ifs Fertiliser Update
News and views about fertilisers and crop nutrition

Issue 1 March 2017

Welcome to the first edition of Fertiliser Update

This new initiative by the International Fertiliser Society is intended to provide you with interest and enjoyment about developments within the fertiliser industry, carrying articles that explain, evaluate, critique or comment upon topical issues.

It will provide a platform for the views and activities of IFS Members, which we hope you will find stimulating, even if you don't always agree with them! As such, it will augment the papers presented at our Conferences, whilst staying true to the Society's traditions of evidence based rigour, independence and commercial neutrality.

Fertiliser Update will be published two or three times a year. It will cover a variety of aspects of both the agronomic and technical parts of our industry, and may venture where our conferences tend not to.

The articles in Fertiliser Update will be proposed and written by IFS Members. We have set up an editorial group whose role is to select articles for each issue, and then edit submissions to ensure that they meet the criteria above.

In this first issue we have three articles, covering a new approach to soil analysis from New Zealand, a demonstration of the IFS's new searchable database of Proceedings, and an article on the hazard of decomposition in fertilisers.

The success of Fertiliser Update will depend upon you. It provides you with a platform to put your views and experiences across to your compatriots. If there is a development in your part of the industry, that you think is important and that you have views on, let us know what you think and why. If someone writes an article that you don't agree with – don't just sit there; send us your riposte. To help, we have developed a detailed guide on how to write appropriate articles.

We anticipate that Fertiliser Update will evolve over time, as we see what works best and what approaches are most appreciated. So the more feedback you can provide, the better we will be able to make it. Please let our Secretary, Steve Hallam, know what you think.

Enjoy!

Antoine Hoxha
President of the International Fertiliser Society

Soil testing from the sky?

Dr. Ants Roberts, Ravensdown Fertiliser Co-op Ltd

Introduction

New Zealand produces a significant amount of meat and fibre for export from its sheep, beef and deer farms, many of which are large hill country farms ranging in size from 500 to over 3,000 hectares (ha). These farms cover a wide range of varying land slope, aspects, soil properties and altitudes (see Figure 1), all of which affect the potential productivity of the grass/legume pastures, the primary animal feed source on these farms. Soil fertility management has been accomplished by soil testing using traditional methods of physically collecting a number of soil samples representing different management areas of the farm to accommodate the variability

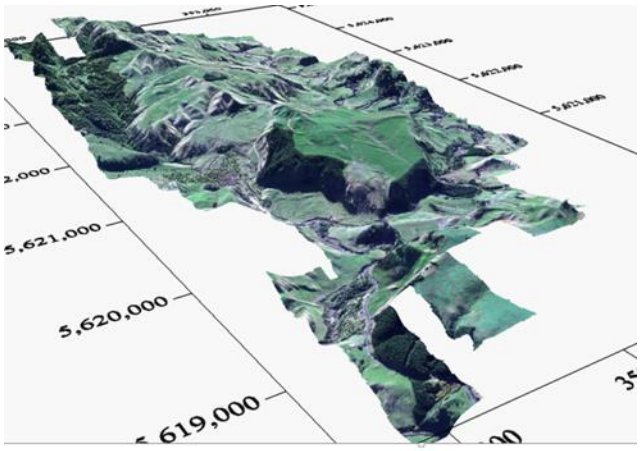


Figure 1: *Digital terrain map of a hill country farm, Whanganui, New Zealand.*

discussed above. Given the large areas of these farms there is a limit to how many samples are collected to represent the farm's soil fertility. Fertiliser nutrient and lime application decisions are then formulated, taking into account current soil fertility, animal productivity, costs of fertiliser, returns for products, physical attributes of the farm and farmer objectives. While this approach has served our farmers well in the past, shrinking margins require that we maximise the return on fertiliser nutrient investment on these farms.

Pioneering to Precision

We are currently in the fourth year of a seven year research project, Pioneering to Precision, under a Primary Growth Partnership (total budget $NZ14 million) whereby half the monetary investment is from the NZ Ministry of Primary Industries and half is from our shareholders who own Ravensdown, their fertiliser co-operative. Our research providers are the Centre for Precision Agriculture at Massey University and AgResearch, a Crown Research Institute. The concept being developed is to use push-broom hyperspectral imaging, using wavelengths from 400 (visible spectrum) through to 2,500nm, from a fixed wing aircraft to detect the nutrient content (and other properties) of pasture across whole farms. In a two-step process the remotely sensed pasture nutrient content will be used to assess the underlying soil fertility status. The key to making imagery successful is calibration and this project is collecting a total of over 20,000 soil and pasture samples from 400 measurement sites at 80 different locations on 8 commercial farms spread across the country. Once successful, this will mean that, instead of the usual 5-20 soil sampling transects (from each of which 15-20 soil cores are bulked), there will be 10,000 locations sensed per hectare (20 million locations over a 2,000ha farm) and with 448 data points per location there will be 8.96 billion data points for a farm this size. The results to date indicate that we are confident of the relationship between the hyperspectral imagery and the plant nutrients nitrogen (N), phosphorus (P), potassium (K) and sulphur (S). This is shown in Figure 2, which is the same farm shown in Figure 1. The potentially more difficult step of meaningfully calibrating the plant nutrient content to underlying soil fertility is currently under scrutiny.

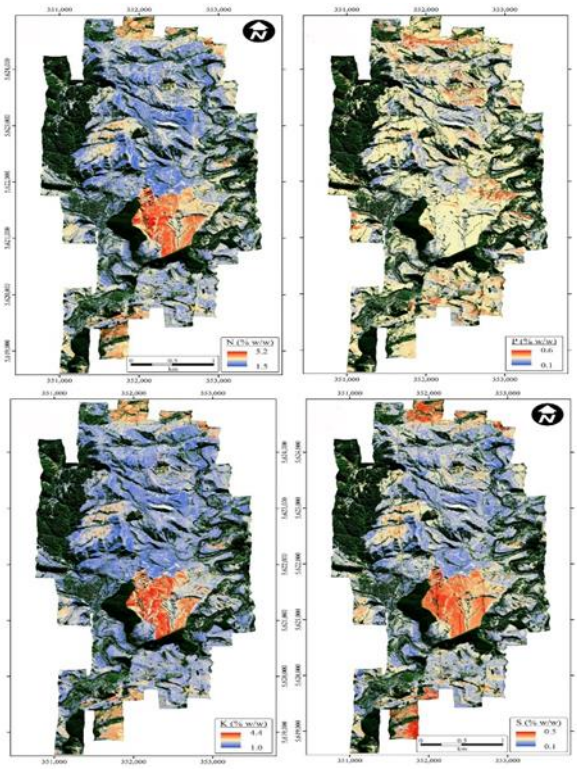
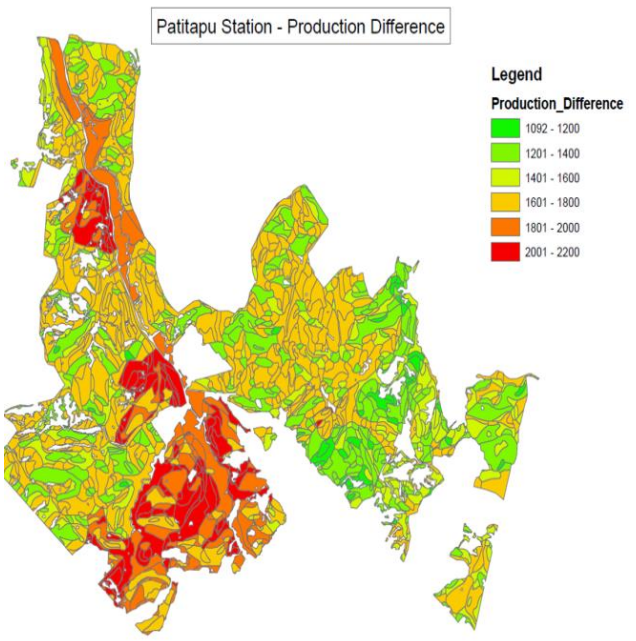


Figure 2: *Pasture N, P, K and S content determined by remote sensing.*

Making better fertiliser decisions

Allied to this project we have developed other tools which use slope, aspect, altitude, soil moisture properties to predict current and

potential (assuming optimal soil fertility) pasture production as well as the responsiveness of the pastures across the farm to N fertiliser application. These predictions, along with a cost:benefit analysis of maintaining or increasing soil fertility (and hence pasture productivity), will greatly support our decision making around the right nutrient, at the right rate, place and time. For example, using GIS linked farm mapping the two images in Figure 3 show the difference between estimated current pasture production and potential pasture production on Patitapu Station, an 1,810ha Wairarapa hill country farm. Currently, we have two fixed wing aerial topdressing planes which have GPS/GIS based aperture control which allows variable rate fertiliser application. This means that non-productive areas of the farm, native bush, plantations and sensitive waterways, can be avoided and different rates of different nutrients (at different times) can be applied to farms. Variable rates of superphosphate (P and S) were applied to Patitapu Station this year, informed by the production difference map and soil fertility assessment (Figure 3). The application map in Figure 3 is actually a 'proof of release' map i.e., the aperture door was open rather than 'proof of placement'. We are working on 'proof of placement', but that is another story for another day!



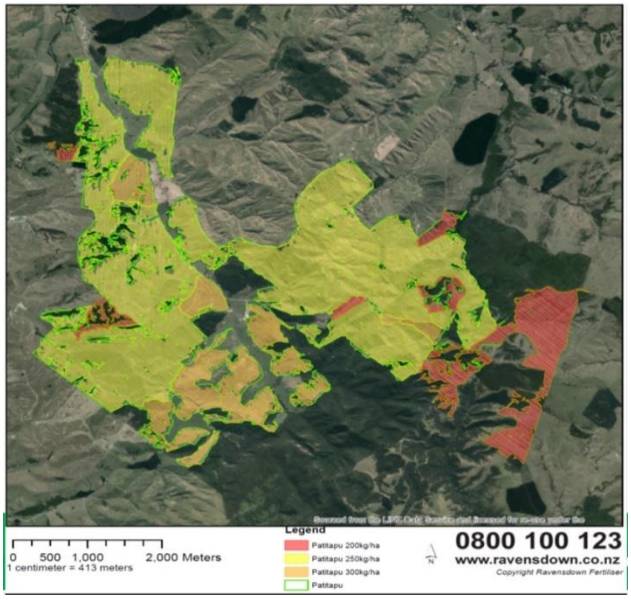


***Figure 3**: Potential production difference and the subsequent application of superphosphate on Patitapu Station.*

Getting the best from the new IFS searchable database of Proceedings

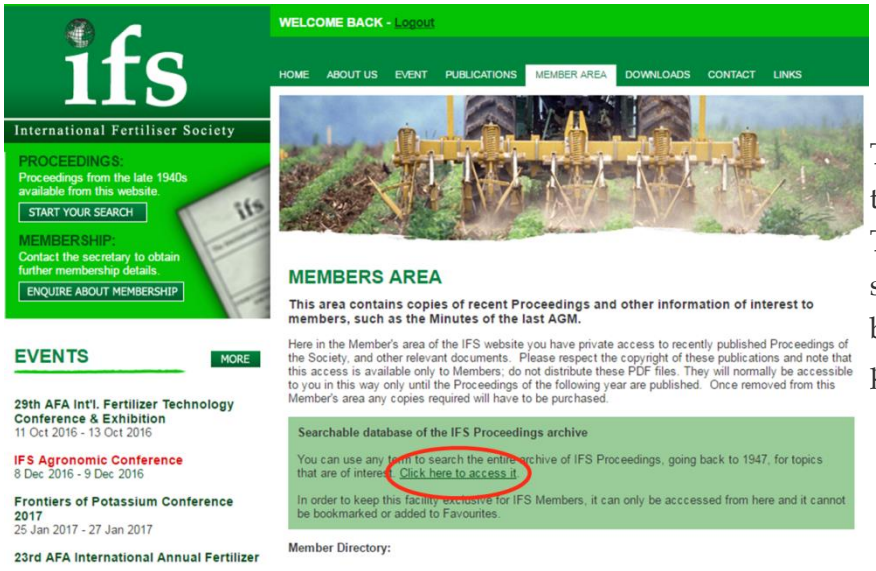
The new searchable database of IFS Proceedings has been developed to make it easier for Members to gain value from our archive of 800 Proceedings. It enables you to identify which Proceedings contain information relevant to specific topics that are of interest to you. Members who have tried it have been pleased with its ease of use and the value of the search results, but we know that many of you have still to try it out.

The search facility enables you to conduct searches using any search term, including chemical formulae. Searches can be refined by using 'nested' searches, down to three levels. The results shown can be focused by being limited to a particular time period, range of Proceedings numbers, or author. Users have the flexibility of carrying out searches within the main text of Proceedings, or just within their references, summaries, titles or names of authors.

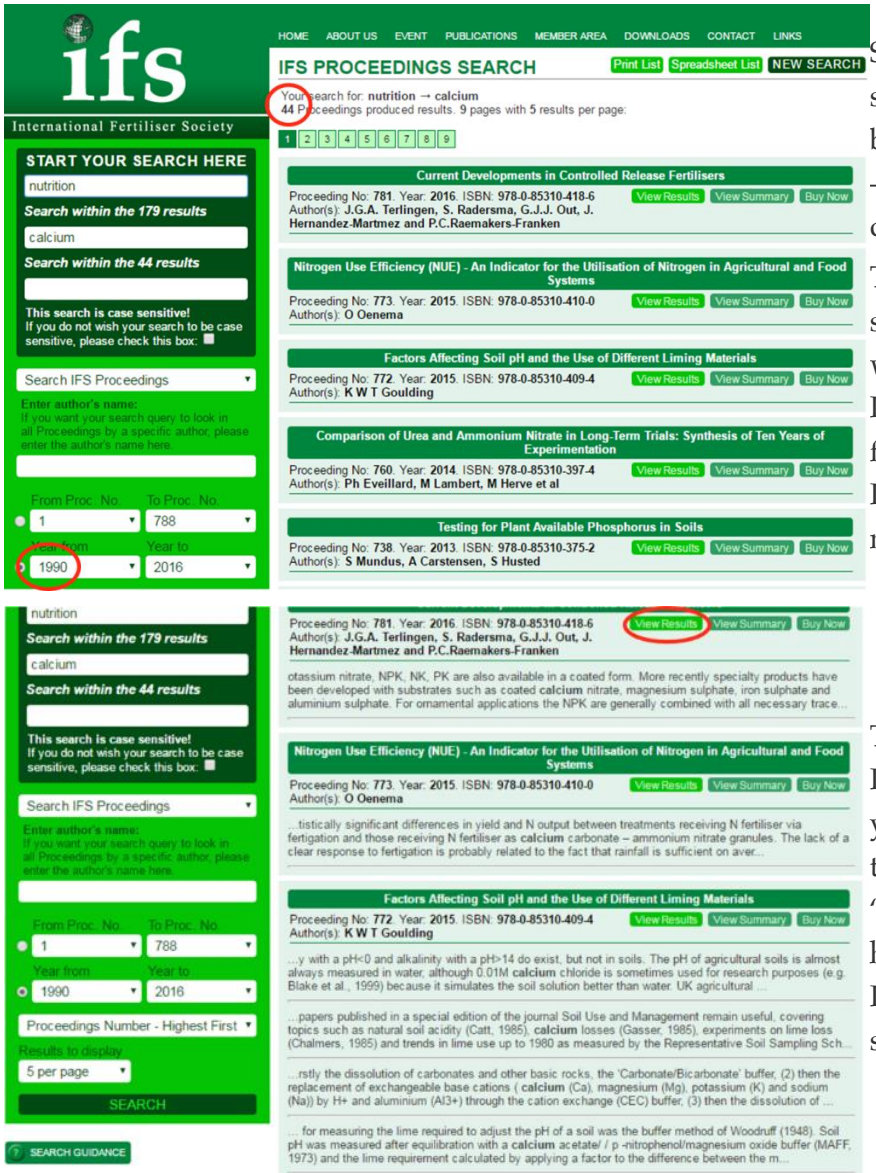
This article demonstrates how to use this search facility and get the best out of it

You access the search facility from the Member area of the IFS website, by clicking on the link

circled in red, as shown in this screengrab.



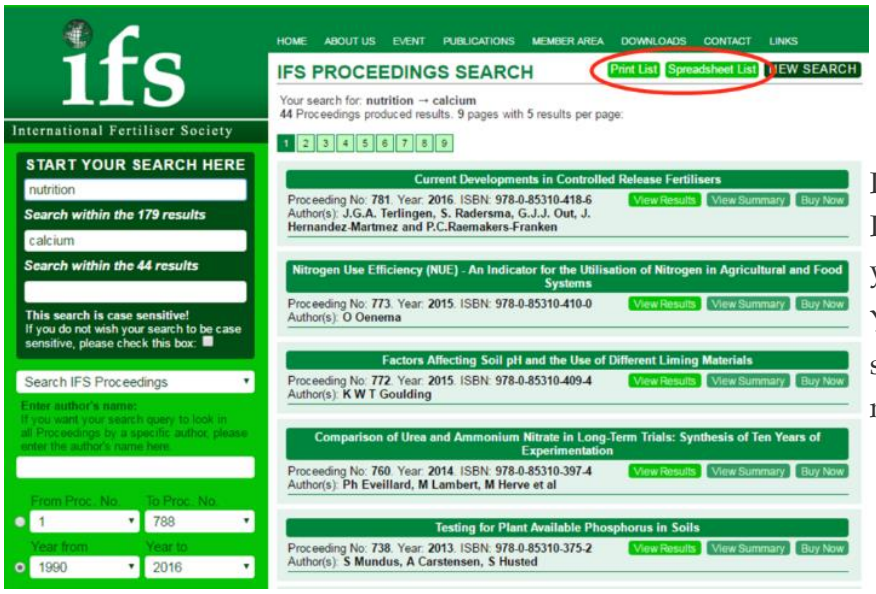
To show how to use the database, we took the topic of 'calcium nutrition'. Typing this phrase into the 'Start your search here' box produced no results, because no authors have used this phrase.



So we typed 'nutrition' into the top search box and clicked the Search button. This produced 179 Proceedings – but many of these are irrelevant to calcium.

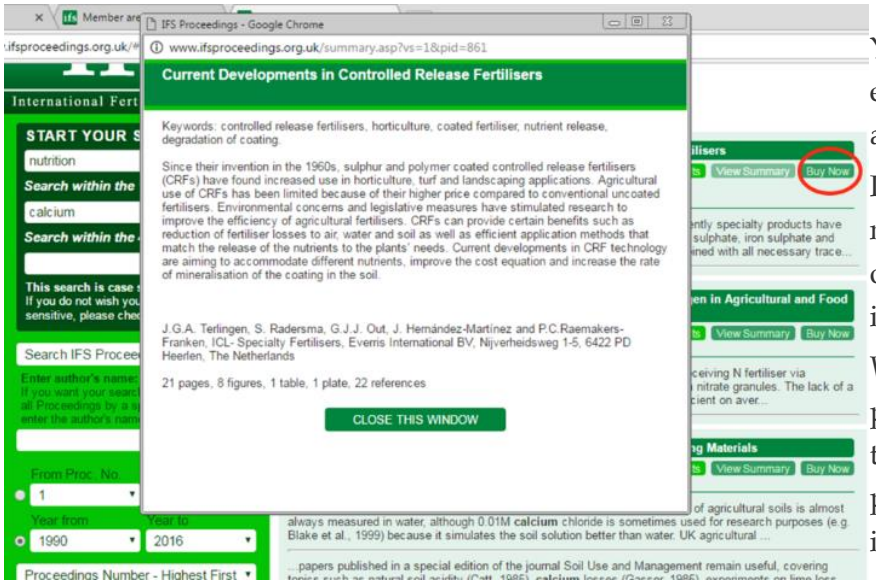
Typing 'calcium' into the second search box produced 88 Proceedings, which we felt was still too many. Restricting the search to Proceedings from 1990 onwards produced 44 Proceedings, which felt a manageable number to look at in more detail.

The first step in evaluating each Proceedings is to view the instances of your last search term as they appear in the text. You do this by clicking on the 'View Results' button. You can see how many instances there are in each Proceedings, and what each one is saying.



If you wish, you can print out the list of Proceedings that have been found. Or you can export the list to a .csv file.

You may find either of these easier to scroll down than viewing a large number of Proceedings on screen.



You can also view the Summary of each Proceedings, to see what it addresses.

If it looks useful you can use the 'Buy now' button to go straight to the page on the IFS website where you can buy it.

We are currently developing a new pricing structure for IFS Proceedings that will reduce the costs of multiple purchases. There will be more information on this soon.

Decomposition Hazard in Fertilisers

Mr Kish Shah MBE

What is decomposition?

Decomposition is a chemical reaction process in which a substance breaks down into a number of other chemical species under the influence of, for example, heat or presence of a catalyst.

Potential Hazards associated with Decomposition

From the safety standpoint there are three main aspects of interest: most of the decomposition reactions relating to fertiliser materials result in the release of gases some of which can be toxic and thus potentially hazardous. Secondly, the process can lead to a build-up of pressure if the gases produced are not allowed to escape. Thirdly, some of the reactions are exothermic in nature; this can under certain conditions cause an accelerating effect, which can lead to a potentially explosive or self-sustaining condition. Therefore, decomposition should be regarded as a potentially hazardous phenomenon, deserving proper understanding and requiring appropriate controls.

Factors affecting Decomposition

The main factors which can affect the rate of decomposition include chemical nature of the substance, temperature and presence of a catalyst (where applicable) or contaminant. In practice

inadvertent mixing of fertilisers with chemicals (e.g. KOH) or improper mixing of non-compatible fertilisers (e.g. TSP + CAN) can lead to decomposition.

Decomposition in Gases and Liquids

Gaseous phase reaction is uncommon and not particularly important from the safety point of view. Decomposition in liquid phase can occur under certain conditions, leading to potentially hazardous situations in some cases. For example, hot ammonium nitrate (AN) melt stored in a tank, if acidic due to loss of ammonia and suitably contaminated, can start to decompose exothermically, releasing toxic gases and causing pressurisation if not adequately vented.

Decomposition in Solid Fertilisers

The phenomenon of decomposition in solid fertiliser is comparatively much more relevant and important.

Decomposition in AN is complex and involves a number of reactions: (i) endothermic reversible dissociation into ammonia and nitric acid vapours and (ii) exothermic irreversible reactions. Acid conditions and presence of certain substances, notably chlorides, enhance the decomposition rate. If the reaction gases cannot escape freely, the heat-absorbing dissociation can reduce/stop and the overall effect can become more exothermic which can lead to a rupture of the equipment or vessel with explosive effects under severe conditions. This 'heating under confinement' is of particular significance for hot work on equipment, which has been used for handling or processing AN-based fertiliser and which may still contain its deposits due to inadequate cleaning and/or inspection.

AN-based fertilisers are thermally stable and are not prone dangerously to self-heat in normal conditions of storage. They require input of external heat to initiate decomposition. Consideration of the potential decomposition hazard is important for AN-based compound fertilisers, which contain chloride e.g. in the form of muriate of potash (MOP).

In many cases, the decomposition, initiated by an external heat source, will stop when the source is removed. With some fertilisers, however, the decomposition will continue and spread deep into the mass of material **even when the heat source is removed**. This is the phenomenon of **self-sustaining decomposition (SSD)**, sometimes referred to as 'cigar burning' where the decomposition propagates through the mass of the material.

In case of a self-sustaining decomposition its characteristics, e.g. speed of propagation, temperature in the decomposition zone and amount of gas produced, depend on the composition of the fertiliser and on the extent of melting at the decomposition temperature. The presence of compounds of trace elements such as copper and impurities such as chromium ions can increase the decomposition rate. It is important, therefore, to be aware of this hazard and assess the product safety before and when adding micronutrients and other additives.

An official test, known as the Trough test (see UN publication: Recommendations on Transport of Dangerous Goods, Manual of Tests and Criteria) is commonly used to determine the SSD behaviour and to measure the speed of propagation. The self-sustaining decomposition area is shown in an illustrative diagram, Figure 1. The risk of SSD is enhanced when the fertiliser is stored in bulk and is affected by a source of heat.

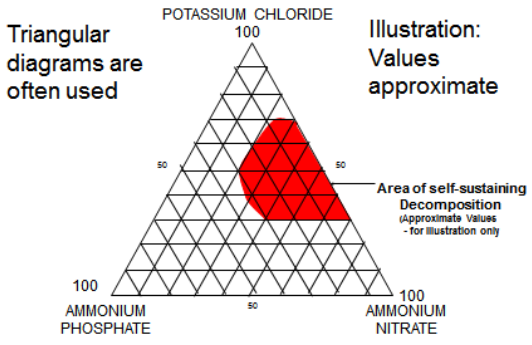


Figure 1: *The area of self sustaining decomposition.*

During decomposition of compound fertilisers, e.g. caused by heating, copious amounts of fumes are given off which contain water vapour and various toxic gases such as oxides of nitrogen, hydrogen chloride, ammonia and chlorine depending on the composition of the fertiliser. The fumes may also contain ammonium chloride and ammonium nitrate, which along with the water vapour can markedly reduce visibility.

Control of Decomposition

Water has been found to be the most effective agent; special lances which permit penetration of the solid heap and injection of water into the base and interior is particularly helpful. Infra-red cameras are useful for locating the decomposing mass in poor visibility.

DISCLAIMER: The information in this article is given in good faith; the author accepts no liability for any loss or damage.

Editor's Note: Kish will be presenting a paper at the 2017 IFS Technical Conference on 29-30 June. This will cover recent developments in United Nation's classification schemes and European Union's security related legislation, which will impact upon the fertiliser industry.

Our thanks to the members of the editorial group responsible for the content of Fertiliser Update: Kevin Moran (Chair), Kieran Murphy, Jacques Neetesen, Hans Reuvers and Charlotte White.

The International Fertiliser Society is a scientific Society founded in 1947, with members in approximately 50 countries worldwide. Its main objectives are:

To provide an international forum for discussion and dissemination of knowledge of scientific, technical, environmental, economic and safety aspects of the production, marketing, use and application of fertilisers.