung Beetles:*

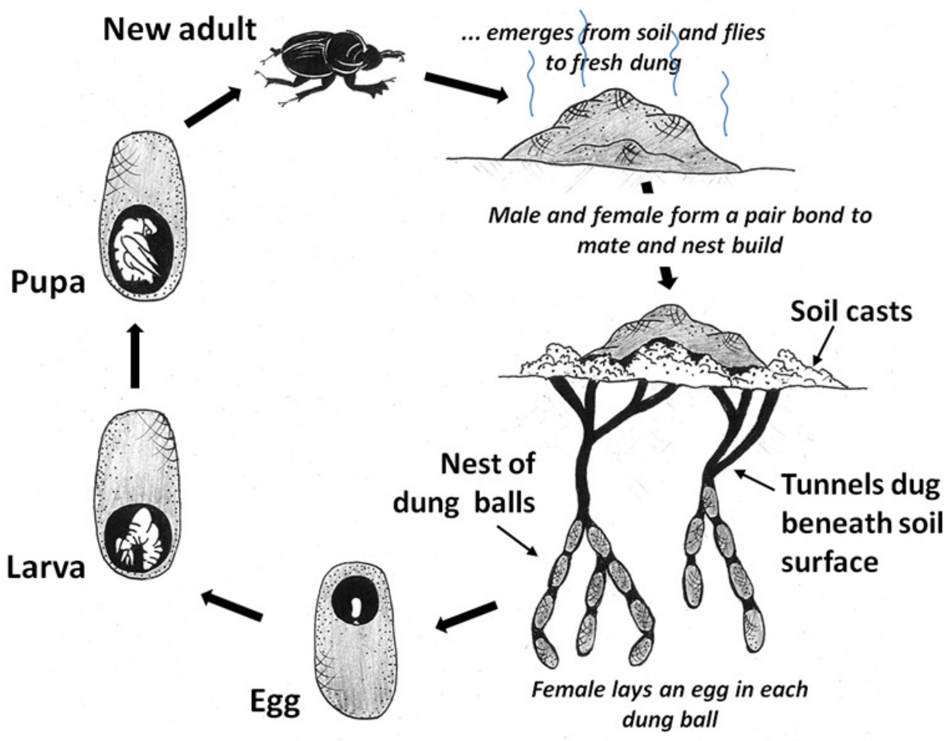
Currently a dung beetle trial is being undertaken in New Zealand by Landcare Research and following contained trials the beetles have been released on commercial test farms in Southland and the Wairarapa. The DBRS Group was established by a group of farmers and other interested parties in 2008 with the objective of importing and releasing dung beetles to assist with the removal of pastoral dung of agricultural livestock. As part of that process Landcare Research was contracted to supply science and technical support.

On the Landcare Research website they describe how the trials work and what they are trying to do: *Permission to import and release 11 additional species of dung beetles was received from the Environmental Risk Management Authority (now EPA) in February 2011 and the beetles were initially held in containment at Landcare Research until given disease clearance by the Ministry for Primary Industries. Once released from containment in 2012 dung beetles were mass reared at both Landcare Research's campuses in Lincoln and Tamaki. Some caged field trials were also undertaken to test how the beetles might perform.*

*Dung beetles search out the faeces of animals which they use for food and reproduction. The species being introduced to New Zealand make tunnels in the soil beneath the faeces which they then bury to lay eggs in.*

*Dung pad being broken down by beetles*

*Source Wikipedia.com*




*Source Tolweb.org*

Diagram of dung beetle lifecycle

*As the eggs hatch the grubs feed on the dung, breaking it down and eventually turning it into a sawdust-like material that adds to the fertility of the soil structure while getting rid of dung sitting on top of the ground.*

*As the eggs hatch the grubs feed on the dung to grow and develop into new adults. Remaining dung is utilised by earthworms and microorganisms in the soil that make the nutrients available for uptake by grass roots. Buried dung has been shown to increase earthworm numbers, increase soil fertility, improved soil structure, and increase the depth at which grass roots grow. Consequently grass becomes more droughts tolerant. At the same time dung beetles get rid of dung sitting on top of the pasture reducing forage foul and forage avoidance around dung.*

*While dung decomposes naturally, intensive farming means large amounts of dung are dropped which can lead to environmental problems such as leaching of nutrients into waterways and reduced pasture production because of increased forage fouling.*

In Australia Dung beetles have been used successfully for a number of years, they were introduced in 1965 during a project run by Dr George Bornemisszc. The main outcome of the project was to eliminate the wastage created by the fact cattle won't graze the fowled grass around dung pads, and also to provide a way for the nutrient to enter the soil and prevent it from running into the waterways when it rains through run off and it also has the added benefits of controlling some parasites in livestock.

### *What are dung beetles?*

Dung beetles are beetles that feed exclusively or partly on faeces. There are thousands of species of dung beetles. They belong to three basic groups: rollers, tunnelers, and dwellers. Those words describe how these beetles use the dung they find.

The rollers shape pieces of dung into balls and roll them away from the pads. They bury their ball to consume later or to use as a place to lay their eggs. Tunnelers bury their dung by tunneling underneath the pads, and dwellers actually live inside dung pads.

Dung beetle on dung ball
Source 6legs2many.wordpress.com

The undigested food in the dung pads is what the beetles live on. Dung beetle larvae eat the solid dung while adult dung beetles stick to liquids. There are thousands of species of dung beetles worldwide that belong to several varieties, including the variety of Scarabaeidae and the Geotrupidae variety.

Dung beetles range from a length of 0.04 inches (1 millimeter) to 2.4 inches (6 centimeters)

They can live for up to 3 years, they have six legs for rolling and burying and unlike our native New Zealand beetles most have wings and can fly.

Dung beetles are part of nature's clean-up crew. By eating and burying animal waste, these beetles recycle nutrients into the soil. They also bury waste that might otherwise attract pests such as flies. On a good night a dung beetle can bury 250 times its weight in dung.

It is believed that at any given time there could 700,000 ha of grazing land covered in dung in New Zealand, which gives a sense of the potential benefits of using dung beetles.

### *Benefits of Dung beetles:*

- Better soil health and structure and less leaching, through better retention of waste in soil and reduced runoff due to rain
- Increased Pasture efficiency, better nutrient recycling and livestock will graze more of the pasture available due to lack of fowling
- Less worm burden from parasites, dung beetles kill eggs and larvae of worms, the dung pads dry out faster killing them also, and they are buried deep below the soil even if they do survive the other two threats.
- Reduced Flies, flies that breed or use the dung as nutrient, struggle to compete with the dung beetles.

There is a large amount of reading available on the subject, and would encourage anyone interested to take a look, again I believe this is another solution that will ultimately make the management of our waste and effluent more sustainable and easier to look after.

Now the third area that I would like you to consider with regard to Effluent management is what do we do with the urine patches that are high in nitrogen?

***Urine Patches:***

This is a very challenging issue. It is believed that the average cow when it urinates releases the equivalent of 800 – 1000 kg of nitrogen per hectare, in the area where the urine lands, so about the diameter of a bucket. When the average farmer applies around 200kg of Nitrogen per hectare per year over a number of small applications, you can begin to understand the scale of the problem. This is approximately 8 to 10 times the amount of nitrogen that a plant can absorb and then the rest seeps through the soil and if not utilized in the plant becomes nitrate when it attaches to water molecules that eventually can make its way into the waterways contributing to nitrate leaching. The root depth and soil types can vary which impacts on the amount of nitrate that passes the root system. During winter periods or times of high rainfall this problem is worse than dry hot periods in summer.

***What can we do about it?***

While away on my travels I came across a number of different precision farming technologies. Having been exposed to the benefits that precision irrigation can make on electricity and water usage in a number of cases, I was very interested to see if any of these technologies would have value to my topic.

Whilst at CIMMYT, The International Maize and Wheat Improvement Center, in Mexico; I was introduced to the Greenseeker technology - a handheld device that measured the amount of nitrogen in a paddock and then using mapping and GPS systems, would apply only the required amount of nitrogen in the right place. This was saving the farmers large amounts of nitrogen and also meant there wasn't a huge amount of wastage, benefiting both the environment and the profitability of the crop.

This got me thinking about if it would be valuable to use similar technology to reduce the risk of nitrate leaching by only applying nitrogen to the spots not previously covered by urine or dung.

On investigating further I discovered that fellow Nuffield scholar Craige Mackenzie has developed a tool which is similar but only better that can do this, It's called Smart-N and has been developed and marketed through Agri-optics in Methven, Canterbury

Using precision techniques the product is capable of avoiding the urine and dung spots and even applying inhibitors to these patches instead, while fertilising on the areas that need it. This is an outstanding new technology and even though it may not solve the initial problem it will reduce the waste and amplification of the problem by over fertilising of these areas

Currently the Tasmanian Institute of Agriculture is running a project to identify the benefits of this technology.

## *Conclusion:*

As I mentioned earlier I believe I have listed some technology that could change the face of New Zealand Agriculture in the near future, but my challenge is for us to give them a go. Get behind them and openly look to improve where we currently are. Far too often we hear of great ideas that are rubbished or dismissed as being just that little bit too hard to implement, but I want to see some change.

I have written this paper not to identify issues but rather to help identify solutions but I need a number to get behind them, prove they can work, or help pinpoint where improvements can be made and let's get some action.

Nutrient management is being challenged globally and it is vital that New Zealand take the lead around this area. We have a wonderful product and we don't want to see it being blocked in certain parts of the globe because of a perceived or created issue.

So if you take anything from this paper please consider these thoughts:

1. Algae technology is exciting and could offer a commercially viable solution to managing our effluent disposal issues. You could be driving a car powered by your farm effluent and current business models indicate that you might just make a nice profit along the way.

2. Dung beetles, the trial is underway, they are present everywhere else in the globe and work hand in hand with pasture eating livestock. Yes lets be careful what we introduce to this country, but cattle were introduced originally also.

3. Precision technology is alive and well, and will continue to offer solutions where we can avoid or identify changes in nutrient and soil type. Let's adopt this as common farm practice and make smarter use of all our resources.

Thank you for taking the time to read my paper. I am more than happy to discuss any ideas, challenges, and opportunities further. I can be contacted by email at natasha.king@meridianenergy.co.nz.

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