ROLE OF FERTILIZERS IN INCREASED AGRICULTURAL PRODUCTIVITY

by
Barrie Bain
Director of Fertilizer Intelligence
FERTECON Limited

IATRC Symposium, Seville, 3 June 2013
FERTECON Limited

- Formed in 1978
- Leading global provider of fertilizer market information, prices and analysis
- Now part of Informa
- The link with Informa gives FERTECON new access to data and analysis resources on agriculture, shipping and freight and energy
FERTILIZER USE
FERTILIZER ESSENTIALS

- There are three main nutrients
- Nitrogen ($N$)
- Phosphate ($P_2O_5$)
- Potash ($K_2O$)

- There are secondary and micronutrients such as sulphur, magnesium, zinc etc.
- Nutrients perform different functions in the growth of the plant and the three main nutrients cannot be substituted for each other
- Plants need balanced nutrient application – how much and in what proportion depends on the soil type and the crop being grown
- Without chemical fertilizers, crop production would be reduced by almost half
- Fertilizers generally account for around 25-30% of a farmer’s direct input costs
WORLD/ EU FERTILIZER USE

2012 estimates

Million tonnes nutrient

EU27 | RoW

N

P

K

FERTECON/ IATRC Seville June 2013
EU FERTILIZER USE

Fertilizer nutrient consumption in the EU-27

Evaluation on base year

<table>
<thead>
<tr>
<th>Year</th>
<th>Nitrogen</th>
<th>Phosphate</th>
<th>Potash</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>+3.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>+1.6%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Fertilizers Europe
UK FERTILIZER USE

Source: DEFRA
FERTILIZER USE BY CROP

Source: IFA
NITROGEN USE BY CROP

Source: IFA

FERTECON/ IATRC Seville June 2013
PHOSPHATE USE BY CROP

Source: IFA
POTASH USE BY CROP

Source: IFA

FERTECON/ IATRC Seville June 2013
FERTILIZER USE BY CROP

Source: IFA

FERTECON/ IATRC Seville June 2013
CROP PRICES

Monthly average price received by US farmers

Soybean
Wheat
Corn

Source: USDA

FERTECON/ IATRC Seville June 2013
CROP vs FERTILIZER PRICES

Monthly average corn price received by US farmers

Source: FERTECON/ USDA
CORN TO FERTILIZER RATIOS

- Current
- 2010-2012
- 2008
- 2003-2006
- 2003-2012

Symbols:
- MOP
- urea
- DAP
# CROP : FERTILIZER CORRELATIONS

<table>
<thead>
<tr>
<th>Period</th>
<th>UREA</th>
<th>DAP</th>
<th>MOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003-2012</td>
<td>0.75</td>
<td>0.71</td>
<td>0.67</td>
</tr>
<tr>
<td>2006-2010</td>
<td>0.75</td>
<td>0.71</td>
<td>0.89</td>
</tr>
<tr>
<td>2011-2012</td>
<td>0.17</td>
<td>-0.23</td>
<td>0.46</td>
</tr>
</tbody>
</table>
CORRELATION BREAKDOWN

• Fertilizer price are driven by supply as well as demand
• Time lags
• Levels were already high enough to stimulate good fertilizer demand at the start of 2011 – you don’t necessarily put more fertilizer on $7 corn than $5 corn
• Influence of non-commercial and semi-commercial markets – especially India
CROP vs FERTILIZER PRICES - EUROPE

DAP for France
AN delivered France
OSR (Liffe)
Wheat (Liffe)

Source: FERTECON/Informa
CROP vs FERTILIZER PRICES - EUROPE

Source: FERTECON/Informa
FERTILIZER TO CROP PRICE RATIOS - EUROPE

Ratio of fertilizer prices to wheat prices

- AN
- DAP

Source: Informa/FERTECON

price ratio 1 tonne fertilizer: 1 tonne wheat
FERTILIZER TO CROP PRICE RATIOS - EUROPE

Ratio of fertilizer prices to oilseed rape prices

Source: Informa/FERTECON
NITROGEN
NITROGEN PRODUCTION

CO$_2$ \rightarrow \text{AMMONIA} \rightarrow \text{NITRIC ACID} \rightarrow \text{UREA} \rightarrow \text{UAN} \rightarrow \text{AMMONIUM NITRATES} \rightarrow \text{AMMONIUM SULPHATE} \rightarrow \text{SULPHURIC ACID} \rightarrow \text{MOP} \rightarrow \text{POTASSIUM NITRATE} \rightarrow \text{NATURAL GAS/COAL/FUEL OIL}
NITROGEN FERTILIZER PRICES

US$/tonne fob (monthly average)

- Urea - $/t fob bulk Black Sea
- NH₃: $/t fob Black Sea
- AN bulk $/t fob Black Sea

08 09 10 11 12 13
THE SHALE GAS EFFECT

US PRODUCTION

million tonnes

2000 2010 2020
AMMONIA

2000 2010 2020
UREA

FERTECON/ IATRC Seville June 2013
US IMPORTS FALL

US IMPORTS

million tonnes


AMMONIA UREA

FERTECON/ IATRC Seville June 2013
US UREA COST OF SUPPLY - 2012

$/tonne cash cost delivered to Midwest terminal/ex-plant Midwest 2012

- barge freight
- freight to US
- other costs
- cost of feedstock

Midwest plant | US Gulf plant | Middle East low | Middle East high | Ukrainian plant | Chinese coal-based
US UREA COST OF SUPPLY - 2015

$/tonne cash cost delivered to Midwest terminal/ex-plant Midwest 2015

- barge freight
- freight to US
- other costs
- cost of feedstock

- Midwest plant
- US Gulf plant
- Middle East low
- Middle East high
- Ukrainian plant
- Chinese coal-based
SHALE GAS POTENTIAL

Source: EIA
SHALE GAS PROSPECTS

• In Europe several countries – e.g. France and Germany are resisting shale gas development

• In the EU, the UK and Poland are the most advanced on shale gas development

• Ukraine is attempting to develop shale gas as quickly as possible to result dependence on Russia

• Shale gas production costs will be higher in Europe due to geology, reserve ownership, availability of rigs. Best estimates of costs are at least $5/mmBtu

• China is looking at rapid development of its shale gas resources
EU UREA IMPORTS

- EU 12
- EU 15
Nitrogen Production Costs

- The EU 15 has the most efficient nitrogen fertilizer plants in the world – more efficient than the US and even new plants in North Africa and the Middle East.

- However, it has some of the highest production costs in the world.

- This is due to high gas costs in Europe.
GAS PRICES

$mmBtu in plant

- U.S. Gulf
- Europe formula
- Russia
- Ukraine
- Europe hub

FERTECON/ IATRC Seville June 2013
US COSTS AND PRICES

AVERAGE ANNUAL UREA PRICES AND US GULF SUPPLY COSTS

$/tonne (price fob USG NOLA, cost fob plant)
UKRAINE COSTS AND PRICES

$/tonne fob Yuzhnyy

- Price
- Ukraine Cost
- Russia Cost

2008 2009 2010 2011 2012 2013
UREA AND GAS PRICES

Correlations:
Europe gas: 0.80
US gas: 0.10
US Gas (2007-10): 0.74
UREA COST CURVES

UREA COST CURVE - 2012

Cash Cost of production in $/tonne in 2012

- China
- Ukraine
- Anthracite
- Steam Coal
- Gas

2012 Production in million

0 25 50 75 100 125 150

L. America
Russia
Other
N. America
Africa

UREA COST CURVE - 2015

Cash Cost of production in $/tonne in 2015

- China
- Gas
- Europe
- Steam Coal
- Anthracite
- Russia
- Other Asia
- India
- Ukraine

2015 Production in million

0 25 50 75 100 125 150 175

M. East
Africa
N. America
L. America
EUROPE: UREA COST OF SUPPLY - 2012

$/tonne cash cost delivered Europe

freight to Europe
other costs
cost of feedstock

NW Europe spot
gas
Europe gas
Formula gas
North Africa low
North Africa high
Ukraine
Russia
EUROPE: UREA COST OF SUPPLY - 2015

$/tonne cash cost delivered to Europe

- freight to Europe
- other costs
- cost of feedstock

- NW Europe spot gas
- Europe Formula gas
- Europe low cost scenario
- North Africa low
- North Africa high
- Ukraine
- Russia

FERTECON/ IATRC Seville June 2013
EMISSION TRADING SCHEME

• EU ETS now applies to CO₂ emissions from ammonia production, N₂O emissions from nitric acid production (for ammonium nitrate) and CO₂ emissions relating to energy use

• Applies even when CO₂ is captured – for urea production or industrial uses

• Benchmarking means that currently the most efficient ammonia plants incur modest costs - although as emission benchmarks are reduced cost potentially will increase

• European plants are the most efficient in the world

• N₂O emissions from nitric acid plants being reduced by retrofitting of plants

• However, the collapse of the carbon price to under €5/t CO₂ has made the scheme meaningless and there are calls for it to be scrapped or amended
NEW UREA SUPPLY

- New low-cost capacity in Algeria (three 1.2 million t/y plants)
- Additional capacity in Africa (Nigeria and Gabon)
- New supply from Middle East (Qatar, Abu Dhabi, Saudi Arabia)
- Lower gas prices in North America encouraging new supply reducing import demand
NEW LOW-COST UREA EXPORT CAPACITY

million tonnes

2012 2013 2014 2015 2016 2017 2018

FERTECON/ IATRC Seville June 2013
UREA COST AND PRICE FORECAST

Current $/tonne fob

- FSU Price
- China Price
- Ukraine Cost
- China Cost
PHOSPHATES
PHOSPHATE PRODUCTION

- PHOSPHATE ROCK
- SSP
- SULPHURIC ACID
- SULPHUR
- PHOSPHORIC ACID
- TSP
- DAP/MAP
- AMMONIA

FERTECON/ IATRC Seville June 2013
PHOSPHATE

- Phosphate prices had been high due to tight supply, but have now fallen
- As the Ma’aden project in Saudi Arabia, plus expansions in Morocco and elsewhere ramp up, the market has become more balanced
- Prices are expected to moderate further
- The very high phosphate prices of 2007-2008 have stimulated a massive interest in developing phosphate rock reserves – in Central Asia, Africa, Australia and Latin America
- “Peak Phosphate” is a myth – current known reserves will last over 300 years – or over 1000 years with increased efficiency of production and use
State-owned OCP has ambitious expansion plans for its phosphate operations. It has been looking for j-v partners, but is willing to go it alone. It has the following projects for finished phosphate fertilizers:

- 2013 – 1 million t/y
- 2014 – 2 million t/y
- 2015 – 1 million t/y

There are likely to be delays but will are likely to see at least part of this come on-stream.
MA’ADEN 3 MILLION T/Y DAP PROJECT

- The Ma’aden phosphate project in Saudi Arabia finally came on-stream in 2011. Full operation will be achieved soon
- Originally scheduled for 2009
- Represents 18% of global DAP export supply
- Delay means that supply was initially easily absorbed into the market given strong demand
- Go ahead and a new project and expansion of existing plant will see Saudi Arabian supply increase substantially over the next 5 years
POTASH PRODUCTION

- SULPHUR
  - SULPHURIC ACID
  - SOP
    - AMMONIA
    - NOP
  - MOP
WORLD POTASH PRODUCTION

million tonnes $K_2O$

- Middle East
- Europe
- Latin America
- Asia
- FSU
- North America

NEW POTASH CAPACITY

Million tonnes $K_2O$

- Latin America
- Asia
- Africa
- Europe
- US
- Canada
- FSU
## POTENTIAL NEW POTASH PRODUCERS

<table>
<thead>
<tr>
<th>Region</th>
<th>2012 existing</th>
<th>2020 additions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>K+S, Israel Chemicals</td>
<td>Sirius (UK)</td>
</tr>
<tr>
<td>CIS</td>
<td>Uralkali, Belaruskali</td>
<td>Acron, EuroChem</td>
</tr>
<tr>
<td>Africa</td>
<td>-</td>
<td>Congo, Ethiopia, Eritrea</td>
</tr>
<tr>
<td>Asia</td>
<td>around 30 enterprises in China, 1 in Laos</td>
<td>Several enterprises in Laos</td>
</tr>
<tr>
<td>North America</td>
<td>Agrium, Mosaic PotashCorp, Compass, Intrepid</td>
<td>IC Potash, several other potential projects</td>
</tr>
<tr>
<td>Latin America</td>
<td>SQM, Vale</td>
<td>Several potential projects in Brazil</td>
</tr>
</tbody>
</table>
POTASH PROJECTS

• Lots of greenfield projects have been announced but few will be developed
• Projects from junior mining companies will struggle to get finance
• Even projects from major companies face challenges – e.g. Vale’s Rio Colorado in Argentina now cancelled, major delays at Eurochem’s first Russia project
• The big unknown - BHP Billiton's Jansen project: over $1 billion spent but still no board approval
• The one certainty with greenfield projects the will cost more and take longer to build than forecast
POTASH PRICE OUTLOOK

$/tonne fob


© FERTECON 2013

fob FSU
SUPPLY/DEMAND OUTLOOK
• Supply is growing faster than demand in all three nutrients, particularly nitrogen
• New urea capacity in the will add 49 million tonnes/year (27 million in China)
• New potash supply adds 22 million tonnes MOP (29% increase)
AFRICA PROJECTS

- Nitrogen
- Phosphate
- Potash
FERTILIZER OUTLOOK

• Supply of all nutrients is growing faster than demand
• Availability of low-cost gas in Sub Saharan Africa, North Africa, Middle East and North America stimulating new nitrogen capacity
• Europe will remain at the high end of the cost curve unless there is massive development of shale gas lowering gas costs
• Europe’s import dependence for nitrogen will increase
• Phosphate supply will grow, especially from North Africa and Saudi Arabia
• There will be more than adequate supply of phosphates – “Peak Phosphate” is a myth
• Potash supply will also increase faster than demand. Potential supply growth in Europe from polyhalite developments in UK
CAPITAL COSTS

- Capital costs of new plants continues to increase and this creates a long term floor price for fertilizers
- A 1 million tonne/year ammonia/urea complex now costs at least $1.5 billion
- A 2 million tonne/year potash mine costs at least $2.8 billion
- A 1 million tonnes/year phosphate fertilizer complex with mine, beneficiation and processing costs around $2 billion
- High capital costs mean fertilizer prices have to be sufficient to justify new investment to maintain supply
NUTRIENT USE EFFICIENCY

• Longer term, fertilizer consumption growth is expected to slow as the efficiency of fertilizer use increases
• This will be achieved by five main trends
  ➢ Improved application techniques – precision farming
  ➢ Controlled release fertilizers
  ➢ Nutrient use efficiency increased in crops through plant breeding – both conventional and GMO
  ➢ Increased nutrient recycling – from crop, animal and human waste
  ➢ Integrated nutrient management – using available on-farm organic nutrients supplemented by mineral fertilizers
• All these are happening now and their impact will accelerate
• The industry promotes nutrient stewardship programmes like the 4Rs – applying the right fertilizer in the right place at the right time in the right way
NUTRIENT USE EFFICIENCY

• Fertilizer use per tonne of crop will fall as improved techniques are applied and new crop varieties introduced
• This suggests that fertilizer costs for crop production could also fall
• However, “smart” fertilizers and smarter application techniques are more expensive
• There is no one “golden bullet” but a range of approaches that together will lead to substantially increased nutrient efficiency
• There is also an environmental benefit – more efficient fertilizer use means less run-off and lower emissions of CO$_2$ and N$_2$O
A recent paper* estimated that net fertilizer use on UK wheat could be halved using *existing* technology.

This would involve use of controlled release fertilizers, precision application and nutrient recovery from waste.

* Scope for innovation in crop nutrition to support potential crop yields. Sylvester-Bradley and Withers, IFS Proceedings No.700, 2012
PRECISION FARMING DOES NOT HAVE TO BE HIGH-TECH

Source: Montpellier Panel report on Sustainable Intensification
IS FERTILIZER SUPPLY SUSTAINABLE?

• The shale gas revolution means there is adequate natural gas feedstock for nitrogen production for the foreseeable future
• Longer term nitrogen fertilizer production is not dependent on hydrocarbons – it can be produced using hydrogen extracted from water using renewable energy
• Fertilizer production is becoming more efficient – lower energy use, processing losses reduced
• Known phosphate and potash reserves will last over 1000 years – increased efficiency and recycling of nutrients will extend this
• Lower grade phosphate and potash ores will become economic through improved technology
WHY FERTILIZERS ARE IMPORTANT

• The core contribution of fertilizers to agriculture is enabling sustainable intensification – growing more food, fibre and fuel on less land

• This is central to alleviating hunger and malnutrition whilst at the same time protecting bio-diversity