Enhanced Efficiency Fertilisers
Forms and Function in Sustainable Agriculture

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World population growth

BUT the most significant issue is not just growth, it is increasing affluence of the population.

Assume no global population growth and only China’s pop. equals USA’s per capita consumption –

Global consumption would have just doubled.
The Global Food Crisis

• The human population is growing (+50% in 50 yrs)
• There is a global water crisis (2/3 of fresh water is used to grow food)
• We are running out of nutrients (Phosphorus supply has 60 to 130 years left at present consumption)
• Biofuel production is eating into food production areas
• 30 year decline in food crop research.
• Price of fuel, fertiliser and chemical rising sharply
• Politics and economics is working against agriculture
• THE CLIMATE IS CHANGING

Food security - WFP

• Food riots have broken out in Morocco, Yemen, Mexico, Guinea, Mauritania, Senegal and Uzbekistan.
• Pakistan has reintroduced rationing for the first time in two decades.
• Russia has frozen the price of milk, bread, eggs and cooking oil for six months.
• Thailand is also planning a freeze on food staples.
• After protests around Indonesia, Jakarta has increased public food subsidies.
• India has banned the export of rice except the high-quality basmati variety
• China introduced 175% export duty on fertilisers
Nitrogen

• Without in-organic nitrogen fertiliser, the world could only sustain 60 per cent of its current population,

Contributing to Sustainable Development, a recent report by the European Fertiliser Manufacturers’ Association.

Phosphorus global outlook

![Fig. 5: Lifetime of reserves](image-url)
How much do we use?

PHOSPHORUS

SUSTAINABILITY

‘Old’ view

‘New’ view

Without a sustainable environment – there is no sustainability
• Sustainability of our environment from a fertiliser use perspective is linked to the following:

“A safe operating space for humanity”, defined critical biophysical sub-systems that are critical to a stable environmental state and thereby humanities ongoing development. These were defined as:

**Anthropic Climate change**
Rate of biodiversity loss

**Land and water degradation**
Interference with global nitrogen and phosphorous cycles
Stratospheric ozone depletion
Ocean acidification
Global fresh water use
Change in land use
Chemical pollution
Atmospheric aerosol loading

Johan Rockstrom and 28 colleagues from Climate Change research centres worldwide

• **OECD Agricultural Directorate**

“For the fertiliser industry to contribute to achieving sustainable agriculture, the future strategy should be to encourage improvements in fertiliser management and efficiency rather than just growth in fertiliser production”

CRF technology does this
India

“The Forum commended the new policy on fortified and coated fertilizers in the country and felt that availability of fortified/coated fertilizers will help increase agriculture productivity in a big way. The Forum made an appeal to the fertilizer manufacturers to produce and make available more fortified/coated fertilizers in the country.”

Products to Improve Fertiliser Use Efficiency

Technologies available:

**Nitrogen only:**
Inhibitors
- Urease
- Nitrification

Slow release Fertilisers (Chemically slow release N only up to 3 mths)
- Methylene Urea
- IBDU
- CDU

**Nitrogen, Phosphorus and Potassium (TE as well)**

Controlled Release (Coated) Fertilisers
Inhibitors

• **Urease Inhibitors** — Interfere with urea hydrolysis to \( \text{NH}_4 \) and thereby reduce localised acidification and \( \text{NH}_3 \) volatilisation.

• **Nitrification Inhibitors** - Interfere with the biological oxidisation of ammonium to nitrate N

### Controlled Release (coated) Fertilisers and the Environment
Osmocote Exact

- Nice round granules
- Homogeneous
- Even coating thickness
- Few irregularities

Coating - Alkyd Resin derived from vegetable oils
- N,P,K and traces released together
- Longevity claims correct

Example 4

- regular coating
- round granules
- homogeneous thickness

- Thermosetting Dual coating of polyurethane and a wax
- Performance
  - high initial release, especially the 9 months
  - 5/6 months product is faster than 4 months (about 30% faster after 70 days)
Coating irregularities

- potato shape
- thickness not homogeneous
- granule inside is heterogeneous

- Coating technology -Semi-permeable, polyurethane
- Claims correct
- Poor release of Mg and Fe
- Release of P not efficient

Example 3

China is moving quickly in CRF manufacture & research

Managers:
- Han Feng (Agrium)
- Kingenta
- Shi Ke Feng
- Shang Dong Jin Zhang Da
- SanYuan Planta Controlled Release Fertilizer Company

CRF Research Centres China
- Shi Jia Zhuang Ag. Res. Centre
- China Scientific Inst. – Nan Jing
- Shan Dong Ag. University
- Sth East Ag. Uni. (Guangzhou)
- Phos. Fert. Res. Centre
- Applicational Bionomics Res. Centre
- Biejing Ag. Science Inst.
- China Ag. Uni.
- Guang Dong Ag Science Inst.
Fluid Bed of Commercial scale

Total Capacity designed as 50,000 ton/Y,

Osmocote Coating Line
Scotts Technologies

- Scotts markets 3 basic coating technologies
  - Osmocote – NPK, NPK+TE
  - Poly S (PSCU) – Urea, KCl, SOP
  - AGRICOTE (PCU, PCNPK, KCl, SOP, MAP)
History of Osmocote development

Osmocote Development

1967
Controlled release
- Controlled
- Longevity

1st generation

1983
Osmocote Pro
Controlled release
- Phases
- Nutrient release

2nd generation

1995
Osmocote Plus
Controlled release
- Phases
- Nutrient release

3rd generation

1999
Osmocote Exact
Patterned release
- Longevity
- Nutrient release

4th generation

2005
Osmocote Exact
Protected Patterned release
- Programmed release
- Uniformity

Osmocote Exact matches the plant need and maximises efficiency of uptake

lo-start
standard
hi-start
Osmocote Hi End – Dual Coating Technology

Current situation

NEW!

Important: the graph is showing an OEI fully double coated. This raw material can be used in other products.
PolyS - PSCU

Used in agriculture and professional turf

CRF Impacts on Soil and the Environment

Environmental Stewardship
- Reduce nutrient (nitrate) leachate & volatilization to environment
- Returning purer water to watersheds and ground water
- Less impact on eutrophication (less algae)
- Lower N & K rates (60% of conventional rates) and fewer applications
CRF Impacts on Soil and the Environment

**Reduce operational costs**

- Reduce number of field visits
- Labor savings & labour efficiencies
- Fuel and equipment savings

CRF and Global warming

- Nitrous Oxide (N₂O) is the 4th largest contributor to greenhouse gases.
- Agricultural activity contributes 60% of N₂O - 5% (16.3% aus) of all greenhouse gases (N₂O is 310 X worse than CO₂ as a greenhouse gas) —
  - 3% from animal farming
  - 2% due to N fertiliser use (2-4 mill tonne / yr.)
    - Direct - N₂O emissions (19%)
    - Indirect (41%) from leached N in waterways and
    - Ammonia volatalisation – CRF reduces volatalisation by 70% vs Urea applications
- CRF can minimise this and help reduce global warming.
- Nitrous oxide credits or carbon offset credits *may be converted into value with state and national agencies*
CRF and the Environment

- **Trial Results**
  - 38% reduction in Nitrogen used
  - 83% reduction in nitrate leaching
  - 17% increase in yield
  - Increase in Nitrogen efficiency from 25-50% for Std. Practice to 60-85% for CRF
  - Increase P efficiency dramatically (5% - 80%?)

- **No adverse effects on soil health**
  - Will not cause soil acidification
  - Maintains a low salt reading in the soil - helping soil micro-organisms and worms
  - Encourages deeper plant roots (organic carbon contribution)

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38% reduction in Nitrogen used

- Less N produced uses less energy = lower production of greenhouse gases
- Reduced labour and able to be mechanised
- Reduction quantity to transport = lower costs and transport pollution
Phosphorus is in limited supply (<100 yrs). Improved efficiency needed to reduce usage. CRF can do it.

Utilisation of applied Phosphorus
-Acacia mangium @ 7 years

Algal bloom in Qingdao from Ag pollution
83% reduction in Nitrate leaching

- Reduced groundwater pollution (Blue baby syndrome)
- Reduced algal blooms (Eutrification)
- More N to the plant (Increase in Nitrogen efficiency from 25-50% for Std. Practice to 60-85% for CRF) and therefore higher quality, yield (17% increase)
- Pest and pathogen resistance due to healthier crop and better cell structure (reduced pesticide use).

Reduced Leaching

![Leaching of Coated Fertilizers vs Soluble Fertilizer](chart.png)
Citrus Fertilization Study South Florida 2006

Schumann et al 2006. Lake Alfred Research Center

Cumulative leachate over one calendar year

Northeast Florida Region

- St. Johns River Basin is center point
- Tri-County Agricultural Area (TCAA)
  - Putnam, St. Johns, Flagler counties
  - 380,500A total area
- 10% of TCAA is irrigated vegetables
  - potato & cabbage are main crops
  - Close association of crops and water presents a risk to water bodies

Developing a BMP

*Federal Point*
The Saint John’s River Basin is the receiving water body for TCAA drainage.

- The lower SJR basin exhibited poor water quality and nuisance algal blooms.
- Fresh water algal blooms coincided with agricultural patterns in the area

CRF Development for Potato

Fertilizer Development
- Programmed release for potato
  - Engineered for Florida soil temps
  - Six seasons of work
  - 15 research farm trials
  - 8 grower trials
• Effect of CRFs on Yield
  – Summary: 25% less N with CRFs gives 5 to 13% more yield

<table>
<thead>
<tr>
<th>Farm</th>
<th>Acres</th>
<th>N Rate</th>
<th>N %</th>
<th>CRF Recipe</th>
<th>Variety</th>
<th>Yield</th>
<th>Yld %</th>
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<tbody>
<tr>
<td>A</td>
<td>CRF Treat (Scotts)</td>
<td>23.2</td>
<td>175 lbs</td>
<td>73%</td>
<td>25 lbs Urea (46) + 150 lbs 38-0-0</td>
<td>Atlantic</td>
<td>279</td>
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<td>33</td>
<td>240 lbs</td>
<td>100%</td>
<td>n.a.</td>
<td>Atlantic</td>
<td>246</td>
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<td>C</td>
<td>CRF Treat (Scotts)</td>
<td>18.7</td>
<td>*205 lbs</td>
<td>76%</td>
<td>25 lbs Urea (46) + 150 lbs 38-0-0</td>
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<td>1867</td>
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<td>n.a.</td>
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<td>B</td>
<td>CRF Treat (not Scotts)</td>
<td>11.7</td>
<td>*205 lbs</td>
<td>82%</td>
<td>43%, 44%, 44.5% (25%, 50%, 25% of N)</td>
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* Supplemental application (25 lb N) following a “leaching rain” (part of BMP guidelines)

• Effect of CRFs on N pollution
  – CRF reduced N leaching by 80% (Farm “A”)

![Farm A - Total Nitrogen](image)

- Growing Season Average Storm Load
- Control: 24.82 lbs/acre
- Treatment: 4.88 lbs/acre
- = 80% ave. reduction of N load

Note: 13% yield increase on Farm A with CRFs
• Effect of CRFs on N pollution
  – CRF reduced N loading by 68% (Farm “C”)

![Graph showing the comparison of total nitrogen between control and treatment fields over time.]

**Farm C - Total Nitrogen**

- Control Field
- Treatment Field

**Growing Season Average Storm Load**
- Control: 14.51 lbs/acre
- Treatment: 4.56 lbs/acre

= 68% average reduction

Note: 5% yield increase on Farm C with CRFs

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**CRFs Work Economically**

- CRF fertilizers cost more…
  - Cost per acre
    - Grower Program ~$250/A for fertilizer costs (w/o labor)
    - CRF Program ~$400/A for fertilizer costs (w/o labor)
- But, CRFs return more…
  - Extra Income
    - Farm A: 13% higher yield than BMP treatment
      (33 cwt (1.5MT) extra yield) * ($8.00/cwt) = +$264.00/A
    - Farm C: 5% higher yield than BMP treatment
      (19 cwt (0.8MT) extra yield) * ($8.00/cwt) = +$152.00/A
- CRFs also offer:
  - Simplicity – 1X application (usually) with CRF vs 2-4 with normal
  - Low Risk – CRF fertilizer is there when the grower can’t be
Further economic gains

• Carbon emission reduction or offset credits?
  – Reduced N\textsubscript{2}O emissions (-50%) and NH\textsubscript{4} volatilisation (-95%)
  – Reduced N leachates (-80%)
  – Less fertiliser used (-40%)
    • Reduced transport costs
    • Reduced carbon emissions from
  – Fewer applications
    • Reduced Carbon emissions from tractor use
  – Increased soil Organic Carbon
Euc.globulus - W.Aust.
(1 Yr - 30 gr agroblen)

A successful Grape trial
(60% vines in NZ planted on Agroblen)
Pineapple

CRF research
Banana

Release Curves 37-0-0

Days After Placement

% N Released
Just a nice photo! The even production of Schleranthus (Aust. native) with Osmocote Exact -
THANKYOU