article

SUSTAINABLE NITROGEN FERTILISER USE IN THE WAIKATO REGION

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At Environment Waikato we are concerned about the potential for poor management of nitrogen fertilisers. We are aware that national and regional use of nitrogen fertiliser has recently increased substantially. As a regional authority we do not discourage wise use *of* fertilisers to improve soil fertility. This is because we realise that New Zealand is predominantly an agricultural country and its economy depends heavily on food exports The Waikato region IN one of the most intensively farmed areas in New Zealand and hence this region has a significant input into the national economy. For example, our region produces about 50% of the total New Zealand dairy milk. Previous and current international market forces suggest that food exports such as dairy produce make dairying an attractive farming option for New Zealand

Although Environment Waikato's *Regional Polity Statement* (RPS) does not refer to the increasing trend of fertiliser nitrogen use and related environmental effects, it identifies farming as the major contributor to non-point sources of pollution in the region. A report by Smith *el al.* (1993) produced for MAF Policy also indicated that freshwater (both ground water and surface water) quality in the Waikato region is affected mainly by fanning. A recent research paper (Selvarajah *et al.*. 1994) also shows that many shallow ground water bores have elevated nitrate levels.

Environment Waikato is currently in the process of developing *Regional Plan.* Since Regional Plans are more issue specific, it is likely that farming effects on the environmental quality will be addressed sufficiently in our plan. Currently, we have no set policy or plans related to fertiliser nitrogen management for the region. However, through ad-hoc presentations and participation at meetings and conferences related to fertiliser use we have expressed our views.

The issue of fertiliser use in New Zealand and overseas is very sensitive from the political, economical and environmental viewpoints. Restrictions on fertiliser use could affect farming and the fertiliser industry significantly. Such restrictions are already in place in Europe and the USA. These restrictions and the related monitoring cost taxpayers substantially. In New Zealand there are conflicting views about fertiliser nitrogen use. Whilst overseas experience and extensive research clearly document the adverse effects of excessive fertiliser nitrogen use, we in New Zealand have only recently begun to research the effects of high fertiliser nitrogen use on the environment. In our opinion considering overseas experience and the lack

The perceptions and facts about fertiliser-N use effects

Environment Waikato discourages excessive use of fertilisers which leads to the degradation of environmental quality. There is a common confusion among many in the fertiliser industry that fertiliser nitrogen use does not contribute to nitrate leaching in soils. Soil and fertiliser research in New Zealand and overseas clearly reveals that unless there is a heavy rainfall or irrigation following fertiliser nitrogen application, and providing appropriate amounts are applied, there is little or no *direct* leaching of applied fertiliser nitrogen in most pastoral soils. This is because pastoral soils contain a significant pool of biologically available organic carbon and apart from the rapid plant uptake of applied nitrogen, a major proportion of the applied nitrogen is converted to microbial biomass. In contrast, continuously cultivated soils for cropping or vegetable growing contain relatively small amounts of biologically available organic carbon and hence microbial immobilisation of applied nitrogen is low. Consequently, in cultivated soils applied fertiliser nitrogen is at greater risk of being *directly* leached. In such cases leaching losses of nitrogen can be in excess of 200-300 kg N/ha/year. In contrast, a grazed pasture system without fertiliser nitrogen input could sustain a leaching loss of 60 kg N/ha/year.

Many years of research indicate that in a dairy pasture system the driving force for nitrate leaching is urine voided by animals. Indeed, such research indicates that among the several nitrogen loss pathways (e.g. denitrification, ammonia volatilisation, nitrogen transfer to unproductive areas, milk protein and nitrate leaching) in a grazed pasture system, nitrate leaching is the major nitrogen loss pathway (under the Canterbury soil and climatic conditions volatilisation may cause high N loss from the grazed pasture systems). It is well known that in dairy pasture system nitrogen removal through milk is relatively minor (in most cases it is 10% of the nitrogen ingested by dairy cows). Thus whilst *direct* leaching of applied fertiliser nitrogen could be minimised through good fertiliser management practices, any nitrogen input into the system be

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of information in New Zealand we need to take a conservative approach to fertiliser nitrogen use.

it clover-N or fertiliser-N will contribute to the overall *indirect* leaching (*indirect* leaching is defined here as nitrate leaching from nitrification of urine-N and mineralisation of organic-N in soil).

The essence of the RMA is an effects based approach rather than controlling particular activities. Nevertheless certain activities are strongly linked with adverse environmental effects and hence it could be argued that controlling certain activities would bring the desired environmental outcomes (e.g. controlling dairy pasture irrigation would minimise nitrate leaching). To a certain extent intensive dairy farming could also be regarded as an activity which contributes to ground water (nitrate) and atmospheric (methane) contamination, and surface water contamination through ground water entering waterways. Although research into reducing nitrogen output through urine and minimising methane production by improving feed quality could help reduce the problem, the effects cannot be completely avoided.

It could be argued to let market forces control activities and that certain unsustainable activities will eventually cease. However, this philosophy will help cull *economically* unsustainable activities not necessarily *environmentally* unsustainable activities.

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lt must be emphasised that a similar philosophy used to exist among several leading western agricultural countries until environmental degradation became a concern. For example, a decade ago, in Germany, fertiliser nitrogen use was actively encouraged through government subsidies to boost food production. In contrast, the German government now grants subsidies to farmers to avoid or minimise fertiliser nitrogen use. Since New Zealand is one of few nations which retains a 'clean and green' image, it is particularly important not to encourage activities which lead to environmental degradation and place New Zealand's future economy at risk I must emphasise that any non-point source of pollution (e.g. nitrate leaching from grazed pasture) is difficult to manage and monitor compared to a point source of pollution (e.g. sewage outfall into surface water). Consequently, even if significant pollution is detected through intensive monitoring, actions to minimise non-point sources are not as straight forward as for point sources of pollution and may not bring the anticipated environmental outcome immediately. In short, management of non-point sources of pollution such as grazed dairy pasture is a complex issue and hence the dairy and fertiliser industries must be responsible for the long-term sustainability of the dairy industry.

It is our opinion that regional or national fertiliser nitrogen loading rates cannot be determined *solely* on the basis of any one fertiliser trial. However, such a trial can be used to assist decision making The fertiliser nitrogen work by AgResearch at Ruakura clearly demonstrated that at a 400 kg N/ha/year loading rate ground water nitrate levels far exceeded the New Zealand drinking water standard (11.3 mg nitrate-N/litre) (Ledgard *et al.*. 1996). At 200 kg N/ha/year ground water nitrate levels stayed at or below the drinking water standard during most seasons except for winter 1995 when it exceeded the standard. Estimates on economical return from these trials

Is nitrate a health issue?

For mam years nitrate has been considered as a contaminant. Many human diseases have been linked to the presence of nitrate in drinking water (e.g. methaemoglobinaemia or 'blue baby syndrome', gastric cancer, hypertension, leukaemia, non-Hodgkin's lymphoma). It has been proven conclusively that infants less than 3 months old are very susceptible to nitrate in drinking water. This is because they have not developed normal haemoglobin in blood which is predominantly a protein material that helps transport oxygen from the lungs to other organs. Young infants have a high 'foetal haemoglobin' which binds readily with nitrite produced from nitrate in the digestive system. Consequently, the oxygen supply in the body is reduced and when not treated results in death. At a nitrate contamination conference Weisenburger (1991) concluded;

Currently, there are insufficient evidence to permit raising the drinking water standard above 10 ppm nitrate-nitrogen, whereas there are some indications that the standard provides the necessary safety factor to prevent most acute and chronic health effects of ground water contamination. Any decision to change the standard must await the results of further research.

There is a general view in New Zealand that the drinking water standard (50 mg nitrate/litre or 11.3 mg nitrate-N/litre) is very conservative and that even if the nitrate level far exceeds the New Zealand drinking water standard it may not cause any serious human health problems. Moreover, it is believed that since there are no reported cases of methaemoglobinaemia in

by the Dairying Research Corporation (DRO indicated that the 400 kg N/ha/year compared to 200 and 0 kg N ha/year was uneconomical. Similar trials showed that the paddocks received 200 kg N ha year marginally but significantly outperformed the economical returns of that of the 0 kg N ha/year loading rate. These trials clearly indicate that high *fertiliser-N loadings are not environmentally and economically sustainable and that fertiliser-N should be used as a strategic supplement to clover-N not a substitute for it.*

New Zealand we should not be concerned about this issue. Burden (1982) reported:

To date, no cases of methaemoglobinaemia have been reported in New Zealand but this could, at least in part, result from the fact that methaemoglobinaemia is not classified as a 'notifiable' disease by the New Zealand Health Department. Bottle-fed infants (≈3 months) are also predisposed to the Sudden Infant Death Syndrome (cot death), a condition of oxygen starvation, from which about 3 per 1000 infants from most Europeanised societies die (Money 1978). Many explanations for the occurrence of the syndrome have been offered but none appear satisfactory. Because of the similarity in symptoms it is possible that methaemoglobin may predispose infants to Sudden Infant Death Syndrome (WHO 1978).

I must draw your attention to a reported infant death case (I994) related to nitrate in ground water in New Zealand. Following a prescription the 6 month old infant (who had vomiting and diarrhoea) received glucose and an electrolyte prepared using contaminated ground water (27 mg nitrate-N/litre) at her home in the Franklin area died after developing symptoms related to methaemoglobinaemia.

Nitrate in drinking water or food materials could seriously affect animal health as well. The Australian and New Zealand Environment and Conservation Council drinking water limit for stock water is 30 mg nitrate-N/litre (ANZECC, 1992). High nitrate levels in grass can also affect grazing animal health. In 1994 death of cows linked to high nitrate in grass have been reported in the Waikato Region. In this case blood nitrate-N levels exceeding 25 mg/litre were detected.

Although the issue of nitrate in drinking water is highly debated in New Zealand, some European nations and North America have policies in place which strictly adhere to the set drinking water standards. These policies have wider implications on trading partners such as New Zealand For example, the European Commission Directive demands that water used for food processing purposes should be of potable water quality (i.e. nitrate-N < 11.3 mg/litre). According to the recent field nitrogen trial (Ledgard *el al*.. 1996) if a Waikato dairy farmer uses fertiliser at 200 kg N/ha/year loading rate, and assuming the EC Directive is enforced, milk produced is likely to be rejected during the early part of the lactation period due to nitrate level in ground water exceeding the EC standard. It must be emphasised that depending on the aquifer characteristics a similar *mass* of nitrate nitrogen discharged into ground water can result in varying levels of nitrate in ground water This highlights the need to consider a mass loading approach to nitrate contamination of ground water.

Ground water quality management is often narrowly focused on human health and market access. Such an approach may ignore the adverse impact of ground water quality on surface water quality. Like many other regions the Waikato has many spring fed or ground water fed streams or rivers. Most of these

Since fertiliser use is a sensitive regional, national and global issue we have to approach it carefully We believe that the following activities will help achieve sustainable management of fertiliser in the Waikato region by providing.

1. Technical advice to dairy farmers' discussion groups and federated farmers groups regarding environmentally and agronomically sustainable nitrogen management. This involves direct participation by providing information through oral presentations and leaflets.

2. Regional water quality monitoring programmes (ground water, river, streams and lakes) to assess the state of the environment and land use impacts.

3. Collaborative research work with research agencies related to land use impacts on the environment,

4 Ongoing advice to the Foundation for Research. Science and Technology (an agency which is responsible for managing research funding in New Zealand) to facilitate research related to sustainable resource use.

waterways are already enriched with nutrients including nitrate. If ground water quality further deteriorates this will have major impact on regional surface water quality. Consequently, the regional councils should consider the impact of ground water quality on surface water quality as well as human health and market access issues.

Until more research work is done to prove nitrate effects on health and environment, we do not consider it appropriate to contemplate or even debate increasing nitrate loading into the environment. The lessons learnt from the USA and Europe indicate that the long-term nsk to human health and national economies associated with nitrate pollution, far outweigh short-term financial benefits.

Role of the regional councils

At present fertiliser nitrogen use in New Zealand is not regulated through the resource consents process because no regional rules for fertiliser use have been introduced. We understand that Hawkes Bay regional council has proposed a regional rule to control the use of fertiliser nitrogen use on grazed dairy pasture. If *necessary*, rules can be introduced to control the use of fertilisers in our region. This can be done through regional planning. The process is democratic (i.e. proposal of rules by council → submissions by public → review by council → council hearing with public → Environment Court hearing (if there are any disputes) → introduction of fertiliser use rules (if accepted)). Even if the rules are introduced monitoring fertiliser use can be a mammoth task for councils. This will require more resources for councils and will be an added burden for our rate payers.

5. Commitment to work with the industries (fertiliser and farming) to solve environmental problems through collaborative work (e.g. proposed regional fertiliser use survey, bulletins for N fertiliser use) and regular meetings (e.g. Environment Waikato Dairy Liaison Group (EWDLG) and Dairying and the Environment Committee (DEC) Meetings).

6. Policies and plans which set a framework for environmentally sustainable farming.

Role of others:

1. New Zealand Dairy industry's commitment to achieve environmentally sustainable farming and hence the recent formation of the Dairying and environment Committee.

2. The increased focus on environmental research by research agencies compared to the past production orientated research. In recent years, millions of dollars have been spent on environmental research in New Zealand.

3. The increasing environmental awareness among the wider community (including farmers and environmental groups) regarding sustainable resource management.

4. Enactment of the RMA in 1991 which provides for the sustainable management of natural and physical resources.

5. The active role of the Ministry for the Environment in developing national environmental standards and/or guidelines.

6. Increased competition for global market access. Most affluent nations demand 'clean and green' production.

7. The pro-active role of the fertiliser industry to fund research related to environmental issues and to produce fertiliser use code of practice.

Fertiliser-N use bulletins

There are many fertiliser use bulletins available in New Zealand. Due to the prevailing wider environmental awareness farmers prefer bulletins with a balanced approach to agronomy and the environment. Such a balanced approach provides farmers with greater certainty about sustainable fanning practices. Hence it is believed that the proposed bulletin will be a success if the bulletin has the support of environmental and research organisations and the fertiliser industry. We are aware that FertResearch (Fertiliser Manufacturers' Research Association) are in the process of producing a code of practice for fertiliser use. We are yet to review this document, but anticipate that it will be sent to regional authorities for review. We gather that this code of practice has useful information with regard to fertiliser management.

In short, we are not ruling out the possibility of introducing rules to control fertiliser use in our region. We consider this as our *last resort.* If the wider community (including the farmers) believe that rules would be helpful we would consider using them to regulate fertiliser use in our region. We will be closely monitoring the trend of fertiliser use and environmental impacts and advising industry, research agencies and the public. We strongly believe in working in partnerships and this is the most effective way to achieve our environmental goals. Many international environmental authorities are already acknowledging the rapid progress they could make by working in partnership coupled with extensive technology transfer rather than solely relying on regulatory approaches to controlling non-point sources of pollution.

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We fully understand some of the key concerns of FertResearch and the fertiliser industry with regard to providing fertiliser nitrogen loading rates in the code of practice. It has been widely argued by the fertiliser industry that different land uses and soil types will require different rates of fertiliser nitrogen loading and hence it is difficult to recommend universal loading rates. Furthermore, fertiliser industries have serious concerns that some regional councils may use the fertiliser loading rates for regulatory purposes. While we appreciate these concerns, to provide a certainty within the fertiliser industry and farmers, we strongly support fertiliser bulletins with fertiliser nitrogen loading rates that are technically defensible and environmentally and agronomically sustainable.

Following a series of recent meetings between Petrochem, AgResearch, the Waikato Federated Farmers and Environment Waikato a fertiliser-N use bulletin has been produced in August 1996. According to this collaborative project, Petrochem funded AgResearch to produce the technical contents; reviewed by all parties involved, and published and circulated by Environment Waikato with a partial financial support from the Dairying and the Environment Committee. The bulletin emphasises the role of clover as major N contributor to the dairy pasture system and recommends fertiliser-N input as a strategic supplement to clover-N. It does not specify an N loading rate for fertiliser-N, however, draws attention to the recent trials by DRC and AgResearch at Ruakura on different N loading rates and their effects on environment. Late winter we circulated 11500 of these bulletins to the Waikato rural households. We have already noticed that there are other regional councils (e.g. Taranaki, Bay of Plenty, Northland and Auckland) interested in the bulletin and we believe that such a collaborative effort will be useful nationally.

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