Production and Environmental Gains from Shell Canada's Sulphur Enhanced Fertilizer (SEF) in Rice and Soybeans in China.

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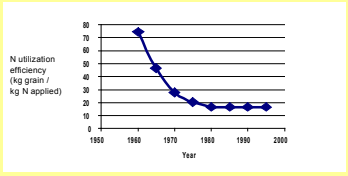
INTRODUCTION

- Increased N and P consumption of so called "high-analysis" fertilizers, together with higher crop yields and more intensive agriculture has led to an increased incidence of sulphur deficiency.
- This nutrient imbalance has resulted in decreased N use efficiency.
- World average N utilization efficiency fell from approximately 75 kg grain/kg N applied in 1960 to 18 in 1995.



Source:FAOSTAT

- Lower N use efficiency leads to increased N losses as ammonia (NH_3) and nitrous oxides (N_2O), both of which are harmful to the environment.
- Many ways have been devised to add S to finished fertilizers but most have deficiencies such as explosion hazard during manufacture, unavailability of the elemental S due to large particle sizes and granules not breaking down and releasing the S when the plant requires it.
- Shell Canada has developed SEF which has been proven to be agronomically effective, resulting in increased N use efficiency and in benefits to the environment.

SEF – SULPHUR ENHANCED FERTILIZER

- SEF- Sulphur Enhanced Fertilizer, is the addition of particles of elemental sulphur to high-analysis MAP, DAP and NPK fertilizers, in a novel fashion.
- As a fertilizer nutrient, sulphur (as sulphate) is required by crops in a ratio of approximately 1:1 to phosphorus.
- Without sufficient sulphate, plants are not able to use nitrogen efficiently which limits yields and in turn limits carbon sequestration in soils.
- Under Shell Canada Limited's direction, SEF was developed and tested at IFDC.
- The IFDC testing resulted in the production of prototype high-analysis fertilizers with entrained sulphur particles, sized such that the sulphur particles oxidize quickly and thereby become readily available to plants as sulphate.
- A range of SEF products have been evaluated in greenhouse studies in Canada and field trials in Australia, Brazil and China.
- These field trials have resulted in an average yield gain of 10%.
- These higher yields have been obtained without increasing N and P application rates.
- The higher N use efficiency would likely result in reduced production of the greenhouse gas N_2O.
- The higher yields of crop residues contributes to carbon sequestration in soils.

SEF ENHANCEMENT OF NITROGEN USE EFFICIENCY (NUE)

In field trials in China increases in NUE in both rice and soybeans resulted in considerable fertilizer N "savings" (i.e. higher yield with the same N application rate) (see table below). The better utilization of N by the crops results in less N being available in the soil for leaching and losses as N_2O, a major greenhouse gas.

Fertilizer	Grain Yield (t/ha)	Nitrogen Use Efficiency (NUE) (kg grain/kg N applied)	% increase in NUE over nil S control	Fertilizer N "saving" (kg/ha)	% N "saved"	Potential N_2O emission saving[1] (kg/ha)
Rice						
- S control	6.53	43.9				
SEF	7.07	48.0	9.4	12.3	6.2	3.9
Soybeans						
- S control	1.89	30.6				
SEF	2.13	34.5	12.6	7.8	11.7	1.2

[1] Assuming loss of fertilizer N as N_2O at 20% for flooded rice and 10% for soybeans. 1kg N when denitrified produces 1.57 kg N_2O

SEF ENHANCEMENT OF CARBON SEQUESTRATION

Additional tops and root yields contribute to stored soil carbon by increasing soil organic matter as shown below. Maximum gains are in temperate areas where all the additional crop residues are returned and amount to in excess of 8t CO_2/ t S applied

Region	Residue management	Incremental CO_2 sequestration (t CO_2/ha)	Incremental CO_2 sequestration per tonne of S applied (t CO_2/t S)
Temperate	All returned[1]	0.25	8.26
Temperate	All removed	0.08	2.75
Tropical	All returned[1]	0.17	5.51
Tropical	All removed	0.06	1.84

[1] In all residue returned areas additional residue returned = 10% of tops = 0.6 t/ha. In all cases 50% of additional roots produced (0.3t/ha) are assumed to remain in the soil. It is assumed that 15% and 10% of the returned crop residues contribute long term to the soil C pool in temperate and tropical areas, respectively.

References: Lal R(1997), Soil and Tillage Res. 43:81, Blair N et al. (2005), Soil and Tillage Res. In press