Environmentally Smart Nitrogen Fertilizers for Nepal

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Product Information and Description

Introduction

Nitrogen is a natural element found in the earth's atmosphere that makes up 16% of proteins that humans, animals and plants need for growth and survival (Frink et al., 1999). Plants naturally acquire nitrogen from the soil via processes that involve the absorption of nitrogen in forms of ammonium and nitrates by plant roots (FAO, 1984). Wheat crops like rice are grown in many parts of the world and constitute the largest source of world calorie consumption (Bender, 1994). However, with global population and food demands both increasing, nations relying heavily on these kinds of crops for food, may need efficient sources of vital elements as nitrogen for farming operations.

In Canada, the use of fertilizers has been coupled with huge surges in expenses related to production and supply. Fertilizers are essentials tools for increasing major crop quality and productivity, whilst preventing likely environmental problems that arise from using more conventional methods of supplying plants nutrients (Fuertes-Mendiz´abal et al., 2012). Due to increases in demands for fertilizers, as much as a quadruple in costs to Canadian producers and farmers has occurred between the periods of 1997 to 2006 (de Avillez, 2011).

The proximity of fertilizer production companies to food producers and suppliers may influence the increase in both major and cash crop profitability. Agrium is a Calgary, Alberta based and Canadian owned company that produces agricultural nutrients and industrial products including nitrogen fertilizers (Natural Resources Canada, 2014). In fact, one of Agrium's major innovative fertilizers is Environmentally Smart Nitrogen also known as ESN. ESN uses polymer coated forms of urea nitrogen granules that release

plant use-able N based on soil moisture and temperature (Qin et al., 2014). The controlled-release feature of ESN is particularly effective in increasing crop yields by supplying readily available nitrogen and decreasing nitrogen losses through volatilization and leaching (Cahill et al., 2010).

Nitrogen Fertilizers

As the demand for food increases, the costs of producing and farming increase as well (Cahill et al., 2010). Farmers need vital production inputs such as fertilizers to be cost effective in order to lessen operational expenses. The application of fertilizer nitrogen has risen rapidly on a global scale, and according to a forecast by FAO in 2012 for the yearly period up to 2016, growth rate percentages of fertilizer demand were projected to be 1.3 percent annually for nitrogen alone (Table 2). Densely populated regions such as South Asia were expected to have a nitrogen fertilizer demand growth rate of 2.6 percent, a figure as much as that of the nitrogen fertilizer demand percentage of the whole continent of Africa (Table 2).

Table 2. World and regional growth in fertilizer demand, 2012 to 2016

(Source: FAO 2012)

Region	Annual growth rate (Compound)			
	N	P_2O_5	K_2O	Total ($N+P_2O_5+K_2O$)
World	**1.3%**	**2.0%**	**3.7%**	**1.9%**
Africa	2.6%	2.9%	3.3%	2.7%
North Africa	2.3%	1.7%	1.2%	2.1%
Sub-Saharan Africa	2.9%	3.7%	4.2%	3.3%
America	1.3%	1.9%	1.9%	1.6%
North America	0.6%	0.6%	0.6%	0.6%
Latin America & Caribbean	2.7%	3.0%	2.9%	2.9%
Asia	1.3%	2.0%	5.8%	2.0%
West Asia	1.8%	3.3%	3.9%	2.3%
South Asia	2.6%	3.0%	10.3%	3.5%
East Asia	0.6%	1.2%	4.2%	1.2%
Europe	1.3%	2.5%	2.0%	1.6%
Central Europe	1.5%	2.4%	2.4%	1.8%
West Europe	-0.2%	1.2%	1.0%	0.3%
East Europe & Central Asia	3.7%	4.3%	3.3%	3.8%
Oceania	1.3%	2.0%	1.4%	1.6%

Enhanced Efficiency Nitrogen Fertilizers

As seen in Table 2, nitrogen fertilizers are highly sought after by farmers. However, it has been observed that increased application of conventional nitrogen fertilizers has contributed to potential environmental hazards such as greenhouse emissions in the form of nitrous oxide, reduction of downstream water quality due to and nitrogen losses due to leaching and volatilization (Ni et al. 2011; Cahill et al., 2010).

The advent and use of enhanced efficiency nitrogen fertilizers (EEFs) has provided farmers and food producers synthetic alternatives to conventional and organic slow release urea nitrogen fertilizers and with the added benefits of being environmentally safe (Ni et al. 2011). EEFs can be classified as slow- release (SRF) and controlled-release fertilizers (CRFs), nitrification inhibitors (NI), and urease inhibitors (UI). All of which are meant to increase nitrogen fertilizer use efficiency and reduces nitrogen losses

(Motavalli et al., 2008).

As outlined in Agrium's EEF brochure (2014), SRFs have polymer and sulphur coated urea granules that slowly release nitrogen based on coating thickness and biological activity. This in turn helps reduce denitrification and ammonia volatilization (Halvorson et al., 2014).

NIs and UIs collectively known as stabilizing fertilizers act by inhibiting or rather slowing down the chemical process by which enzymes and microbes in the soil convert plant use-able urea and ammonium nitrogen forms, to ammonia and nitrates (Halvorson et al. 2014).

Environmentally Smart Nitrogen

ESN is a form of a controlled release fertilizer (CRF) that was developed and produced by Agrium in Calgary, Alberta, Canada and is made up of mostly urea, 94 percent and the rest being small quanities of plyurethane, biuret and products of urea reactions (Agrium Inc., 2014). ESN uses light green soluble polymer coated urea granules that provide nitrogen to plants upon contact with water through diffusion, and the rate of diffusion is regulated by the coating thickness and soil temperature (Qin et al., 2014).

ESN has been tested and used on farms producing crops ranging from canola *(Brassica napus L.)* to durum wheat *(Triticum turgidum L.)* amongst other crops grown widely in Canada and the United States as mentioned by Golden et al. (2010).

Uses

Agrium is a global supplier of nitrogen fertilizers and as a result, ESN has been tested and applied on crops grown on the soils of continents as far as South Asia and Africa (Agrium, 2014). Cereal crops such as maize (*Zea mays)* and wheat *(Triticum spp.),* grown vastly in

those areas benefit highly from having readily available of nitrogen with little risk of burns in comparison with the application of urea or ammonium nitrate (Agrium, 2014).

In a study conducted in North Carolina, USA, it was discovered that the application of ESN on corn *(Zea mays)* increased corn stover yields (Cahill et al., 2010). However, it is important to note that factors such as climate, location and purchase costs needed to be taken into account by farmers and agronomists when deciding to use ESN as well as any other synthetic fertilizer (Cahill et al., 2010).

Handling and Application

Like many synthetic fertilizers, ESN remains intact and retains optimal efficiency when handled with care during storage, blending and application (Agrium, 2014). Due to ESN's physical properties, care should also be taken when using conveyance systems such as belt conveyors that may cause abrasion and wear the polymer coatings (Agrium, 2014). Qin et al. reported the significance of abrasion on nitrogen losses accounting up to 20 percent for ESN in particular (2014). ESN can be field applied using spinner and airflow spreader machines (Agrium, 2014). The cost of the machinery is dependent on farm operation size and application method (Khakbazan et al., 2013). However, on alibaba.com (2014) a resourceful website for purchasing agricultural machinery, typical cone tractor fertilizer spreaders range between $500 to $1000 United States per set.

Costs

Khakbazan et al. (2013), cited that ESN only costs between 15 to 30 percent more than uncoated urea and other similar CRFs. Upon correspondence with agronomic sales representative Julie with Farmers Alliance (2014), a supplier of ESN in the United States, the price for a tonne of ESN was close to $700 Canadian. That figure would equate to

about $0.70 Canadian per kilogram, and with an average requirement of about 45 kilograms per acre of crops needed to be fertilized, the cost of ESN would be about $31 Canadian per acre. (Julie , pers. comm., November 13, 2014). Similarly, OMAFRA (2012) conducted a comparative evaluation of the economic benefits of using ESN over urea application on corn *(Zea mays)* and spring wheat (*Triticum aestivum)* yields. It was concluded that ESN use was economically beneficial when treated on spring wheat grown in fields with a history of protein deficiency (OMAFRA, 2012). The results of the study reinforce the importance of considering other economic factors including labor, machinery, weed management, fuel and other miscellaneous farm operational costs, as Khakbazan et al. (2013) described.

Benefits to Canada

Despite the obvious potential economic benefits of ESN production and supply in Canada, trends in world fertilizer demands forecast a growing need for products like ESN (FAO, 2012). Canadian farmers have access to readily available forms of nitrogen that increases both crop yields and quality, while reducing potential environmental hazards (Cahill et al., 2010). Additionally, with climate being a current global issue, the use of nitrogen fertilizers that are environmentally smart could highlight Canada as yet another agriculturally innovative nation.

Export Potential to Nepal

Introduction

Located between China and India in South Asia, is the nation of Nepal. Kathmandu is the capital city and the country's population as of 2011 was 26,494,504 million people (Nepal Embassy, 2014). Nepal's total land area of 143,351 square kilometers consists of mountainous, hill and Terai terrain (IndexMundi, 2014). Land use in Nepal can be classified into 3 categories namely arable land, making up 16 percent of total land use, permanent crops, comprising 0.8 percent and other land, making up the remaining 83.2 percent (IndexMundi, 2014).

Agriculture in Nepal

Agriculture is the mainstay of the Nepalese economy with over 70 percent of the country's population engaged in agriculture for livelihood (Government of Nepal, Ministry of Agricultural Development, 2012). Consequently, the agriculture sector accounts for at least one third of Gross Domestic Product (IndexMundi, 2014). Cereal crops occupy the greatest portions of arable land and paddy is the most grown on over 1.5 million hectares of land (Government of Nepal, Ministry of Agricultural Development, 2012).

Nitrogen Fertilizers

The global use of nitrogen fertilizers by farmers and producers has risen due to food demands of growing populations (Frink et al.,1999). This is accompanied by an increase in the global production of cereals, resulting from both fertilizer input and other advances in agricultural technology (Ni, Liu, Xie and Wag, 2011). In particular, for largely populated and developing countries, such as Nepal, more than half of the nation's

population occupies agriculturally viable areas and as a result, locally produced food and efficient agronomic farming practices are important (Pilbeam et al., 1999).

As shown in Table 3 below, urea nitrogen fertilizer inputs have increased steadily over the last decade from 10,043 Megatonnes in 2004 to a significantly larger 97,956.515 Megatonnes in 2012.

Table 3. Annual sales of chemical fertilizer and improved seeds, 1992/93-2011/2012

(Source: Government of Nepal, Ministry of Agricultural Development, 2012)

Fertilizer:											Unit: Mt.	
Type	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Urea	29528	17697	34449	7428	10043	1960	14985	2500	5935	5048.90	85190.965	97956.515
DAP	15633	20645	33331	11377	19436	10857	7437	1990	-	2523.11	22001.4	43146.06
Complex	-	-	-	-	-	-	2747	2156	1198	2521.14	-	
Potash	58	1016	2966	1688	2332	478	-	-	-	235.68	2820.636	3710.91
A.Sulphat	-	-	-	-	-	-	-	-	-	-	-	
TSP	-	-	-	-	-	-	-	-	-	-	-	
Others	-	-	-	-	-	-	-	-	-	-	-	
Total AICI	45220	39358	70746	20493	31811	13295	25169	6646	7133	10328.83	110013	144813.485
Private Sectors	101145	101408	103636	118265	90895	78258	65679	47107	5677	NA	NA	NA

In an outlook focusing on world fertilizer demands and trends leading up to the year 2016, FAO (2012), anticipated an increase in global demand for nitrogen fertilzer of about 6 million tonnes between 2012 and 2016. The bulk of the demand was projected to from India and China, amongst the other nations of Asia (FAO 2012).

For a developing country rich with agriculture such as Nepal, nested between the emerging and strengthening economies of China and India, the need for cost effective ways to boost agricultural production is essential for economic sustenance. An increase in Nepal's agricultural produce would result in inclined food exports to their neighbors that continue to grow in numbers of people that occupy more land but lack farming acreage.

ESN in Nepal

Farming in Nepal has relied on traditional methods of producing and supplying nitrogen to crops as described by Pilbeam et al. (1999). The reliance on livestock for farming operations in combination with manure produced, has typically provided crops with non-synthetic nitrogen in most small scale farms in Nepal, but dependence on just traditional nitrogen sources is becoming difficult as a result of population increases and environmental pollution concerns (Pilbeam et al. 1999).

Agrium's ESN could be a vital agricultural input for farmers looking to increase crop yields while preventing nitrogen losses that can contribute to environmental hazards. Conventional synthetic urea fertilizers are highly susceptible to volatilization and leaching when exposed to rain (Linquist et al. 2013). Introducing enhanced efficiency nitrogen fertilizers to a warm and wet climate such as Nepal's may allow farmers to confidently apply ESN without the fear of losses related with rainfall or floods, as reflected in a report by Linquist et al. (2013).

Export and Handling

Care would need to be taken to ensure ESN is shipped and handled in manner that will avoid or at least minimize abrasion of the polymer coatings. Significant damage of the coatings may lead to nitrogen loss as described in Agrium's product information website (2014). Upon searching Industry Canada for information on export prices to Nepal of fertilizers, there was no information (Industry Canada website, 2014). Even the miscellaneous fertilizer category yielded no results. This may indicate that fertilizers are currently not a major Canadian export to Nepal if any at all.

Costs and Challenges

Urea is the most commonly purchased form of nitrogen fertilizer in Nepal as seen in Table 3. This may be due to the low cost of urea fertilizers in comparison with other synthetic nitrogen fertlizers (OMAFRA, 2012). Another reason may be close proximity with East Asia. FAO's (2012) outlook on global fertilizer demands for the yearly period up to 2016, highlights East Asia as projected to have increased demands for potash fertilizers, however with an expected decline in nitrogen fertilizer imports. The aforementioned outlook on East Asia potentially having surplus nitrogen fertilizer available could mean countries that are close by could import nitrogen with lower costs involved.

Discussion

Despite the financial challenges that may be faced by Nepalese farmers when purchasing imported ESN to Nepal, there are cooperative ways to reduce the cost of purchasing agricultural inputs such as collective contributions by community farmers. With an initial purchase of a few bags of ESN, and shared application, farmers may be encouraged by increased yields and diversity of crops that can be sold for return profit. Cooperative farming may also lead to further exchange of ideas and agricultural knowledge useful for advancing Nepal's agri-food sector, and potentially develop the nation into a major exporter of food products to adjacent nations.

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