3R ENVIRONMETAL TECHNOLOGIES LTD.

General Manager: Edward Soméus

www.3ragrocarbon.com

November 5, 2009

Energy demand of the intensive farming

Intensive farming is concerned above all with productivity and uses a high level of inputs to achieve it. The inputs are usually in the form of chemicals, fertilisers, pesticides and growth-regulators produced by energy intensive industrial processes and additional energy in the form of high levels of mechanisation. Intensive farming does provide large quantities of relatively cheap food - but often at a cost to the environment, nutrient content.

Food production systems are partially re-sponsible for contributing to elevated levels of green-house gases in the atmosphere due to the heavy reli-ance on fossil fuels.

Indirect energy use involves agricultural inputs, such as fertilizers, which have a significant energy component associated with their production. Expenses from indirect energy use increase total energy expenditures to 15 percent of operating costs. Changes in energy prices may have a greater effect on producers of major field crops.

Primary production in the agricultural industry is highly dependant upon fossil fuels. Inorganic fertilizers are major consumers of energy in the agricultural sector. In the United States, inorganic fertilization accounts for about a third of total energy input to crop production. The bulk of energy use associated with fertilizers is not consumed directly at the agricultural site, but indirectly during its production, packaging, and transportation to the site. Additional energy is then used on-site during fertilizer application.

According to the OECD , the absolute energy consumption per hectare increased in OECD countries by 39% between 1970 and 1989. On average, some 1734 MJ are consumed per hectare of agricultural land, rising to 46,400 MJ for the highest consumer, Japan.

Most chemosynthetic fertilizer energy use is attributable to the production of nitrogen fertilizers with natural gas. Natural gas is the principal energy resource for creating anhydrous ammonia, a key nitrogen fertilizer.

Over 90% of nitrogenous fertilizers contain ammonia and/or other fertilizer elements derived from ammonia (e.g., ammonium nitrate, sodium nitrate, calcium nitrate, ammonium sulphate, ammonium phosphates, and urea). Producing ammonia is a very energy intensive process; it requires about 1090 to 1250 m^3 of natural gas to produce 1 metric ton of anhydrous ammonia (35 000 to 40 000 ft^3 natural gas per short ton). In 1999, over 15 million metric tons (17 million short tons) of ammonia were produced in the United States, with almost 90% of that going to the fertilizer industry. This amount corresponded to about 3% of total US natural gas production.

3R Environmental Technologies Ltd.

H-1222 Budapest, Szechenyi str. 59. Hungary Tel.: (36-20) 201 7557 or (36-20) 805 4727

Tel./Fax: (36-1) 424 0224, SKYPE: Edward.Someus

E-mails: edward.someus@gmail.com - edward@terrenum.net

WEB: www.3ragrocarbon.com WEB: www.terrenum.net

Each of the three primary nutrients (N,P,K) in inorganic fertilizers has a different set of energy requirements during its life cycle. However, these requirements can be separated into four main stages: production, packaging, transportation, and application. Table 1 summarizes the world average energy requirements by nutrient type and life cycle stage for inorganic fertilizers. The table clearly shows the relatively high energy intensity of nitrogen production. This corresponds to almost 90% of nitrogen's total energy requirement. In contrast, the production of phosphate and potash account for only about 45% of the total energy requirement for these nutrients. Moreover, the energy requirement for nitrogen fertilizer is 4.5 times that of phosphate fertilizer, and 5.7 times that of potash fertilizer.

Traditional chemosynthetic P fertilizer production is based on chemical processing of insoluble mineral phosphate high-grade ore, which includes an energy intensive treatment with sulphuric acid at high temperature.

Ammonia is a basic industrial material and is the material from which other nitrogen fertilizers are made. It has been manufactured on a commercial scale since 1913, and the process used to produce it, originally developed by Fritz Haber, has changed little since that time. In the Haber process, gaseous hydrogen (H_2) and nitrogen (N_2) are combined under high temperature and pressure conditions to produce ammonia.

Ammonia production is an energy intensive process, not only because of its temperature requirements, but also because it requires large quantities of purified H_2 that is usually derived from natural gas, or methane (CH_4).

Table 1. Energy requirements to produce, package, transport, and apply inorganic fertilizers.

	Energy reqirement (world avarage) Btu/lb(kj/kg)		
	Nitrogen	**Phosphate**	**Potash**
Produce	29899 (69530)	3313 (7700)	2753 (6400)
Package	1119 (2600)	1119 (2600)	774 (1800)
Transport	1936 (4500)	2452 (5700)	1979 (4600)
Apply	688 (1600)	645 (1500)	430 (1000)
Total	**33642 (78230)**	**7529 (17500)**	**5936 (13800)**

Since natural gas is such a critical resource in fertilizer production, natural gas price fluctuations have a dramatic effect on fertilizer costs. As energy costs continue to rise, and the demand for fertilizers increases, this effect is becoming more pronounced.

Energy conservation in primary agricultural production must make the most efficient use of non-renewable energy resources while integrating on-farm resources such as biological cycles and controls. At the same time, the conservation measures must strike a balance with the industry-wide goal of maximizing food production and economic returns from a given land base.

3R Environmental Technologies Ltd.
H-1222 Budapest, Szechenyi str. 59. Hungary Tel.: (36-20) 201 7557 or (36-20) 805 4727
Tel./Fax: (36-1) 424 0224, SKYPE: Edward.Someus
E-mails: edward.someus@gmail.com - edward@terrenum.net
WEB: www.3ragrocarbon.com WEB: www.terrenum.net

Reference list:

Eckert,D.,Efficient Fertilizer Use Mannual - Nitrogen

Gellings, C.W., Parmenter,K.E.. Energy Efficiency in Fertilizer Production andUse. *Encyclopedia of Life Support Systems*(EOLSS)

Gold, M.V. (1994). Sustainable agriculture: definitions and terms. SRB 94-05. Beltsville, MD: U.S. Department of Agriculture.

Helsel Z.R. (1992). Energy and alternatives for fertilizer and pesticide use. *Energy in Farm Production*, Volume 6 (ed. R.C. Fluck), pp. 177–201. New York: Elsevier.

OECD (1993) World Energy Outlook. OECD, Paris.

Shoemaker; R., McGranahan, D., McBride, W. (2006). Agriculture and Rural Communities Are Resilient to High Energy Costs. Rising energy prices may prompt farmers and rural residents to make tradeoffs in their production practices and daily lives. Economic Research Service/USDA

Vassilev, N., Vassileva, M. 2003. Biotechnological solubilization of rock phosphate on media containing agro-industrial wastes. *Applied Microbiology and Biotechnology.* Publisher Springer Berlin / Heidelberg ISSN0175-7598. Volume 61, Numbers 5-6.

3R Environmental Technologies Ltd.
H-1222 Budapest, Szechenyi str. 59. Hungary Tel.: (36-20) 201 7557 or (36-20) 805 4727
Tel./Fax: (36-1) 424 0224, SKYPE: Edward.Someus
E-mails: edward.someus@gmail.com - edward@terrenum.net
WEB: www.3ragrocarbon.com WEB: www.terrenum.net