ACHIEVING SELF-REGULATION FOR DRAIN MAINTENANCE IN THE NEW SOUTH WALES SUGAR INDUSTRY

By

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KEYWORDS: Acid Sulfate Soil, Self-Regulation, Drain Management Plans, Best Practice Guidelines, Sustainable Development.

Abstract

The farming and development of land where acid sulfate soils (ASS) occur represent environmental issues for sustainable sugar cane production in northern New South Wales (NSW). An initial farm sampling project established the acid sulfate hazard on every cane farm in NSW in order to develop effective and sustainable management. Acid hazard and drain management plans were developed for all cane farms in NSW and the industry has progressed towards the first approved self-regulation scheme for agricultural activities in acid sulfate soil areas in Australia. NSW cane growers are aware of their responsibilities in relation to acid sulfate soils, and manage existing canelands according to best practice guidelines for acid sulfate soils. Achieving self-regulation has come at a significant cost of about US$750 000. The industry is committed to an ongoing cost for maintaining self-regulation, but this investment has had some very positive benefits for the industry. The work undertaken is now regarded as a model for the development of good environmental management by other agricultural industries.

Introduction

The New South Wales (NSW) sugar industry occupies 35 000 ha on the lower flood plains of the Tweed, Brunswick, Richmond and Clarence Rivers. These flood plains have very low slope and the sugar industry relies on an extensive network of drains for efficient production. Drains in this text refer to a range of drainage structures varying in depth from 0.5 m to flood mitigation type channels. The industry operates on less than two per cent of the combined catchment areas, but the lower flood plains contain acid sulfate soils (ASS) that can release acid into river systems. Acid sulfate soils are the common name given to soils containing iron sulfides. When exposed to air, these sulfides oxidise to produce sulfuric acid; hence, the name acid sulfate soils.

Approximately 50% of the 600 NSW cane farms are underlain by acid sulfate soils. Although acid releases are natural phenomena, their cause and effects have only been recognised locally in the past 20 years, with the impact of farm drainage practices on strong acid release receiving attention in the past 10 to 15 years.

Although few new drains in cane lands have been built in recent times, the existing drainage network provides a conduit for the movement of acidity to river systems. Drain cleaning operations and the construction of new drains have the potential to remove pyrite and other acidifying substances, including iron monosulfides, from below the water table, exposing them to oxidation with the subsequent production of large quantities of acid. This paper describes the process of raising grower awareness of the problem and the steps taken to achieve sugar industry self-regulation of drain maintenance operations in acid sulfate soil areas.
Recognising the issue

Cane farmers in New South Wales became aware of the ASS issue following a major fish kill incident in the Tweed River in 1987. After rain, which followed the driest period for 80 years, the river water became clear due to the high levels of aluminium in acid water and remained devoid of aquatic fauna for several months. Poor water quality with pH as low as 2.6 in floodwater discharges from tributaries of the Tweed River following cyclone-induced flooding has been measured (Quirk et al., 2002). Similar incidents had been reported in 1880, 1916 and 1954 but the cause is unknown. Following the 1987 fish kill, the NSW sugar industry received concerted criticism by the Tweed fishing and oyster industries. As this concern spread to the Richmond and Clarence communities, awareness about ASS increased within the sugar industry.

At the 1993 National ASS conference held at Coolangatta, the sugar industry was again criticised by the fishing industry. Adverse media attention led to widespread public concern about ASS and the role of the sugar industry in exacerbating the problem. One NSW government minister suggested the introduction of strict drain water discharge requirements for cane growers, similar to those applicable to point source discharges from industrial sites.

By 1996, the sugar industry had ‘taken ownership’ of the potential problem on cane lands. The industry recognised that the release of acid was a natural phenomenon but assumed a stewardship role in the management of ASS. The industry believed that external regulation and enforcement would not be effective and that only the landholders themselves could solve potential ASS problems. At an early meeting between government natural resource and planning agencies and sugar industry representatives, the possibility of self-regulation by the industry was first raised. Achieving self-regulation became an industry goal.

Awareness, extension and research activities

Early in the awareness phase, the NSW sugar industry developed a practical guide for NSW cane growers on managing acid sulfate soils, ‘Guidelines for Drain Construction and Maintenance in Acid Sulfate Soil Areas’. The NSW Sugar Milling Co-operative in conjunction with the NSW Environment Protection Authority prepared these guidelines. The aim of the guidelines was to alert and inform cane growers of the issue and to provide advice on how to minimise the impacts of drainage works in acid sulfate areas. The guidelines were circulated to all growers and were supported by a series of articles in grower newsletters, presentations at a range of industry meetings and distribution of an information booklet ‘An Introduction to Acid Sulfate Soils’.

The research and extension activity that was most successful in increasing the knowledge base of growers with respect to ASS was the interactive farm sampling project conducted by the Co-operative Research Centre for Sustainable Sugar Production (CRC Sugar) and the NSW Sugar Milling Co-operative. The field phase of this five-year project commenced in August 1996 and involved sampling and analysing soil on all cane farms in NSW. As well as informing growers about ASS, the project served to:

- develop local laboratory capacity to analyse soils for actual and potential acid sulfate conditions, using nationally endorsed methodology;
- establish relationships between field tests and lime requirement;
- allow individual drain management plans to be produced for each farm;
- better define the location of ASS in the cane growing regions of NSW.

Sampling on each farm involved the project officer and the grower using a farm map to first decide on the sampling locations. Soil cores were taken in the lowest part of the farm immediately adjacent to a drain that was being maintained by the grower. The number of soil cores varied from 2 to 3 cores on most farms with up to 7 cores taken on some.

In most cases, sampling took place in the presence of the growers who were able to observe the field testing, have the nature of ASS explained by the project officer, and observe the location and depth of ASS from the project officer if it was present on their property.

In addition to a detailed description of the soil profile, field tests conducted included field pH, reaction to hydrogen peroxide and oxidised pH. A laboratory facility, established at the Broadwater Sugar Mill as part of the CRC Sugar activity, analysed selected samples for total actual acidity, total potential acidity and peroxide oxidisable sulfur. These laboratory parameters were used to calculate the lime requirement of drain spoil.
Towards self regulation

The NSW Government indicated that State planning provisions would be introduced to control drain maintenance and construction in ASS areas. The Government regulators also indicated that there might be an interim measure to exempt industry groups from the provisions of the planning instruments, provided the sugar industry complied with a range of performance conditions.

All growers in NSW are members of the NSW Sugar Milling Co-operative and are signatories to a cane supply contract called a Memorandum of Agreement (MOA). The first alternative to the proposed planning controls was the insertion of a clause relating to earthworks in acid sulfate soil areas in the MOA. The Agreement now specifies that a member of the Co-operative agrees to conduct earthworks, land grading, drain construction and maintenance that may disturb ASS or lower the water table in accordance with the farm drain management plan and the NSW Sugar Industry Best Practice Guidelines for Acid Sulfate Soils. The MOA also specifies that any new cane land will require a drain management plan that addresses any ASS hazard. The Environment Committee of the NSW Cane Growing Industry and NSW Canegrowers Association played pivotal roles in introducing this clause.

NSW local government authorities have Local Environment Plans (LEP) that cover development on land that contains ASS. The objective of the LEP in this regard is to require special assessment for development on land with acid sulfate risk. Under the terms of an LEP, cane growers would require development consent for most earthworks including laser grading or drain cleaning in an ASS area. Local councils would have had to deal with up to several hundred development applications per year, potentially a lengthy and expensive process for both growers and councils.

When councils advertised and sought comment on the LEP, the NSW Sugar Milling Co-operative Ltd made submissions to seek exemption from the consent process in order to permit sugar industry self-regulation in the management of ASS. It was argued by the industry that self-regulation would allow a more practical regime for cane growers given the constraints of weather. It was also argued that the issue could be managed most effectively by all growers adopting an individual assessment of acid hazard and drain management plans, and the Best Practice Guidelines for Acid Sulfate Soils. Compliance would be monitored by an annual audit of drain management practices by the Co-operative and the relevant council.

Self-regulation was accepted by all of the local authorities where sugar cane is grown on the north coast of NSW. Under self regulation, consent for earthworks in acid sulfate soil areas is not required if the land is designated as cane land by the Co-operative and the works are carried out according to a drain management plan issued by the NSW Sugar Milling Co-operative Ltd.

Drain management plans and responsibilities

The NSW sugar industry produced individual ‘Assessment of acid hazard and drain management’ plans for all NSW cane farms (Appendix 1). These plans provided information on location, depth and intensity of ASS and also indicated the circumstances where further sampling would be required. The plans also gave the amounts of lime required to neutralise any acid hazard in the drain spoil and indicated the circumstances under which lime would be required following laser grading. The location of sampling sites was shown on a farm plan and field and laboratory data for individual soil depths presented. These drain management plans were used in conjunction with the best practice guidelines.

Growers are aware of their responsibilities in relation to ASS as indicated by their willingness to accept new terms relating to ASS in their contract with the sugar mill. Under this arrangement, members of the Co-operative are required to manage their existing cane lands according to the best practice guidelines for ASS. The contract includes a clause that any proposed new cane land must be assessed for an acid hazard, and, where relevant, a management plan developed to address the actual or potential hazard.

Changes in attitude and practices

Woodhead (1999; 2003) surveyed cane farmers, tea tree growers, beef producers and dairy farmers in NSW in relation to their knowledge and understanding of ASS best practices and their attitudes to these practices. The survey showed that catchments with a predominance of cane growers had the highest levels of awareness. Cane farmers generally felt they were in control of ASS management and were proud of the way the industry had responded to ASS.

In a survey of farmer attitudes to canegrowing, sustainability and environmental issues, O’Grady and Christiansen (2000) noted that the highest response rate was from NSW growers. They suggested that this may indicate a higher level of awareness and interest in environmental management in NSW and that
the acid sulfate soil management program in NSW may have stimulated greater interest in and acceptance of environmental issues. Almost all NSW growers (95%) were aware of the Best Practice Guidelines for Acid Sulfate Soils and 95% were in agreement with the ASS guidelines.

The increased awareness and knowledge of ASS resulted in improved drain management practices on NSW cane farms. Concurrent with this activity, research in collaboration with Australian Universities showed that practices such as laser field grading, elimination of lateral field drains and regular application of agricultural lime significantly reduced acid discharge (Quirk et al., 2002).

Recognition and publicity

In late 1998, the interactive farm sampling project won a Gold Award in the NSW RiverCare 2000 Awards. This award recognised the highest standards of work achieved by community, education and business groups to improve water quality and river restoration. The project also received an Award for Excellence from RiverCare 2000 in December 2000 for activities continuing to provide ongoing environmental sustainability. In May 2001, this activity won the President’s Medal at the Australian Society of Sugar Cane Technologists Conference in Mackay, Queensland. These awards recognised work in the Australian sugar industry that has led to major benefits for the sustainability of the industry.

A planned program of press releases and media days was implemented to promote the industry’s approach to ASS. There were successful and not so successful encounters with the media. It was difficult to get good news stories into prime position in newspapers and television to raise awareness of the positive aspects of the program. However, the industry considers that the program was worthwhile and will be continued.

Government agencies have reviewed the project, which is now held throughout the Australian sugar industry as the model for tackling a major environmental issue such as ASS.

The cost of self-regulation

The direct cost of achieving self-regulation is estimated at about US$750 000. While the industry took the lead role and has borne most of the cost, other organisations have contributed significantly. These included the CRC for Sustainable Sugar Production, Queensland Department of Natural Resources and Mines, BSES Limited, National Heritage Trust and the NSW government. The major cost components for the industry were soil sampling and analysis of the samples. The best practice guidelines required extensive consultation and took over two years to develop. From 1998 until the final format was agreed upon in March 2000, more than 20 drafts were reviewed involving extensive negotiation with five NSW government agencies. Preparing individual drain management plans is estimated at US$100 per farm. There are ongoing costs of maintaining self-regulation that include annual audit costs and ongoing support for research.

The benefit-cost ratio for the soil survey and analysis components was estimated at 7:1 in a study commissioned by the CRC for Sustainable Sugar Production (Agtrans Research and eSYS Development, 2000). This study considered the costs of regulation avoided by the introduction of drain management plans and benefits to the environment. It undoubtedly overlooked less tangible environmental and community benefits.

Conclusions

The NSW sugar industry is the first Australian rural industry to achieve self-regulation in the management of an environmental issue. The work of the sugar industry in NSW is being used as a model for other agricultural industries in the development of environmental management. Despite the costs in money and time, the approach of the NSW sugar industry has produced positive benefits. It has enabled self-regulation with respect to drain management, given the industry positive publicity in the community, demonstrated to the wider community the NSW sugar industry’s ability to handle environmental issues and raised grower confidence in the industry’s ability to deal with environmental concerns. Recognition of ASS and the development of Best Practice Guidelines for Acid Sulfate Soils have resulted in changes to the way drains are managed.

Acknowledgements

Gaining self-regulation by the NSW sugar industry for ASS is the result of commitment and goodwill by a wide range of people. Those deserving special mention include Julian Collins, Tim Shapter and Tony Meston (Project Officers), T. Balakrishnan (Lab analyst), Yolande Stone and Mike Svikis (NSW Planning Department), Mike Melville (UNSW), Ian White (ANU), Douglas Jardine and Mark Tunks.
APPENDIX 1 – Example Assessment report provided to NSW cane growers

ASSESSMENT OF ACID HAZARD & DRAIN MANAGEMENT PLAN

Farm Name:

Farm Number:

The assessment is part of the NSW Sugar Industry Acid Sulfate Soil Sampling Project (see footnote). The assessment was prepared using field and laboratory data collected during the project.

This farm will be managed in accordance with the current NSW sugar industry best practice document in relation to Acid Sulfate Soil.

Field sampling was carried out on 18/3/99.

Methodology

Two cores were obtained from this farm. The soil was sampled to a depth of 1.5 metres and selected depths subjected to field tests. Samples from core 1 were analysed in the laboratory at Broadwater Mill.

The sites selected were in the lowest sections of this farm.

Drains marked as follows:

- green – farm drains 0.5 m to 0.7 m deep
- red – farm drains greater than 0.7 m deep
- blue – flood mitigation drains

Results

Field and laboratory results are shown in the attached tables.

The field tests can only be used as an approximate guide to the presence of acid sulfate material. A possible indicator of the presence of significant amounts of acid sulfate material is pH values less than 3 after oxidation with peroxide (pHox).

The following Table summarises the results and indicates any likely acid hazard.
Cleaning of drains

Any mechanical cleaning of drains with an acid hazard should remove a minimum of spoil. The acid hazard in the spoil needs to be neutralised with lime as shown in the following table.

<table>
<thead>
<tr>
<th>Sampling site</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Field and laboratory data indicate an acid hazard below a depth of 0.35m</td>
</tr>
<tr>
<td>2</td>
<td>Field data did not indicate any acid hazard to a depth of 1.5m</td>
</tr>
</tbody>
</table>

Liming recommendations have been made considering the depth of drains, depth of a severe acid hazard and allowing a buffer between the bottom of the drain and the acid hazard.

*No liming of spoil (to 1.5m depth) is required around site 2.*

*For ‘spinner drains’ it is best to lime the spoil and the drain after cleaning.*

*When using an excavator or similar it is best to apply lime before drain cleaning. Half the lime should be applied to the drain and half applied to the area on which the spoil will be placed.*

All drainage works on this property will be managed according to the current NSW Sugar Industry Best Practice Guidelines for ASS. If mechanical cleaning is required an open (slotted) weed bucket is recommended to minimise the amount of spoil removed and drains should not be deepened beyond their original depth during cleaning. A laser-guided excavator should be considered as an option for removing spoil.

**New drains**

No new drains should be constructed without further assessment of acid hazard, and if necessary, modification to this plan.

**Laser grading**

Site 1 – an acid hazard occurs 500 mm from the soil surface. If laser grading occurs near this site, any cuts deeper than 300 mm will be treated with lime at 5 to 10 t/ha to the cut area.

_Agricultural Officer_

_NSW Sugar Milling Cooperative_

_Owners and Managers_

This assessment and plan was developed by the property manager in conjunction with staff of the NSW Sugar Milling Cooperative Limited and BSES. The analysis was performed at Broadwater Mill as an activity of the Co-operative Research Centre for Sustainable Sugar Production.

Enclosed: The NSW Sugar Industry Best Practice Guidelines (For Acid Sulfate Soils)

Farm drainage map, Glossary of terms

Acid Sulfate Farm Report

Mill Area:   Farm No:  

93
Grower:
Phone No

See attached glossary for explanation of units and testing procedures

<table>
<thead>
<tr>
<th>Paddock No</th>
<th>Core No:</th>
<th>1</th>
</tr>
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</table>

**Field Data:**

**Sample Date:** 18-Mar-99

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Colour</th>
<th>Texture</th>
<th>Jarosite</th>
<th>Mottles</th>
<th>Reaction</th>
<th>pH (H₂O)</th>
<th>pH ox</th>
<th>Horizon (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.40</td>
<td>Dark Brown</td>
<td>Clay</td>
<td>No</td>
<td>Moderate</td>
<td>5.35</td>
<td>2.7</td>
<td></td>
<td>0–35</td>
</tr>
<tr>
<td>0.70</td>
<td>Dark Brown</td>
<td>Clay</td>
<td>No</td>
<td>Moderate</td>
<td>6.1</td>
<td>2</td>
<td></td>
<td>35–90</td>
</tr>
<tr>
<td>1.00</td>
<td>Dark Grey</td>
<td>Silt</td>
<td>No</td>
<td>Vigorous</td>
<td>7.41</td>
<td>1.8</td>
<td></td>
<td>90–150</td>
</tr>
<tr>
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<td>Dark Grey</td>
<td>Silt</td>
<td>No</td>
<td>Vigorous</td>
<td>7.35</td>
<td>1.7</td>
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<td></td>
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</tbody>
</table>

**Laboratory Data**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>PH (KCl)</th>
<th>PH (ox)</th>
<th>EC 1:5</th>
<th>pH</th>
<th>TAA</th>
<th>TP</th>
<th>TSA</th>
<th>%S (KCl)</th>
<th>%S (ox)</th>
<th>%S</th>
<th>Lime requirement (kg lime / tonne soil)</th>
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</thead>
<tbody>
<tr>
<td>0.4</td>
<td>5.25</td>
<td>4.80</td>
<td>0.0</td>
<td>1.0</td>
<td>1.0</td>
<td>0.03</td>
<td>0.13</td>
<td>0.10</td>
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</tr>
<tr>
<td>0.7</td>
<td>5.15</td>
<td>2.30</td>
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<td>18.2</td>
<td>0.08</td>
<td>0.82</td>
<td>0.73</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>2.00</td>
<td>0.0</td>
<td>36.9</td>
<td>36.9</td>
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<td>1.47</td>
<td>1.40</td>
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<td>34.9</td>
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<td>1.37</td>
<td>66</td>
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<table>
<thead>
<tr>
<th>Paddock No</th>
<th>Core No:</th>
<th>2</th>
</tr>
</thead>
</table>

**Field Data:**

**Sample Date:** 18-Mar-99

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Colour</th>
<th>Texture</th>
<th>Jarosite</th>
<th>Mottles</th>
<th>Reaction</th>
<th>pH (H₂O)</th>
<th>pH ox</th>
<th>Horizon (cm)</th>
</tr>
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<td>No</td>
<td>40% OR</td>
<td>Slight</td>
<td>7</td>
<td>5.79</td>
<td>0–15</td>
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<tr>
<td>0.70</td>
<td>Light Blue/Grey</td>
<td>Fine Sandy Silt</td>
<td>No</td>
<td>Slight</td>
<td>7.08</td>
<td>5.38</td>
<td>15–50</td>
<td></td>
</tr>
<tr>
<td>1.00</td>
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<td>Fine Sandy Silt</td>
<td>No</td>
<td>20% OR</td>
<td>Slight</td>
<td>7.2</td>
<td>5.67</td>
<td>50–90</td>
</tr>
<tr>
<td>1.50</td>
<td>Medium Blue/Grey</td>
<td>Fine Sandy Silt</td>
<td>No</td>
<td>40% OR</td>
<td>Vigorous</td>
<td>7.3</td>
<td>5.78</td>
<td>90–150</td>
</tr>
</tbody>
</table>
LA RÉALISATION DE L'AUTORÉGULATION DANS L'ENTRETIEN DES DRAINS DANS L'INDUSTRIE SUCRÈRE DE LA NOUVELLE-GALLES DU SUD

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MOTS-CLÉS: Sol sulfaté Acide, Autorégulation, Plans de Gestion de Drain, Directives pour une Bonne Gestion, Développement Durable.

Resumé
La culture et le développement des terres avec des sols sulfatés acides (SSA) présentent des problématiques environnementales pour la production durable de canne à sucre en Nouvelle-Galles du Sud (NGS). Un premier projet d'échantillonnage des terres a permis d'établir la proportion de sols sulfatés acides sur chaque ferme de canne de la NGS permettant ainsi leur gestion efficace et durable. Des plans pour la gestion des risques d'acidification et des drains ont été mis en place sur toutes les fermes de canne dans la NGS et l'industrie a fait un pas en avant vers le premier système agréé d'autorégulation des activités agricoles dans les régions avec des sols sulfatés acides en Australie. Les cultivateurs de canne de la NGS sont conscients de leurs responsabilités par rapport aux sols sulfatés acides, et cultivent les terres à canne existantes selon les directives établies pour une bonne gestion des sols sulfatés acides. La réalisation de l'autorégulation a été atteinte au coût important de US $750,000. L'industrie s'est engagée à en faire les frais pour maintenir l'autorégulation, puisque l'investissement a donné quelques avantages très positifs à l'industrie. Le travail entrepris est maintenant considéré comme un modèle pour le développement de la bonne gestion environnementale par d'autres industries agricoles.

EL LOGRO DE AUTO-REGULACIÓN PARA LA MANUTENCIÓN DEL DRENAJE EN LA INDUSTRIA AZUCARERA DE NEW SOUTH WALES

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Resumen
El uso agrícola y el mejoramiento de las tierras, que contienen suelos ácidos sulfatados (ASS) traen problemas ambientales para la producción sostenible de la caña de azúcar al norte de New South Wales (NSW). Para poder desarrollar un sistema de administración efectivo y viable un proyecto piloto de muestras de suelo reconoció el peligro del sulfato acido en todas las plantaciones de caña de NSW. Planes contra el riesgo del ácido y para el manejo del drenaje fueron elaborados para todas las plantaciones de caña en NSW y la industria pudo progresar hacia el primer esquema de auto-regulación aprobado para actividades agrícolas en áreas con suelos de sulfato acidos en Australia. Los productores en NSW son conscientes de su responsabilidad en relación a los suelos ácido-sulfatados y administran las tierras de caña de acuerdo a las mejores directrizes técnicas para éste tipo de suelo. La auto-regulación fué lograda a un costo significativo de cerca de US$ 750,000. Además la industria se comprometió a cubrir un costo permanente de manutención de la auto-regulación; éste investimiento ha traído beneficios muy positivos a la industria. El trabajo emprendido es ahora considerado como un modelo para el desarrollo de una buena administración del medio ambiente por otras industrias agrícolas.