Improving Farm Dairy Effluent Management!

Compliance or Best Practice?

Peter Walters
Kellogg Rural Leaders Project
11/11/2010
## Contents

**Executive Summary** ................................................................................................................................. 5

1  Introduction .................................................................................................................................................. 8

2  Background ............................................................................................................................................... 10

3  Industry Initiatives ..................................................................................................................................... 14

   3.1  The Clean Streams Accord ................................................................................................................ 14

   3.2  Fonterra Effluent Improvement System (EIS) ..................................................................................... 14

   3.3  Fonterra - Every Farm Every Year ....................................................................................................... 15

   3.4  Dairy NZ – Effluent Warrant of Fitness .............................................................................................. 15

   3.5  Regional Councils – Pond Storage Calculator .................................................................................... 16

   3.6  Education and Effluent Field Days ...................................................................................................... 17

   3.7  Private Business Projects .................................................................................................................... 17

4  Farmer Feedback ......................................................................................................................................... 18

   4.1  Sampling ............................................................................................................................................. 18

   4.2  Purpose ................................................................................................................................................. 18

   4.3  Results/Discussion .............................................................................................................................. 19

      4.3.1  Herd Size and Region .................................................................................................................. 19

      4.3.2  Farm/Herd Size .......................................................................................................................... 20

      4.3.3  Effluent Systems and Storage ....................................................................................................... 21

      4.3.4  Effluent as a Fertiliser .................................................................................................................. 22

      4.3.5  Effluent System Investment ......................................................................................................... 23

      4.3.6  Advisory and Regulation ............................................................................................................. 25

      4.3.7  Effluent Improvement Scheme (EIS) .......................................................................................... 26

      4.3.8  Tougher Penalties? ....................................................................................................................... 27

      4.3.9  Industry Performance and Perception ......................................................................................... 28

5  Recommendations ....................................................................................................................................... 30

Appendix 1 ...................................................................................................................................................... 32

Appendix 2 ...................................................................................................................................................... 33

Appendix 3 ...................................................................................................................................................... 35

References ........................................................................................................................................................ 36
List of Tables

Table 1: Compliance Statistics for the Waikato Region for the Years 2007/2008 to 2008/2009 ........ 11
Table 2: Table Showing the Relationship between Herd Size and System Type ............................. 20
Table 3: Table Showing Number of Participants and who they think should Regulate and Advise
Regarding Effluent Management ..................................................................................................... 25
Table 4: Table Showing Responses to Industry Performance Questions ........................................ 29

List of Figures

Figure 1: Chart Showing Reasons for Significant Non-compliance in the Waikato ......................... 11
Figure 2: Cyanobacteria (blue-green algae) bloom Lake Rotorua. Photo courtesy of David Burger... 12
Figure 3: Chart Showing Sample Proportion by Regional Regulator .............................................. 19
Figure 4: Graph Showing the Number of Effluent Systems and Associated Storage ..................... 21
Figure 5: Flow Chart Showing Effluent Value in Dollars ................................................................. 23
Figure 6: Chart Showing Reasons for Recent Investment .................................................................. 24
Figure 7: Chart Showing Respondents Preferred Funder of Regulatory Activities ......................... 26
Executive Summary

The dairy industry provides a significant contribution to the economic and financial well being of all New Zealanders. In order to produce milk profitably a dairy farmer must manage the resources at his/her disposal as efficiently as possible. Effluent captured from standing areas around feed pads and farm dairies are essentially a free source of nutrients that can be applied to the land in lieu of fertiliser.

Although New Zealand has a very high standard of water quality compared with international standards, the pressure on water quality is becoming increasingly significant as land use intensifies. The high profile nature of the dairy industry and the 'dirty dairy' campaign has put a lot of pressure on regulators and farmers alike. Regional councils through the RMA (Resource Management Act) are responsible for protecting water quality. Other industry organisations are assisting with extension resources and inspections. Fonterra is implementing the ‘every farm every year’ triage inspections and together with Dairy NZ are implementing advisory roles to farmers. Regional Councils have developed a storage calculator in conjunction with Massey University to enable the most suitable amount of storage for different systems and soil type. Environment Waikato (EW) and other Regional Councils have also supported projects by private organisations as they develop technology to enhance the efficiency and utilisation of dairy effluent onto the land.

With almost a third of New Zealand’s dairy industry the Waikato region is the most intensively dairy farmed region. The results of EW compliance monitoring are providing some concerning information regarding the performance of dairy effluent management, in particular the increase of significant non compliance of permitted activity land application, rising from 7.5% in 2007/2008 to 15.7% in 2008/2009. Approximately 90% of Waikato farmers currently apply effluent to land; many farmers are confused or sceptical that rules relating to compliance and the interpretation of these rules can lead to non-compliance with a system that’s design and management were once compliant.

The average farm owner has had to evolve their effluent system as rules governing the treatment and disposal of dairy farm effluent has changed over time. Results from the survey are indicative that there is a change of attitude from most farmers in respect to dairy farm effluent and how it is best utilised. With 72% having recently or are planning to invest more
into their systems; of this 72% only 11% are motivated by compliance, indicating that the majority of respondents are targeting a best practice philosophy when managing dairy effluent.

Economic drivers are an important factor to changes in attitude, 96% of respondents believe that dairy effluent is an economic source of nutrients when applied as a fertiliser. Farmer’s reputation and ability to maximise value from the consumer is a significant factor in determining behaviour change. The results from the survey are indicative that the majority of respondents believe that the industry is making progress with effluent management but that more progress is required. This is supported by the 76% of respondents that thought that New Zealand’s dairy effluent management can affect its reputation and hence product sales. This is reinforced by the marketing research conducted in the US stating that 72% of affluent consumers are willing to pay a premium for food that is produced sustainably and is safe.

The argument for more carrot or more stick is still alive. The opinions of the farmer participants were reasonably split with 40% thinking that tougher penalties would be effective at improving the performance of those that mismanage dairy effluent and 44% believing that the opposite would be true. A further 16% were unsure. However 68% of respondents thought that a scheme where fines can be relieved to improve system design would have a positive effect on the rate of non-compliance. It seems from a farmer’s perspective at least, a combination of carrot and stick methods will always be required to improve compliance rates regarding effluent management. The possibility of fine redemption or release could be considered on a case by case basis.

All but one respondent believed that dairy effluent was an economic source of nutrients, indicating that attitudes of farmers regarding dairy effluent is moving away from it being a waste product to being a resource that can be utilised in lieu of fertiliser. Regulators would be wise to use more tools from the tool box, the conclusions drawn from the Waikato and Sheperton report would go a long way to gaining farmers trust. Regulators need to be seen to be operating in best interests of the environment and the public. Waving the big stick around is not the only solution although it needs to be there for those that are deliberately discharging nutrients into waterways and/or those that are repeatedly failing to manage their effluent appropriately. For those farmers that are struggling with a non-compliant system that is not
applying the nutrients in a beneficial manner, a carrot/stick combination ensuring that investment is compulsory would be the most effective. Providers need to be providing systems that are up to task. Farmers need to have confidence that once a system is installed the nutrients are going to be applied in an efficient manner that allows the soil to absorb them. Combined with good advice that is consistent from all industry organisations and tools such as the pond size calculator and developing technology that identifies the appropriate time and amount of application, significant non-compliance and dirty dairy can be sent to the history books.
1 Introduction

Dairy effluent and how it is managed has been the cause of much frustration and reputational damage of the dairy industry within New Zealand. As a farmer representative on the Waikato executive of Federated Farmers I became very concerned with some comments that I had received on this topic. These ranged from “We’ve been discussing this for the last 10 years and we will probably be in the same position in another 10 years” to on the more positive side of “If more farmers learned how to harness the potential of these nutrients they could save a lot of money and reduce their environmental impact all at the same time”. How we bridge this gap has been a question many have asked but none have answered.

The average age of New Zealand dairy farm owners is now 58 years. Assuming that most of these farmers have farmed most of their working life, these farmers have seen the rules regarding how to manage effluent change markedly over the years. Such systems range from no system (straight to water way) in the 1970’s; to barrier ditches; to 2 pond oxidation systems in the 1980’s; to small sump and pump to land in the 1990’s till now; to the current advice of large storage with pump to land. The result is that many are sceptical and cynical that investment to become compliant today will only require more investment to become compliant in a few years time.

The industry has seen a lot of change with regard to effluent management with little to no consultation with the very stakeholders that are required to achieve a successful outcome. Nothing is more frustrating than being told that you are non-compliant or you are breaking the law, often when trying very hard with systems that are perhaps not up to task. People and farmers in particular tend to pride themselves on the results they obtain from their efforts regardless of what the task is. Subsequently for some if there is confusion on what the rules are, or the rules are too hard to adhere to, the likelihood of ‘cheating’ in order to remain ‘compliant’ is possible. It is for this reason that compliance as a term or objective is fundamentally flawed and the likelihood of 100% achievement is slim at best.

As a dairy farmer I see the benefits of dairy effluent nutrients in relation to growing grass or any other forage crop. The world has changed a lot over the last 20-30 years, for that matter the last 3-5 years, gone are the days of ‘cheap’ fertiliser. Food production is now a global concern and hence the demand for mined nutrients is ever increasing. It is now logical to re-use those nutrients that are easy to capture and store and apply them to the land in lieu of
some of the nutrients that were formally purchased and applied. How these captured nutrients are applied can vary markedly and as a result the response to or utilisation of these nutrients by pasture varies also. The rules around compliance are supposed to enhance the ability of the soil and the plant to utilise these nutrients, however as I have mentioned compliance carries some negative connotations, not to mention that there is no such thing as a one size fits all recipe with regard to soils and climate within a single region let alone from one region to another. I believe that more focus on a ‘best practice’ philosophy will result in a more concerted effort by many dairy farmers, compliance then can become a welcome by product.

Although dairy effluent management is a national issue the Waikato region accounts for 31% of all dairy farms representing 26% of the national dairy herd (New Zealand Dairy Statistics 2008/2009, LIC and Dairy NZ). How the farmers and regulatory body (Environment Waikato) address this issue is monitored by other regions in New Zealand. Furthermore according to the recent Clean Streams survey data, the Waikato region has shown an increase in the level of significant non compliance. For this reason a large amount of the resource in this report is focussed on the Waikato region although most, if not all, can be related to the country as a whole.

The purpose of this study is three-fold. The first is to investigate how it is we have got to this stage that we are at now, i.e. increasing levels of non compliance throughout the country. The second is to investigate what is being done by industry organisations to rectify the situation and the third is to obtain a farmers view on effluent best practice and the relationship this has with compliance.

To achieve the third aim, a survey was conducted with the aim of getting responses from a wide range of dairy farmers. The purpose was to ascertain the type of system; whether or not each farmer felt it required more investment to become compliant or simply to be improved for better nutrient management. It was also designed to gain an understanding on farmer’s perspective in relation to who should regulate, monitor and provide advice on effluent system design and management. The survey also investigated how participants thought the industry was doing and whether the environmental performance of the New Zealand dairy industry would affect the sales and reputation of our products to our global customers. All of these factors will most likely have a significant influence on how behaviour is likely to change from those that make the investment.
2 Background

New Zealand and its dairy industry have a clean green image internationally. However here, within New Zealand, the public perception of dairy farming is quite the opposite. There can be no argument that human activity of any kind has an environmental impact. In New Zealand agriculture is regarded as the 'back bone' of the economy. However dairy is the most intensive form of livestock farming in New Zealand, particularly with respect to nutrient use and hence nutrient losses into the environment. Although point source nutrient losses from areas such as effluent holding and application facilities are only part of the overall nutrient picture, it is a very visual example of nutrient management to the general public.

The population of New Zealand is now split 14% rural areas and 86% urban (Compendium of New Zealand Farm Facts), this contributing to the perception that nutrients from the dairy industry are largely responsible for the degradation of this nation’s water ways, despite the fact that a recent newspaper article has stated that New Zealand has the second cleanest water ways in the world behind Iceland (Dominion Post, 2010). To put this in perspective New Zealand has the cleanest waterways of any country with a significant dairy industry. Also dairy exports account for over a quarter of all manufactured exports and contributes approximately 7.5% of GDP. Nevertheless this has transferred into a very public and damaging ‘dirty dairying’ campaign which over time will affect the image the New Zealand dairy industry enjoys around the world. However public pressure on the dairy industry seems justified when taken in the context of published statistics.

Environment Waikato statistics (Table1) have shown that the percentage of farms that irrigated effluent to land in the region that were fully compliant declined from 52.6% in 2007/2008 to 48.6% in 2008/2009. Perhaps of more concern was that the percentage of farms that showed significant non compliance doubled from 7.5% to 15.7% during the same period. Furthermore of those farms that have consent to discharge treated effluent into a waterway only 11.5% of farms are fully compliant and 37.5% are significantly non compliant.
Table 1: Compliance Statistics for the Waikato Region for the Years 2007/2008 to 2008/2009

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Farms applying effluent to land as permitted activity</td>
<td>4083</td>
<td></td>
</tr>
<tr>
<td>No. Farms assessed</td>
<td>626</td>
<td></td>
</tr>
<tr>
<td>% farms fully compliant</td>
<td>48.6%</td>
<td>52.6%</td>
</tr>
<tr>
<td>% farms high level of compliance</td>
<td>22%</td>
<td>27.1%</td>
</tr>
<tr>
<td>% farms partial compliance</td>
<td>13.7%</td>
<td>12.8%</td>
</tr>
<tr>
<td>% farms significant non-compliance</td>
<td>15.7%</td>
<td>7.5%</td>
</tr>
<tr>
<td>No. Farms discharging effluent with resource consent</td>
<td>574</td>
<td></td>
</tr>
<tr>
<td>No. Farms assessed</td>
<td>157</td>
<td></td>
</tr>
<tr>
<td>% farms fully compliant</td>
<td>11.5%</td>
<td>11.4%</td>
</tr>
<tr>
<td>% farms high level of compliance</td>
<td>26%</td>
<td>34.3%</td>
</tr>
<tr>
<td>% farms partial compliance</td>
<td>25%</td>
<td>21%</td>
</tr>
<tr>
<td>% farms significant non-compliance</td>
<td>37.5%</td>
<td>33.3%</td>
</tr>
<tr>
<td>Infringement notices issued for non-complying systems</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Abatement notices issued for non-complying systems</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Prosecutions for unlawful discharge of FDE</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>


Reasons for these results can be varied (Figure 1). For land application common causes of significant non compliance can range from over application causing runoff into a waterway, a lack of storage causing overflow into a waterway, split hoses or blown joins causing runoff into a waterway, basically any fault that can cause effluent to enter the waterway.

Figure 1: Chart Showing Reasons for Significant Non-compliance in the Waikato
For two pond treatment systems the rules governing the discharge in the Waikato Region is that there is to be no more than 100g/ml of suspended solids and no greater than 100μg/ml biological oxidation demand (bacteria). Most pond systems were designed prior to the use of supplementary feeds such as maize silage and palm kernel which are high in fibre and difficult to break down. The result is that many two pond treatment systems are not removing enough solids, therefore the nutrient (nitrogen and phosphorous) loading of the waterway which receives the discharge increases, contributing to eutrophication (see below).

Figure 2: Cyanobacteria (blue-green algae) bloom Lake Rotorua. Photo source: David Burger Source: The University of Waikato.

Looking at the compliance statistics from the Waikato it is easy to see how some are getting concerned that voluntary projects such as the Clean Streams Accord and farmer initiated programmes are not enough to change behaviour. Environment Waikato changed the rules governing the treatment of dairy effluent in 1994 as the number of farms and animals in the region were becoming too much for the waterways to cope with the suspended solids discharging from two pond systems. The impact of the rule change and education campaign on treatment methods was dramatic. Between 1993-94 and 1996-97 the proportion of farmers using land-based treatment increased from 39 percent to 63 percent with a corresponding decline in the number of discharges of treated (and untreated) farm dairy effluent to water. (Parminter, I. 1999). Since then almost 90% of Waikato dairy farms now have land based irrigation systems (Derived from Table 1). This suggests that farmers will change behaviour for more than financial reasons as the average internal rate of return for the capital invested is a low 4%, although as size of operation increases the internal rate of return increases to about 8%. (Parminter, I. 1999). Note also that as fertiliser price increases the return from effluent increases proportionally.
So why are non compliance rates on the rise? Are farmers ignoring the rules and if so for what reason? Or have the rules or interpretation of the rules, from both farmers and regulators, changed over a period of time? A report commissioned by Environment Waikato investigated the reasons for effluent non compliance in the Sheperton Irrigation Region, Victoria, Australia and in the Waikato region, New Zealand. The main findings were that farmers felt they were compliant even if they were not. Most non compliance was a result of blocked hoses/nozzles as a result of poor system design and a lack of storage to contain effluent during periods of wet weather when the ground was too water logged to hold the effluent. The main recommendations of the report were as follows: (Davies A, et al, 2007)

- Address the gap in the provision of technical assistance for system design and management.
- Assist research into development of systems that meet farmer’s expectations for low maintenance, simple systems that reduce the risk of non compliance.
- Provide incentives that contribute to buffers in systems to prevent the possibility of non-compliance, e.g. increased holding capacity.
- Determine the appropriate level of inspections in order to enhance the perception of being caught.
- Determine the appropriate level of penalty, taking into account factors that influence credibility and enhance fairness.
- Understand the effect of enforcement officers’ styles and review their current approach in order to ensure that they enhance rather than detract from farmer’s compliance aspirations and are aligned with agency strategy.
- Ensure consistency and accuracy of information provided to farmers from all those associated with effluent management systems, e.g. consultants, contractors and system suppliers, and addressing any gaps in the information regarding compliant systems.
- Consider the role of incentives to assist with the upgrade of systems.
3 Industry Initiatives

3.1 The Clean Streams Accord
The clean streams accord is an industry initiated partnership formed in May 2003 between Fonterra, MAF, Regional councils and the Ministry for the environment. This Accord provides a template for actions to promote sustainable dairy farming in New Zealand. It focuses on reducing the impacts of dairying on the quality of New Zealand streams, rivers, lakes, ground water and wetlands, while recognising the importance of dairy as a land use in New Zealand.

The three key goals are to have water that is suitable for:
1. Fish
2. Stock drinking water
3. Swimming

The accord set targets for the control and management of farm nutrients. However it is the failure to achieve the target of; ‘100% of farm dairy effluent to comply with resource consents and regional plans immediately’ (Dairying and Clean Streams Accord 2003), that has caused the most frustration. After 7 years New Zealand’s biggest dairying region is still struggling to achieve 70% of significant compliance or better and of that only 50% are fully compliant (Table 1).

3.2 Fonterra Effluent Improvement System (EIS)

This is an example of combining the initiatives of both the carrot and stick type methods. The system has been implemented for the 2010/2011 dairy season with the goal to reduce significant non compliance by 50% by August 2011 (Appendix 1). The process starts with either an infringement notice or a prosecution (depending on the severity of the breach) from the regional council to Fonterra. Fonterra can then deduct $1500 for an infringement or $3000 for a prosecution from the milk payment. The supplier can apply for the money to be used for ‘relief’ in order to help pay for advice and/or make system upgrades. Very serious breaches can result in Fonterra refusing to collect milk. This though has the potential for
further environmental risk and/or animal welfare issues as something must be done with the milk that is produced daily.

3.3 Fonterra - Every Farm Every Year
As at the start of the 2010/2011 season Fonterra will inspect every farm effluent system as part of the annual dairy shed assessment undertaken by the contractor in that area. This programme has been trialled in the latter part of the 2009/2010 season in the Waikato region and has generally been well accepted. The inspection is referred to as a ‘triage’ assessment. The purpose is to ascertain whether the system is up to standard and/or if it will pose a risk of failure at some time in the future. If required the supplier is referred to Fonterra’s own sustainable dairy specialists who can offer advice (without the fear of prosecution), on the appropriate action needed to obtain a more robust system.

3.4 Dairy NZ - Effluent Warrant of Fitness
The focus of the warrant of fitness system is to shift the focus away from compliance (or non-compliance) to fixing the problem. Dairy NZ strategy and investment leader for sustainability leader Dr Rick Pridmore believes that the viability of New Zealand’s low cost dairy industry is at risk due to the ever increasing cost of compliance monitoring. With an annual staff turnover in the dairy industry of 25-30% and the multitude of systems in use there are many instances where the person in charge of the system does not understand how the system is supposed to be managed. Dr Pridmore believes that an industry focus on three main systems would enable the industry to educate the managers and rural professionals (advisors, consultants etc) how to manage these systems correctly (pers. comm. 2010). Furthermore there is reluctance from farmers to have ‘outsiders’ or regulators come to assess the system for fear of prosecution.

Pridmore, (2010) What we are trying to do is work with the regional councils to try to understand the rules in place, question and improve them if necessary, and then design and agree on effluent systems that will meet these requirements. We want you (the farmer) to have an effluent system that you know will be compliant as long as you maintain and run it well (p.75).
One of the issues with land application systems is that they were installed to get effluent out of a hole and onto the land any way possible and usually for the least possible cost. Without the appropriate advice and an understanding of the best use of these nutrients, application is often too heavy resulting in runoff and/or ponding. Also effluent systems like all mechanical equipment are prone to wear and tear often leading to investment in the form of maintenance. This is often overlooked as a priority on the farm giving rise to the concept of an annual WOF check.

3.5 Regional Councils – Pond Storage Calculator
Applying effluent to water logged soils resulting in ponding or runoff is the cause of a significant amount of non compliance. Not only do the nutrients enter waterways but the nutrients are no longer available for the pasture plants to use for growth. The most common reason that this occurs is due to a lack of storage, leaving the operator in the conundrum of either pumping to land causing runoff into waterways or allowing the holding facility to overflow into waterways. Either way the nutrients are lost and the effluent falls into the significant non-compliant category, which can lead to prosecution and/or instant fines.

Massey University and Horizons Regional Council are developing a programme that uses farm data to calculate the size of the pond required on a case by case basis. As the calculator has developed, other regional councils have contributed regional rainfall and soil type data to enable farmers and/or consultants across the whole country to use this tool for their own situation. Such data includes:

- Herd size.
- Time taken to milk (estimates the amount of water used.)
- Soil type (determines whether it is high, low or medium risk.)
- Application rate.
- Rainfall averages and patterns.

The result is a minimum pond size including dimensions, of which effluent would be required to be irrigated on every available day in order to prevent overflow during the winter/spring period. The calculator can also be used to help make an informed decision as to what type of system would suit a farm with existing pond storage.
3.6 Education and Effluent Field Days
Regional Councils, Federated Farmers, Dairy NZ and various milk processing companies regularly hold educational days on farm to highlight good systems and discuss the benefits both to the environment and potentially to profit margins. Agriculture ITO also provides custom courses to educate farm staff and owners on how to deal with dairy effluent. The only problem with these schemes is that they target and get the 50-60% of farmers that are proactive and are likely to be doing a reasonable job already. The challenge is to educate and get the participation of those that are not active learners.

Regional Councils also have the challenge of defining where the role of education and enforcement starts and stops. Davies et al., (2007) stated in their report that past efforts to change behaviour by offering extension on the benefits of the correct use of dairy effluent had lead to an unexpected response by farmers with an unacceptable level of non-compliance still occurring. This has resulted in an increase in regulatory efforts in recent years (p. iii). The question though does remain whether the target audience was ready for the message in the past and a renewed focus on education and extension could have a more profound effect if applied to farmers today.

3.7 Private Business Projects
Many engineering businesses claim to have the best, most reliable system available. The problem is that farmers are choosing on price or sometimes spending large sums in an attempt to future proof their system, only to find that they are not compliant or not doing what they were promoted as been able to do. Travelling irrigators have a tendency to apply effluent unevenly as a large proportion is applied to the outside of the area irrigated. Many engineering companies are now modifying these applicators to have one long arm and one short arm giving a more even spread of effluent over the area. Combined with fast gearing and different nozzle types a typical travelling irrigator can reduce application rates from 20-25mm to as low as 5-10mm.

Some technology companies using data based on research done by Massey University have developed monitoring and communication products that provide the user with information as to when to apply effluent safely on the land. Such systems have sensors in the ground to measure soil moisture levels, rain sensors to measure rainfall, movement sensors on the travelling irrigator and pond level sensors. Decisions based on this information enable the
user to make informed decisions as to when to apply effluent and also if there is any problem with the system such as a stalled irrigator, which if this occurs the system communicates to the pump and automatically shuts off. Information is sent to the user either through a text message to cell phone or via the internet through a secured website.

4 Farmer Feedback

4.1 Sampling
As with any attempt to understand the behaviour of a group of individuals there is the challenge to get a true reflection of that group. The decision to create a short survey (appendix 2) and obtain a random sample of dairy farmers was made in order to obtain a general perspective of the industry. The survey was distributed at the annual Agricultural field days at Mystery Creek. This event was chosen for the likelihood of a wide variety of farmers in regard to age and attitude to be in the one place at the same time.

The surveys were sited at various stands where dairy farmers would likely visit. However it became evident through the collection process that participation was not high. A decision was made to actively approach farmers for participation. Obtaining a suitable pool for the sample proved a challenge so additional surveys were conducted by random ‘cold calling’ and phone calls. A sample pool of 25 farmers predominately from the Waikato region was collected and collated.

In regards to statistical randomness it was very difficult to obtain a truly random sample. Some areas to note are as follows:

1. Farmers to attend the field days are not necessarily a reflection of all farmers.
2. Farmers that voluntarily fill in a form are perhaps proactive by character.
3. Even those that participate under persuasion are not a full reflection of the industry.

4.2 Purpose
The purpose of this exercise was to gain an understanding of what dairy farmers in general felt was important in relation to effluent management. The survey consisted of five main categories:

1. Their herd size and system
2. Effluent as a fertiliser and the benefits.
3. Does their system require more investment and reasons for and against?
4. Who should regulate and provide advice on dairy effluent management and who pays?
5. How is the industry doing? Does it need to improve? Is this important for the reputation of the New Zealand dairy industry globally?

How participants respond to these categories could provide some insight into what areas governing bodies could invest resources into in order to give the best return or in this case implement the most change.

4.3 Results/Discussion
The survey process revealed more than what the questions were asking. Of those that participated there was a lot of comment regarding that state of the political issues relating to the topic of effluent management. Comments such as “It’s good that the industry is starting to utilise their nutrients better” and “Tougher penalties should be implemented to those that refuse to fix their systems” suggested the attitude of many farmers has moved into a ‘lets’ fix this issue’ mode. There was however some concerning comments regarding trust and confidence with regulators. Comments such as “they are sneaky” and “they keep changing the rules” suggest the relationship between some farmers and regulators are strained which could be an issue in respect to making progress in regards to compliance.

4.3.1 Herd Size and Region
The majority of the sample was farmers from the Waikato region (Figure 2). This was expected as even though the field days event was chosen as an opportunity to gain access to farmers from around the country, the location of the event meant that there was always likely to be proportionately more farmers from the Waikato in the sample pool.

Figure 3: Chart Showing Sample Proportion by Regional Regulator
4.3.2 Farm/Herd Size

This information was gathered in order to observe a relationship, if any, between herd size and system type. The four categories were:

1. 0-250 cows
2. 250-500 cows
3. 500-750 cows
4. 750+ cows

As can be seen in Table 2 below the majority of farmer's surveyed applied effluent directly to land through a travelling irrigator. The only variation to this pattern was in the herd size 0-250 cows where 50% of those surveyed still had two pond treatment systems. When asked (in discussion) if they would change to a land application system, most stated that they desludged at least once annually and preferred the flexibility that discharging provided through the wet months. The capital cost of installing a land application system was also a limiting factor.

Table 2: Table Showing the Relationship between Herd Size and System Type

<table>
<thead>
<tr>
<th>Herd Size</th>
<th>2 Pond Treatment</th>
<th>Travelling Irrigator</th>
<th>Canon</th>
<th>Low Application</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-250</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>250-500</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>500-750</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>750+</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>15</td>
<td>5</td>
<td>2</td>
<td>25</td>
</tr>
</tbody>
</table>
4.3.3 **Effluent Systems and Storage**

The survey asked what type of system farmers had including the number of storage day’s that corresponded to their system. Figure 3 shows a representation of the sample irrespective of herd size, or region. Systems generally fell into four main categories:

1. Two Pond treatment
2. Pond/Sump to pump to travelling irrigator
3. Pond to pump to canon
4. Pond/Sump to low application (pods/centre pivot)

There are still some farmers that have the two pond oxidation systems where consent can be obtained to discharge treated effluent into a waterway. These systems tend to have more storage than land application systems and most farmers that have these systems said that they had the first (anaerobic) pond desludged annually, usually in late summer when the soils were dry enough to ‘handle’ the application.

**Figure 4: Graph Showing the Number of Effluent Systems and Associated Storage**

![Graph](image)

The majority (88%) of those surveyed applied effluent directly to land with no consent to discharge to waterways, either immediately or stored to apply when soil conditions were suitable. Sixty percent of these farmers had a pond or sump to collect effluent and then pumped directly onto pasture through the use of a travelling irrigator. Of this 60% over half
(60%) had less than a week of storage available and many only had between 1 and 3 days. The risk of spill due to a wet weather event or system malfunction is obviously of concern for these farmers. Also even if the system is working well there would be many times when the system would need to apply effluent to wet and water logged soils.

Those farmers that used high volume pumps and canons tended to have more storage, usually due to these ponds formally been designed for two pond treatment that have become too small due to expansion or intensification. This form of land application tends to have a higher rate of application requiring soils to be drier.

The most advanced system could be argued to be low application systems of which there were two in the sample group. One of which was from the Waikato region and one from the Canterbury region. These two systems were very different from one another. The system in Canterbury has a solids separator which were stored and applied as fertiliser to crop ground, the liquid then pumped through the centre pivot irrigation system covering 126 ha. A good system for utilisation of nutrients, although with only one day of storage there is risk that a mechanical fault in the separation process could result in the inability to apply raw effluent through the fine nozzles of a centre pivot. In contrast in the Waikato a pond system is used to store effluent and pump it through specially designed effluent irrigation pods.

4.3.4 Effluent as a Fertiliser

This part of the survey was very simply to investigate whether farmers knew or understood the economic value of their effluent and whether they regarded this as an economic source of nutrients. An overwhelming 21/25 (84%) of those surveyed felt they knew or understood the value of effluent as a fertiliser. However 24 of the 25 (96%) surveyed thought that effluent is an economic source nutrients. Suggesting that although some were not aware of the value they still felt it was an economic source of nutrients. Most citing that it is a 'free' source; and "all you need to do is get it on the ground". Only one respondent felt that the cost of application outweighed the value of effluent as a fertiliser source.

In April 2009 the potential equivalent fertiliser value of land applied effluent is $30/cow per year on an all grass system or $55/cow per year on a feed pad system feeding 2t of maize dry matter/ha (Bramely, M. 2010). This corresponds to the effluent analysis report (appendix 3) showing the quantities of nitrogen, phosphorus and potassium in a typical all grass system.
The sample from appendix 3 was taken from a typical grass based 150ha farm that has a carrying capacity of 450 cows. Figure 4 below shows a calculation of effluent value in respect to the cost of getting basic fertiliser on farm (including transport) using Ballance fertiliser pricing as at October 2010 as a base price.

**Figure 5: Flow Chart Showing Effluent Value in Dollars**

- **Holding Capacity of 30 Days covers 6 ha at a 20mm application depth**

- **Nutrients Applied per Application (refer appendix 2):**
  - N: 63kg/ha
  - P: 4.9kg/ha
  - K: 23kg/ha

- **Total Nutrients per Year (9 Applications):**
  - N: 3402kg
  - P: 523.8kg
  - K: 2484kg

- **Fertiliser Equivalent: (approx cost on farm)**
  - N – Urea: 7.4T @ $650/T = $4810
  - P – Super 10: 5.8T @ $350/T = $2030
  - K – MOP: 5.0T @ $1000/T = $5000
  - TOTAL: $11840

- **Total/Cow (430 Cows):** $27.40

### 4.3.5 Effluent System Investment

The questions relating to investment were aimed at investigating what farmers are doing in respect to system improvement and also to investigate the drivers or motives for which this investment was either made or not made. It is important to note that the concept of compliance is one that can be interpreted somewhat differently from one farmer to another. I did not spend time discussing what was compliant and what was not. The results for this section are based on the perception of compliance from the individual farmer/participant.
When asked whether their system required more investment, not including maintenance, 72% of those surveyed said yes. However when asked if their system required more investment to become compliant only 20% of respondents felt this was necessary. The reason primarily for this was unsurprisingly storage, as seen in figure 5. 60% of respondents had less than a week of storage (figure 3). Respondents suggested that they were compliant now but felt that rule changes in the future would mean that they would need further investment to remain compliant. The survey did not delve into the details of what was or was not compliant, participants answered in relation to their own perception. Further work here could be interesting to ascertain whether farmers were aware of what compliance rules actually are.

**Figure 6: Chart Showing Reasons for Recent Investment**

![Figure 6: Chart Showing Reasons for Recent Investment](image)

Figure 6 shows that recent or planned investment is motivated largely by a willingness to utilise effluent nutrients more efficiently, either through more storage to enable effluent to be applied when soil conditions suited or providing infrastructure to spread the nutrients over a larger area, largely for the benefit of animal health. A small proportion (11%) of respondents initiated recent investment in order to become compliant. On the converse side of investment, there were 7 respondents that felt that their effluent system required no significant investment, aside from maintenance. Of this group 5 felt they were compliant already and another 2 respondents felt that cost was the most significant deterrent to investment.

A research paper written for the 2009 AARES conference concluded that of the 9% (2006/2007 year) of farms that were significantly non-compliant in the Waikato region half would make money ($1.61/farm/day) by becoming compliant. This is due to the fertiliser
benefit of effluent that is being wastefully discharged into waterways. Furthermore of those that had a net cost by becoming compliant the majority would be looking at only $5-$10/farm/day (Gauntlett, 2009). For these farms other incentives need to be investigated. Gauntlett suggests that the risk of fines and the associated costs could outweigh the daily cost, although further investigation is required. These comparative costs change as the costs of fertiliser change.

4.3.6 Advisory and Regulation

There has been, and still is, a lot of debate on the role of industry organisations including regional councils regarding how they can effectively influence change. Just how effective they are is constantly discussed in media and within the farming community.

Questions for this section were asked in order to obtain some understanding of which organisation farmers felt advice and regulation should come from. Who should pay, and what would be more effective at initiating change, i.e. tougher penalties or a more hand up approach. Some questions relating to the Fonterra EIS scheme were asked because at present this is the only scheme that combines a penalty with an incentive for improvement. Table 3 shows the results of the questions relating to advice and regulation.

Table 3: Table Showing Number of Participants and who they think should Regulate and Advise Regarding Effluent Management.

<table>
<thead>
<tr>
<th>Who Should Regulate?</th>
<th>Dairy NZ</th>
<th>Fonterra/or other Dairy Companies</th>
<th>Reg. Council</th>
<th>Combination</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>8</td>
<td>11</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Who Should Advise?</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>10</td>
<td>4</td>
</tr>
</tbody>
</table>

Clearly most respondents felt that it was the role of the regional council to regulate the performance of effluent systems and management of these. However a significant 32% suggested that Fonterra should regulate effluent systems. The most common reason for this response was that the respondents did not trust their regional council so were looking for an organisation that could fill the role with integrity. Conversely others felt that this was not the role of a dairy company and that they would then develop a conflict of interest. In addition the likelihood of the relationship between farmer and dairy company could be compromised and in the case of Fonterra the trust that is required for system advice would be put at risk.
However when concerning advice, most respondents felt that a flow of information should be provided from a combination of industry sources. The 4 respondents that chose ‘other’ for the advisory question were choosing effluent system providers as they felt that since it was their business to provide and install systems they could be the best source of information and advice. Interestingly it was the fact that these organisations had a vested interest in their own product that most other respondents felt that a balanced and unbiased source of advice would be more reliable. All respondents were adamant that the advice had to be appropriate and needed to ‘do the job’ and be compliant once installed.

In conjunction with the question of who should regulate effluent systems and the management of these, the survey investigated who should fund such activities. Figure 6 shows a somewhat surprising response from farmer participants with most suggesting that it should be a user pays system. However some respondents believed that all those that benefit from regulation, i.e. the general public, should contribute to the cost. This is a good example of some of the issues regarding interpretation. If policy was implemented from data sourced from figure 6 a debate would soon be had as to who is the user. Is it the person with the system or is it the persons that benefit from improved water quality? That is all persons within that community.

**Figure 7: Chart Showing Respondents Preferred Funder of Regulatory Activities**

4.3.7 **Effluent Improvement Scheme (EIS)**

As previously mentioned there is no bias towards this scheme nor is this scheme the only potential ‘hand up’ scheme that could be implemented. It is though, at the time of compiling this report, the only initiative to my knowledge, that any industry organisation has developed and implemented that combines the deterrence of a fine (the stick) with the opportunity to be
redeemed on receipt of improvement made to the system (the carrot). Not all non compliance is the result of system failure or design. Mismanagement of a good system is likely to lead to non compliance. There have been some instances where an operator has deliberately dumped effluent into water ways in order to relieve the storage capacity and appear to be compliant. Such an operator is not likely to be reimbursed.

The survey sought to gain an understanding of the knowledge of the farmer participants of the EIS scheme and furthermore whether they thought that such a scheme could be adopted or adapted by regulators as a tool to improve the rate of compliance. Most respondents had some knowledge of the scheme which is as much an indication that 90% of all New Zealand dairy farmers supply Fonterra, as to the importance to the dairy industry of effluent management.

Most respondents (68%) thought that this was a useful scheme to improve the rate of compliance, or more importantly reduce the rate of non compliance. Most thought that this was a well intentioned scheme, even if they were not comfortable with the thought of a potential double penalty. 12% of respondents were not sure of the EIS indicating that they were unaware of the scheme or did not understand how it was supposed to be effective. The remaining 20% thought that it would be ineffective as a means of improving compliance rates. Interestingly of this group, many commented that Fonterra should stay away from the on farm effluent compliance issue and focus on its core function of processing and marketing milk. For this group the focus was less on the merits or issues with the scheme, but more to do with the organisation implementing it.

4.3.8 Tougher Penalties?

Part of the focus of this report is to investigate the effectiveness of the carrot and stick methods to influence behaviour. Therefore part of the survey was to ask participants if a carrot based system such as the EIS could be implemented by the regional regulators. The results were; 56% responded yes; 12% responded no; 32% were not sure.

With Ministers for the Environment and Agriculture demanding tougher penalties for non compliance and a changing attitude to industry compliance by those within, it was logical to investigate how farmer participants felt on the effectiveness of tougher penalties. The results
were; 40% thought that it would be effective; 44% thought it would not be effective; 16% were not sure.

Those that believed tougher penalties would be more effective suggested that the reputation of our industry was too important to risk on the environmental performance of the few operators that were constantly letting the industry down. It is worth noting that at the time the survey was conducted there was a high profile large scale family farming company, which had continually been in the media for breaches of effluent management, going through a receivership process.

Those that felt tougher penalties would not be effective believed that further extension would be more beneficial. Some cited that if fines were too tough the opposite effect would be true as financial positions of many farmers were not good, largely due to increasing costs and too much debt. For these farmers a ‘hand up’ or a compulsory investment approach could be more effective.

4.3.9 Industry Performance and Perception

How farmers perceive the importance of improved effluent management to the industry as a whole is a good indication of the amount of effort and resources that they will put into their own systems and the management of it. The survey gave a scale for respondents to indicate the level of which they agree with three statements. These statements related to the perception of how the industry is currently doing; whether the industry is improving, and a statement suggesting further improvements are required. These responses can be seen in table 4 on page 29.

Most respondents felt that we are generally doing ‘pretty well’ in respect to dairy effluent disposal/management. However it is quite clear that there is some differing opinions with regard to this statement as there are some that disagree. However when asked to respond to the statement that the industry is improving all but one of the respondents agreed to this statement. Some of the older farmer participants discussed the ‘old’ days when untreated effluent was discharged directly into surface water ways. They went on to suggest that the industry had ‘come along way’. The general consensus was that the industry still had some
work to do with how effluent is discharged with most agreeing with the statement and only 1 respondent strongly disagreeing.

**Table 4: Table Showing Responses to Industry Performance Questions**

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The industry is doing well</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Industry performance is improving</td>
<td></td>
<td>1</td>
<td></td>
<td>18</td>
<td>5</td>
</tr>
<tr>
<td>We need to better as an industry</td>
<td>1</td>
<td>4</td>
<td></td>
<td>16</td>
<td>3</td>
</tr>
</tbody>
</table>

New Zealand dairy farmers are aware that their livelihoods depend on our ability to sell our products off shore. About 95% of dairy products produced in New Zealand are exported off shore. The question the survey asked was; do you think that dairy effluent management, whether good or poor, influences our international reputation and therefore our product sales? The majority (76%) believed that, yes, this is likely to be the case. They believed that New Zealand’s clean green image was worth protecting; some participants felt strongly that we are leaders in dairy and should continue to be so. Of the remaining participants 20% or 5 respondents thought that dairy effluent management had no consequence on our ability to sell product to the world. Also one participant was not sure, but was sceptical that we are being made to believe this to be so and that this was another example to ‘scare’ us into spending more on compliance and therefore bureaucracy. Some other comments included “customers don’t care where their food comes from as long as it is safe and tastes good” and “with a shortage of food in the world and plenty of hungry people to feed we will always be able to sell product”.

Context, a US marketing company, conducted a study based on the on-line survey of 600 affluent, metropolitan consumers aged between 20 and 64 representing male and female equally. They found that 41% of respondents felt sustainably produced food was either very important or important when considering food purchases. Furthermore the report found that while low price is always important, 60% of respondents would pay up to 10% more for food
that promises to be healthier, safer or produced to higher ethical standards. Interestingly a
further 12% of respondents said that they would pay more than 10% (Context Marketing,
2009). Here in New Zealand we need to take note that while price will always be important,
there are many other factors that influence consumer buying behaviour.

5  Recommendations

The huge amount of media coverage that dairy farm effluent attracts is not only an indication
of the amount of research being undertaken to prevent nutrients from harming our waterways
but also the amount of emotion involved with this issue. Dairy farmers appear to be taking a
very significant amount of the responsibility of all the environmental harm, without regard
for other factors that may contribute to the degradation of New Zealand’s water quality.

Despite the efforts of the majority of dairy farmers and the awareness of the importance of
industry sustainability, there are still some who are not trying to improve the way they are
utilising dairy farm effluent. However despite the results of significant non-compliance, not
all those that are included in these results are deliberate polluters of the environment. Often
systems have been installed that will never deliver 100% compliance 100% of the time. Also
there appears to be a gap between the perception of being compliant from the farmer’s
perspective and what actually is compliant.

To improve the rate of compliance or conversely reduce the rate of non compliance the
following recommendations need to be considered:

- Ensure that advice from all industry organisations (including engineering companies)
  and regulators is aligned.

- Encourage system investment by promoting the financial benefits of delivering the
  nutrients in a way that optimises utilisation for pasture or crop production.

- Develop the rules of compliance to ensure they are practical and achievable. Also
  align compliance rules in relation to the benefits of best practice.
• Don’t sweat the small stuff. Regulators need to ensure that farmers are not alienated by enforcing and punishing farmers for minor or technical breaches of compliant rules.

• Compliance officers need to be offering advice to minimise environmental impact as they inspect. Farmers need to see that the focus is to reduce water/environmental degradation. It is important that farmers don’t perceive that they are being used as an easy target.

• Deliver compliance rules and best practice advice in an easy to understand and visually appealing way. They need to be easy to display so all those that are involved in the farm operation can see and understand the objectives.

• Consider the release of infringement fines or a portion of the prosecution fines to be contributed to system investment.

• Further development of effective, reliable and cost effective systems needs to occur. Dairy farming is a labour intensive industry, effluent systems need to be reliable and designed to be labour and time efficient.

• Including a system WOF as part of the effluent system triage inspection will likely improve the reliability of systems as farmers would be more likely to instigate an effluent system maintenance plan.

These recommendations are all dependant on the ability of all industry organisations to work together. Compliance can be costly but if there is a clearly defined role for each organisation to undertake then this cost can be minimised. Dairy farmers have the biggest role to play, a continuation of the attitude to focus on best practice will most likely lead to cost savings in the long run and eventually lead to a demise of the damaging ‘dirty dairy’ campaign that frustrates even the most cynical of farmers. New Zealand dairy farmers are world leaders in quality and sustainability and with continued development we can still be world leaders in the future.
Appendix 1: Flow Chart of the Fonterra Effluent Improvement System
Appendix 2: Survey Questionnaire

So What’s Up With All That Cow Shit? I Want To Know What You Think!!

Hi my name is Peter Walters and I am a dairy farmer from Otorohanga. The purpose of this survey is to gain an understanding of how dairy farmers feel the issue of dairy effluent affects our industry. Plus what techniques would be effective to improve those that are performing poorly in this area. The results of this survey are confidential and anonymous and once compiled, the forms will be destroyed. The information will be presented in a report as part of a Lincoln University post graduate course.

Thank you for taking the time to complete this survey. (Circle where appropriate)

1) What region are you from?

2) Size of herd?
   a. 0-250 cows   b. 251-500 cows   c. 501-750 cows   d. 751 plus cows

3) What type of dairy effluent system do you operate including days of storage, and hectares irrigated?
   Type of system ____________________ ________________
   Storage in days ____________________ ________________
   Hectares irrigated ____________________ ________________

4) Are you aware of the dollar value of dairy effluent nutrients on your farm?
   a. Yes   b. No   c. Not Sure

5) Do you think that it is an economic source of nutrients?
   a. Yes   b. No

6) Do you feel that your effluent system requires more investment? If yes, go to question 7. If no go to question 8.

7) Have you recently invested in your effluent system? Yes/No (Go to Q8)
   If yes, what were your reasons for doing so?

8) What are the main reasons for not investing in more effluent technology on your farm?

9) Do you feel that your system needs more investment to become compliant?
   a. Yes   b. No

10) Who do you think should regulate effluent management systems?
    a. Dairy NZ   c. Regional Councils
b. Fonterra  
d. Other – specify

11) Who should pay for compliance monitoring?
   a. Dairy NZ Levy payers  
   b. All Regional Rate payers  
   c. All Regional Rate payers that have effluent systems  
   d. Suppliers

12) Do you think that Fonterra’s Effluent Improvement System (EIS), where industry fines can be contributed to system upgrades, is a good way to improve effluent compliance?
   a. Yes  
   b. No  
   c. Not sure  
   d. Don’t know enough of EIS

13) Please explain your answer for Q12.

14) Do you think that regional council regulators could adopt the EIS system or something similar?
   a. Yes  
   b. No  
   c. Not sure

15) Do you think that tougher penalties for effluent non-compliance would be more effective at improving the performance of poor performers?
   a. Yes  
   b. No  
   c. Not sure

16) Who do you think should provide advice on effluent systems and management?
   a. Dairy NZ  
   b. Regional Council  
   c. Effluent System Provider  
   d. Fonterra, or other milk companies

17) For the following statements thinking about dairy effluent disposal, how do you think the New Zealand dairy industry is performing?
   a. The industry is doing well
      Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree
   b. The industry performance on effluent disposal is improving
      Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree
   c. We need to do better as an industry on our effluent disposal
      Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

18) Do you think that dairy effluent management, whether it is good or poor, influences our international reputation and therefore product sales?
   a. Yes  
   b. No  
   c. Not sure

Thank you for your time.
## Appendix 3: Nutrient Analysis from the Stored Effluent of a Typical Grass Farm

### Sample Type: Aqueous

<table>
<thead>
<tr>
<th>Sample Name:</th>
<th>Dairy Effluent Sample</th>
<th>Lab Number:</th>
<th>773610</th>
<th>10-Mar-2010</th>
<th>16-Mar-2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm Effluent Samples</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>kg/m²</td>
<td>0.32</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>kg/m²</td>
<td>0.049</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Potassium</td>
<td>kg/m²</td>
<td>0.23</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Calcium</td>
<td>kg/m²</td>
<td>0.13</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Magnesium</td>
<td>kg/m²</td>
<td>0.054</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Sodium</td>
<td>kg/m²</td>
<td>0.026</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Sulphur</td>
<td>kg/m²</td>
<td>&lt; 0.21</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NPK applied for a 10 mm application depth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen applied</td>
<td>kg/ha</td>
<td>32</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Phosphorus applied</td>
<td>kg/ha</td>
<td>4.9</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Potassium applied</td>
<td>kg/ha</td>
<td>23</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NPK applied for a 20 mm application depth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen applied</td>
<td>kg/ha</td>
<td>63</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Phosphorus applied</td>
<td>kg/ha</td>
<td>9.7</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Potassium applied</td>
<td>kg/ha</td>
<td>46</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

<table>
<thead>
<tr>
<th>Sample Type: Aqueous</th>
<th>Test</th>
<th>Method Description</th>
<th>Default Detection Limit</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy Effluent Nutrient profile</td>
<td>Filtration, Unpreserved</td>
<td>Sample filtration through 0.45μm membrane filter.</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Total Digestion</td>
<td></td>
<td>Boiling nitric acid digestion. APHA 3030 E 21st ed. 2005.</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Total Kjeldahl Digestion</td>
<td></td>
<td>Sulphuric acid digestion with copper sulphate catalyst.</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>Calculation: Total Kjeldahl Nitrogen (TKN) + Nitrate-N + Nitrite-N (NO₂⁻N)</td>
<td>0.00010 kg/m³</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TKN determined by Total Kjeldah digestion, phenolphthalein as indicator.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NO₃⁻N determined using a filtered sample. Cadmium reduction,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Azo dye colorimetry. Discrete Analyser. APHA 4500-NO₃-C.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(modified) 4500 NH₃ F (modified) 21st ed. 2005.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen applied</td>
<td>Calculation based on a 10 mm application rate. Total Nitrogen (kg/m²) x 100.</td>
<td>0.050 kg/ha</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Nitrogen applied</td>
<td>Calculation based on a 20 mm application rate. Total Nitrogen (kg/m²) x 200.</td>
<td>0.10 kg/ha</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
References


