Global Supply and Demand for Urea*

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Introduction

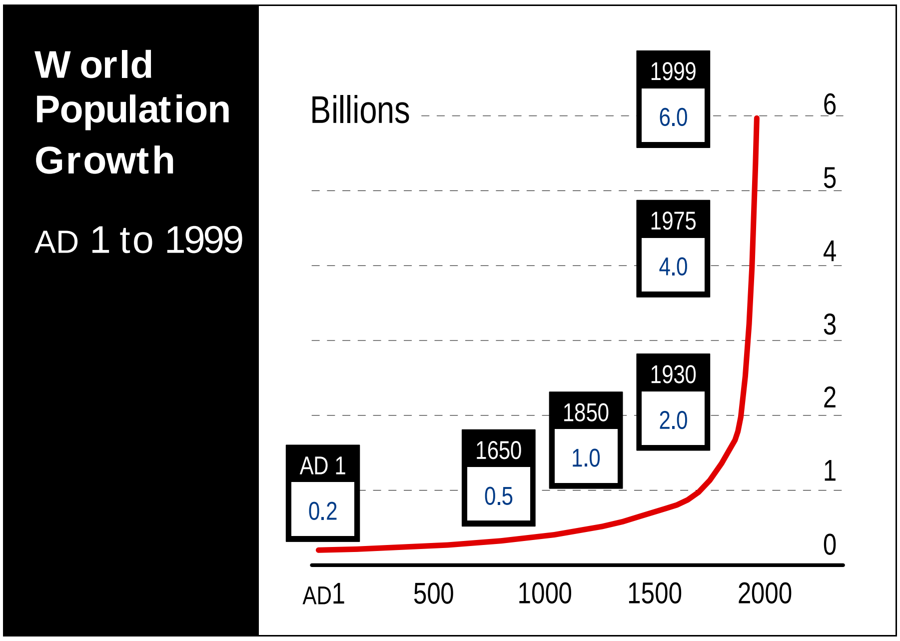
The phenomenal growth of urea production since the 1960's without any serious competitive threat, reflects the very essential role it serves in the agriculture sector. In support of this success, the development of its production technology had attracted fundamental researches, and efficiency in production has benefited from such efforts.

The fertilizer sector is driven by the world's ever growing population's need for food and fibres. Probably three major developments have moulded its present shape : the Green Revolution of the 1960's, the oil crisis of 1973/74 and the collapse of agricultural production in the Former Soviet Union and Central Europe. It is likely that the implementation of the Uruguay Round Agreement on Agriculture now administrated under the WTO will also significantly impact the fertilizer sector.

The Green Revolution prepared the stage for the fertilizer industry by breeding high-yielding crops that can benefit from nutrient inputs; the oil crisis shifted the emphasis to efficient plants and competitive energy sources while the collapse of the centrally planned economies in Europe helped to channel the agricultural efforts to the developing countries.

At the onset of the first millennium, global population was around 200 million. It reached the first billion in 1850 and thereafter the pace of growth quickened. From that milestone, it took 80 years for the population to double and then only 45 years to re-double. The sixth billion mark was reached in October 1999 (Figure 1).

Figure 1



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Experts differ widely in their prognosis on the timing and size the global population would peak : from a low estimate of 9 billion by 2070 to a medium of 12.5 billion and a high of 28 billion, with both the latter marks by 2150, before stabilizing. Such projections are of utmost relevance to the fertilizer industry due to the intimate linkage between food production and population growth.

Figure 2 : World Fertilizer Consumption

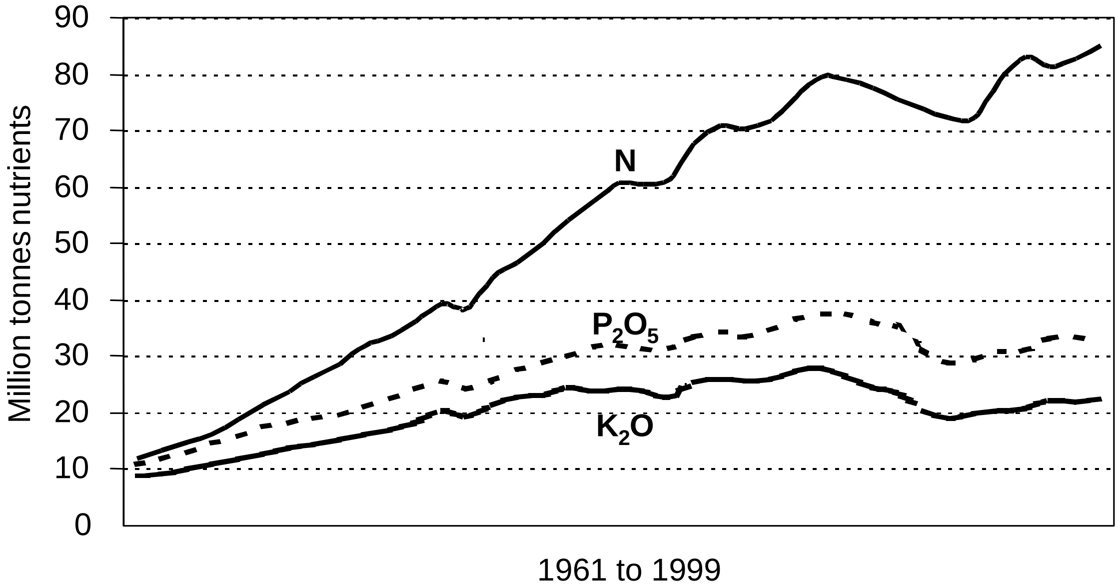


Figure 2 shows the global fertilizer consumption trend since 1961 for the three major nutrients : nitrogen, phosphate and potash. There were two key set-backs during the period : 1974, as a result of the oil crisis and 1989-1993 due to the collapse in consumption in the Former Soviet Union and Central Europe. There is a major shift in consumption as well : in 1961, the developed countries accounted for 87% of the off-take. Currently, their share is only 38% and diminishing. At their peak in 1987, the developed countries consumed nearly 84 M.t. nutrients while their average over the last 5 years was some 52 M.t. nutrients. Some 70 million tonnes a year in that market have disappeared.

It is indeed of interest to note that in 1961, all three major nutrients were around similar levels in off-take. While current nitrogen consumption has gained by almost 8-fold, that of phosphate and potash are only twice and double the 1961 level respectively.

Table 1 : Major Fertilizer Products Consumed : 1998
(000t product)

1.	Urea	86,130
2.	NPK/Blends	43,180
3.	ABC	42,000
4.	AN/CAN	35,420
5.	SSP	34,880
6.	DAP/MAP	28,720
7.	MOP	22,360
8.	Nitrogen solutions	13,150
9.	Ammonium sulphate	12,580
10.	Ammonia D.A.	5,490
11.	TSP	4,750
12.	Others	10,000
	TOTAL	**338,660**

Table 1 shows the major fertilizer products consumed in 1998. Urea is by far the most widely used product. Together with other straight nitrogen : ammonium bicarbonate and ammonium nitrate/CAN, they make up nearly half the total market share.

Nitrogenous Fertilizers

The sharp volatility in ammonia and urea prices at the beginning of this year shows the tight bondage between the prices of natural gas and nitrogenous fertilizers. As a result of a sharp hike in the gas price from around US $ 2 to over US $ 9 per mmBTU, there were temporary shutdowns in a number of ammonia plants in USA and this immediately caused a serious supply gap. Currently, about three-quarters of the world's ammonia production is derived from natural gas. Of the balance, 16% is obtained from coal, mainly among the 800 small ABC plants scattered all over China. Fuel oils and naphtha have a limited share and these plants are mostly confined to India. Ammonium sulphate is the significant nitrogenous fertilizer that is not directly derived from ammonia. It is a by-product of the caprolactam and acrylonitrite manufacture.

- *Ammonia supply*

Ammonia supply holds the key to the understanding of nitrogenous fertilizers supply. Some 90% of the ammonia produced are channelled into the fertilizer sector, while the remainder are used as a base for other synthetic products : plastics, refrigerants and explosives.

Ammonia production continues to grow from strength to strength despite a slow-down in demand for nitrogenous fertilizers during the last few years (Table2).

Table 2 : World Ammonia Production
(000t N)

	Tonnage
19994	93,339
1995	99,927
1996	104,567
1997	102,594
1998	103,238
1999	106,044
2000	107,797 est.

A breakdown in ammonia production by region for 2000 is shown in Table 3.

Table 3 : Ammonia Production and Export by Region : 2000
(000t N)

Region	Total Tonnage	% share	Export tonnage	% share
Socialist Asia	27,762	25.8	0	0
Rest of Asia	19,777	18.3	943	7.4
North America	16,125	15.0	1,550	12.2
East Europe/C. Asia	14,498	13.4	3,815	30.0
West Europe	10,894	10.1	1,528	12.0
Middle East	7,340	6.8	1,298	10.2
Latin America	4,981	4.6	2,880	22.7
Central Europe	4,664	4.3	387	3.0
Africa	1,076	1.0	312	2.5
Oceania	681	0.6	0	0
TOTAL	**107,797**	**-**	**12,712**	**-**

The bulk of the ammonia produced in Asia is for home consumption, while the export-oriented countries are Trinidad, Ukraine, Russia, Qatar and several others from the gas-rich regions (Table 4). Trade in ammonia is far more restrictive than any other fertilizers since special terminals and storage facilities are necessary.

Table 4 : Major Ammonia Producers & Exporters : 2000
(000t N)

Country	Tonnage	% Global	% Exported
China	27,650	25.6	0
USA	11,995	11.1	5.5
India	10,148	9.4	0
Russia	8,735	8.1	28.0
Canada	4,130	3.8	21.5
Indonesia	4,011	3.7	19.6
Ukraine	3,577	3.3	33.8
Trinidad	2,686	2.5	90.1
Netherlands	2,543	2.4	23.1

Country	Tonnage	% Global	% Exported
Germany	2,473	2.3	12.7
Pakistan	1,884	1.7	0
Poland	1,862	1.7	10.7
Saudi Arabia	1,743	1.6	23.5
Egypt	1,511	1.4	4.4
Japan	1,405	1.3	0
Bangladesh	1,255	1.2	10.2
Qatar	1,097	1.0	28.0

Despite a very large tonnage that is produced, USA continues to rely on ammonia imports to support its production of ammonium phosphate in which it is the leading exporter (Table 5). Sizable quantities are imported by India and the leading industrialised countries in West Europe and Asia.

Table 5 : Major Ammonia Importers : 2000
(000t N)

	Tonnage
USA	4,215
India	1,105
Korea	654
Turkey	600
France	513
Spain	495
Taiwan	411
Belgium	396
Morocco	321
Italy	288
Finland	266
Norway	264
Sweden	246
UK	236
Denmark	216

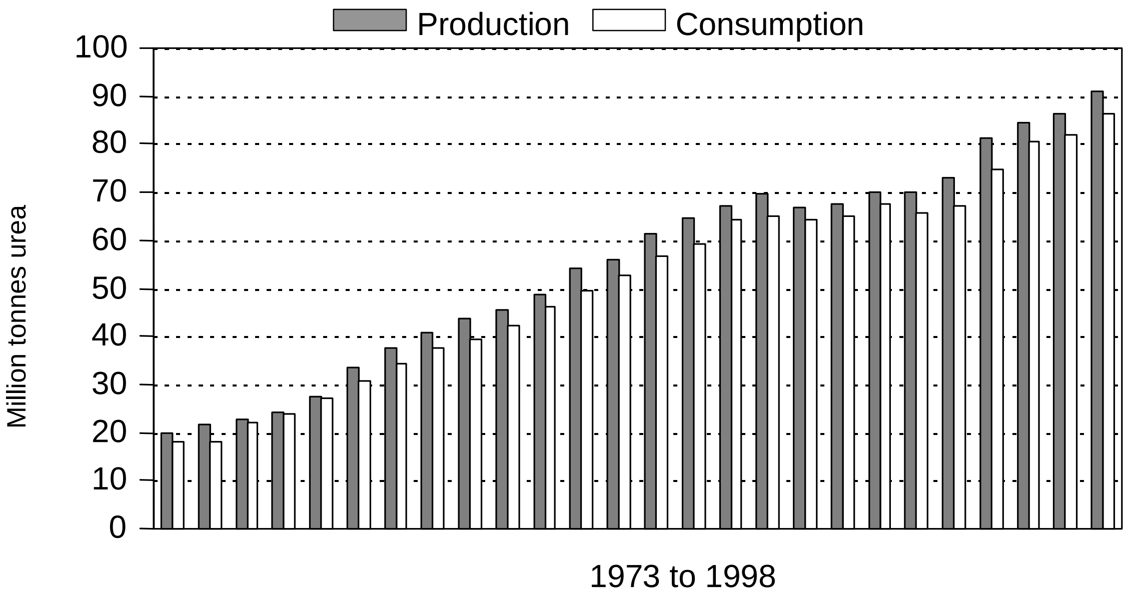
- *Urea supply*

In 2000, a total of 55 countries produced 107.4 M.t. of urea (Table 6). The 10 biggest producers are located either in the highly populous rice growing areas in Asia or where natural gas is readily available. The global production and consumption pattern since 1973 is shown in Figure 3.

Table 6 : Urea Producers : 2000

Production Range	# Countries	Total Production (000t urea)	% Share
Up to 0.5 M.t.	27	5,415	5.0
> 0.5 M.t. to 1.0 M.t.	10	6,913	6.4
> 1.0 M.t. to 2 M.t.	8	10,893	10.1
> 2 M.t.	Bangladesh	2,388	2.2
	Saudi Arabia	2,638	2.5
	Ukraine	3,128	2.9
	Pakistan	3,535	3.3
	Russia	4,332	4.0
	Canada	4,530	4.2
	Indonesia	6,319	5.9
	USA	6,935	6.5
	India	19,697	18.3
	China	30,700	28.6
	TOTAL	**107,423**	

Figure 3 : Global Urea Production and Consumption



From the trend, it is obvious that setbacks in either production or consumption are extremely rare events. The reason for its resilience is that urea trends to cannibalise other straight nitrogenous fertilizers, AN, CAN, AS and even ammonium phosphates under difficult market conditions.

Table 7 : World Urea Capacities by Region
(000t urea)

		1990	1996	2000	2005 + Planned
Asia excl. China	Total	26,556	34,169	37,504	46,787
	Granular	n.a.	1,448	2,759	4,093
Asia-Socialist	Total	14,707	24,663	34,874	42,811
	Granular	n.a.	1,952	3,350	4,880
Central/East Europe	Total	18,826	17,028	17,026	19,125
	Granular	n.a.	0	0	0
Middle East	Total	9,411	10,335	13,467	19,308
	Granular	n.a	2,872	6,024	9,478
North America	Total	9,641	11,520	12,935	14,211
	Granular	n.a	6,252	7,226	7,226
West Europe	Total	6,963	6,109	6,091	6,072
	Granular	n.a	1,217	1,439	1,439
Latin America	Total	4,563	5,065	5,689	11,089
	Granular	n.a	1,193	2,265	5,187
Africa	Total	757	789	815	496
	Granular	n.a	789	815	496
Oceania	Total	407	383	472	1,209
	Granular	n.a	137	472	1,209
TOTAL		**91,831**	**110,061**	**128,873**	**161,097**
GRANULAR		**n.a**	**15,860**	**24,350**	**34,428**
% Share Granular		**n.a**	**14.4**	**18.9**	**21.4**
% Capacity utilisation		**82.4**	**84.7**	**83.3**	**-**

n.a. : data not available

Table 7 provides a detailed summary of the urea capacities by region, including that of granular urea. During the last decade, the greatest growth took place in China in which nearly 20 M.t. of new capacities were added; the rest of Asia also put up an impressive 11 M.t. The Middle East region together with Latin America are planning to accelerate the pace of expansion over the next 5 years. West Europe is the only region that is cutting back on capacities.

Capacity utilisation follows closely to market demand. The 1995/96 period was particularly buoyant for the agricultural commodities when cereal prices reached an all time record. Current conditions are fairly muted.

- *Granular urea production*

The granulation technology had been around for more than 40 years. It started with drum granulation in the sixties. By the seventies, penetration of this technology was already widespread in North America due to the strong demand for blending and mechanical application. The development of fluidised bed granulation in the 1980's provided another impetus to granular urea production.

Statistics on granular urea capacity were started quite recently. To date, there is no separate statistical data on granular urea consumption and trade. North America currently leads the world in granular urea capacities followed by the export-orientated Middle East region. Over the next 5 years, the share of granular urea against the prills will continue to increase. Aggressive expansion is planned in the Middle East and Latin America and to a lesser extent in Asia. In the Middle East, the new capacities would be from Saudi Arabia (2 x 600 Kt), Oman (830 Kt), Iran (660 Kt) and Kuwait (585 Kt). The Chinese are likely to add some 1.5 M.t. of granular capacity by 2005. For the rest of Asia, Indonesia plans to bring 1.14 M.t. on-stream on or before 2005, while Bangladesh would upgrade an existing plant from 645 Kt to 840 Kt. The Plenty River project in Australia for 726 Kt capacity is planned to come on-stream only after 2005. Except for the countries with a sizable domestic market, the production from the new capacities would be geared almost entirely for export. No granular plant has been on the drawing board for Central and East Europe despite their large export of prills.

- *Urea trade*

Over 90% of the urea produced is used as fertilizers. Industrial uses include the manufacture of adhesives, resins, dyes, feed supplements for livestocks, pharmaceuticals and many other specialised products.

About 25% of urea produced is exported. Although, 42 out of 55 producing countries sell their product abroad, 12 of the largest players make up three quarters of the total exports (Table 8).

Table 8 : Urea Exporters : 2000
(000t urea)

Export	# Countries	Total Volume	% Share
Up to 250 Kt	19	1,220	4.7
250 Kt to 500 Kt	5	1,656	6.3
500 Kt to 750 Kt	7	4,037	15.4
750 Kt to 1 M.t.	5*	4,411	16.8
> 1M.t.	Qatar	1,639	6.3
	Canada	2,033	7.8
	Indonesia	2,085	8.0
	Saudi Arabia	2,180	8.3
	Ukraine	3,107	11.9
	Russia	3,824	14.6
	TOTAL	**26,192**	

* Malaysia : 867 Kt.

The trade is complex since some 120 countries import varying quantities of tonnages (Table 9).

Table 9 : Urea Importers : 2000
(000t urea)

Import	# Countries	Total Tonnage	% Share
Up to 250 Kt	91	3,931	15.0
250 Kt to 500 Kt	11	3,815	14.6
500 Kt to 1 M.t.	6	3,835	14.6
> 1M.t.	Mexico	1,220	4.6
	Italy	1,237	4.7
	Turkey	1,263	4.8
	Thailand	1,293	4.9
	Australia	1,361	5.2
	Brazil	1,822	7.0
	Vietnam	2,252	8.6
	USA	4,163	15.9
	TOTAL	**26,192**	

Among the large users, China has been absent from the market since 1998 due to import ban instituted a year previously. In 1996, it imported over 6 million tonnes. India also took a dip in import from around 800 Kt to less than 175 Kt last year. Meanwhile, USA has taken up the slack and increased its import by nearly 1.5 M.t. over the last two years. West Europe also took advantage of the low prices by increasing its import by more than 1.3 M.t. over the previous two years. Latin America, a region with vast potential for growth, had also increased its import lately.

Urea Demand

The demand for urea is ultimately entwined with the need for fertilizers as a whole. As the population grows, the pressure to provide adequate food and fibres intensifies. With continuous improvements in agricultural production, cereal production, for example, has clearly outpaced population growth. (Table 10).

Table 10 : Cereal Production vs Population Growth

	1930	**1975**	**1999**	**1999 vs 1930 % change**
Population	2 billion	4 billion	6 billion	+ 200
Wheat	127	355	584	+ 360
Maize	113	324	600	+ 431
Oat	64	48	25	- 61
Barley	41	150	130	+ 217
Rye	47	24	20	- 57
Padi	89	360	596	+ 570
Total (M.t.)	**481**	**1261**	**1955**	**+ 306**

In this respect, fertilizer usage has played an important role. Various studies have shown that between 40 to 60% of the yield increase is attributed to fertilizer application. The impressive growth in the use of fertilizers is shown in Table 11.

Table 11 : Global Fertilizer Consumption

	1930	1975	1999
N	1.3	43.9	85.0
P_2O_5	2.8	25.8	33.4
K_2O	1.4	21.4	22.1
(M.t. nutrient)	**5.5**	**91.1**	**140.4**
Av. yield cereals t/ha	**1.1**	**2.0**	**3.3**

Equally important is the yield per unit area : from 1.1 t/ha to 3.3 t/ha of cereals. This has greatly alleviated the pressure for more arable land, water and other natural resources.

It is of interest to note that of the three nutrients, nitrogen continues to grow from strength to strength while those of phosphate and potash have slowed down over the last two decades. There is a fundamental difference between nitrogen and the others : nitrogen will rapidly undergo denitrification, volatilisation or leach-off while the phosphate and potash are largely fixed or accumulated in the soils if they are not removed by the plants.

The popularity of urea goes beyond economics. For urea to be taken up, it must first be hydrolysed to ammonia, which in turn is oxidized microbiologically to nitrite and then to nitrate. In temperate regions, urea is used for top-dressing cereals and pasture, through at 80-85% the efficacy of AN/CAN. For rice, urea is the preferred nitrogen source, since the rice plant is uniquely predisposed to absorb the ammonium radical. In flooded rice, under anaerobic conditions, the nitrates are rapidly reduced to N_2O and gaseous nitrogen and hence lost to the atmosphere. Elsewhere, urea is used in virtually all crops due to its widespread availability and competitive pricing.

The largest consumers of urea with an off-take exceeding 1 million tonnes in 1998 are shown in Table 12. They account for well over 80% of the total off-take. The largest consumers, China and India, have steadily built new urea capacities to avoid dependency on huge imports. In the past, the urea market would await for the policy announcement on fertilizers by the respective governments. The recent loss of 4 to 6 million tonnes import by China had been largely absorbed by the market but at a price. Urea prices tumbled and the re-export of urea by China worsened the situation.

Table 12 : 1998 Urea Consumption (million tonnes)

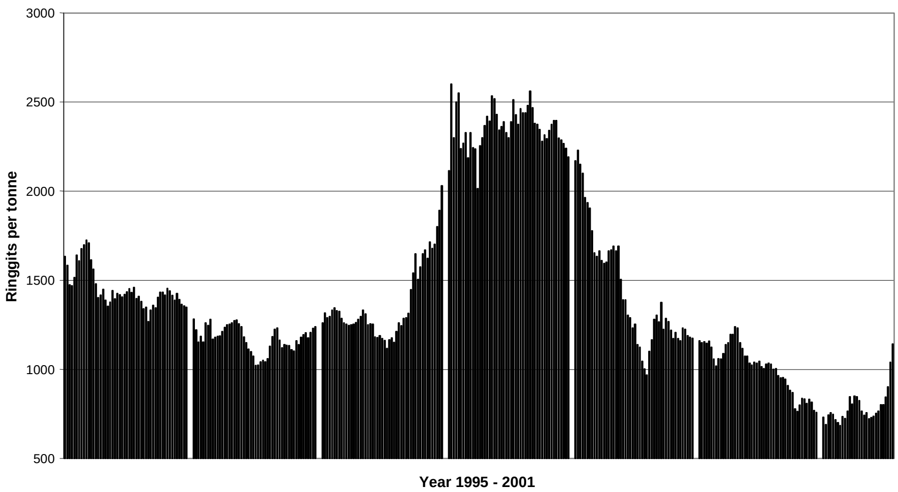
1	China	26.19
2	India	20.40
3	Indonesia	4.29
4	USA	4.01
5	Pakistan	3.89
6	Vietnam	2.33
7	Bangladesh	1.90
8	Brazil	1.86
9	Iran	1.54
10	Canada	1.40
11	Australia	1.09
12	Egypt	1.09
13	Thailand	1.03
	WORLD	**86.13**

The poor urea scenarios affected the granular urea and prices moved downwards in tandem. However, granular urea commands a premium over the prills. The superior and uniform granules facilitate application, particularly when carried out mechanically. They blend well with DAP/MAP and granular muriate of potash (MOP). In recent years, the trend is towards “Precision Agriculture” by the North American farmers and “Site-Specific Application” by the European counterparts (see pictures). Both techniques deploy soil analysis and yield data with computer-aided blending as the machines, guided by GPS, applies the fertilizers. Aerial application of fertilizers would also place a high premium on the quality granules as well. In Australia, USA, Colombia, etc, seeding fertilizer and pesticide applications for rice are aerially delivered.

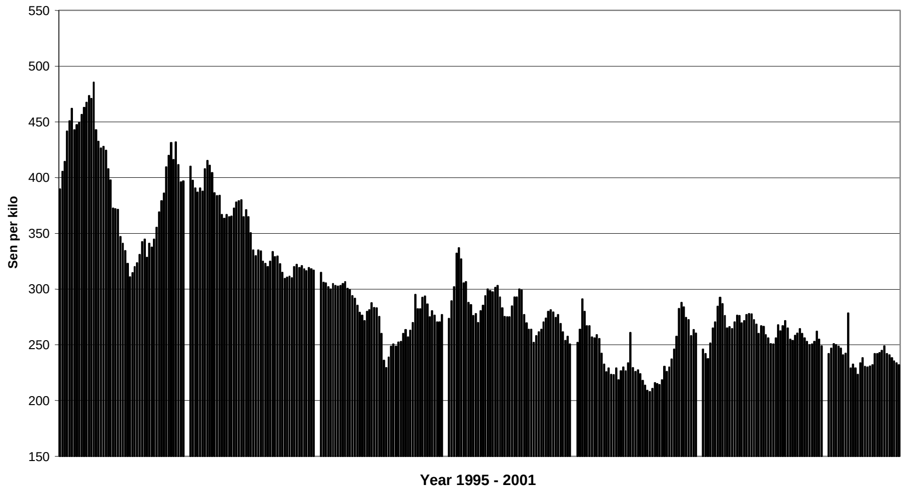
Outlook

The current agricultural scenarios remain poor. Global cereal production, now totalling 2.2 billion tonnes, matches consumption and stocks are adequate. Oilseeds production continues to create new records of harvests. There are huge stock overhangs for sugar, cotton, rubber, cocoa, coffee, etc. Over the last two years, commodity prices are dredging the bottom (Graphs 1 to 8).

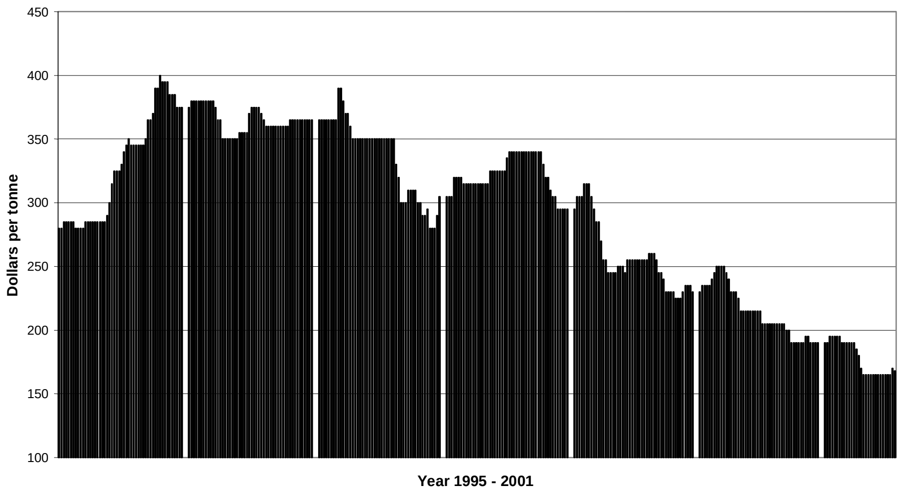
Graph 1 :Palm-oil Price Trend



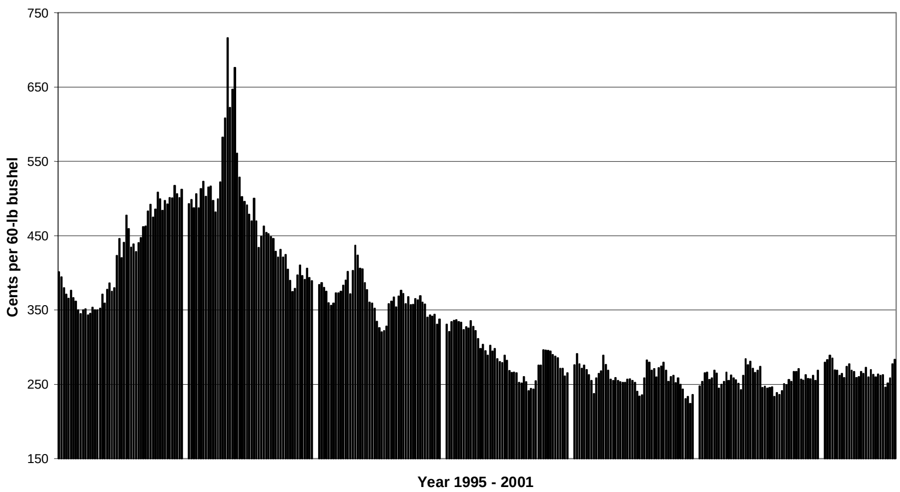
Graph 2 : Rubber Price Trend

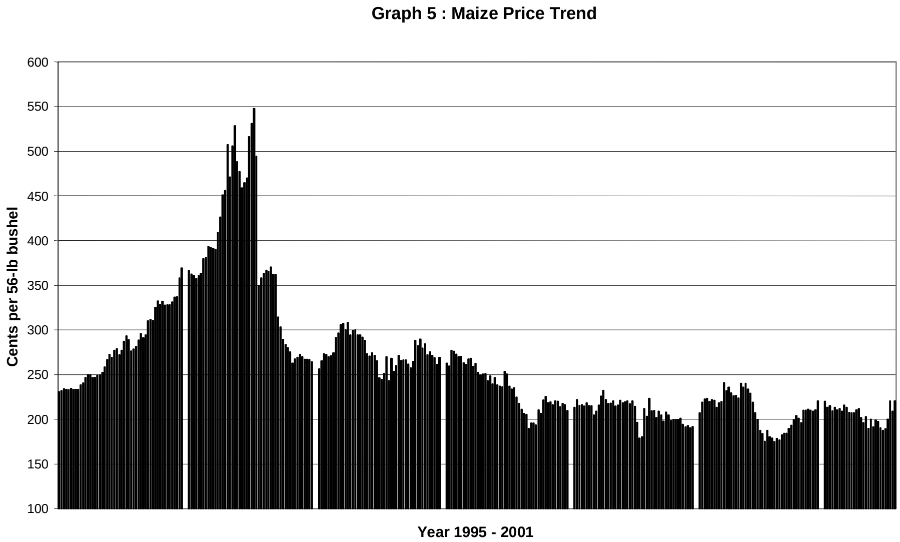


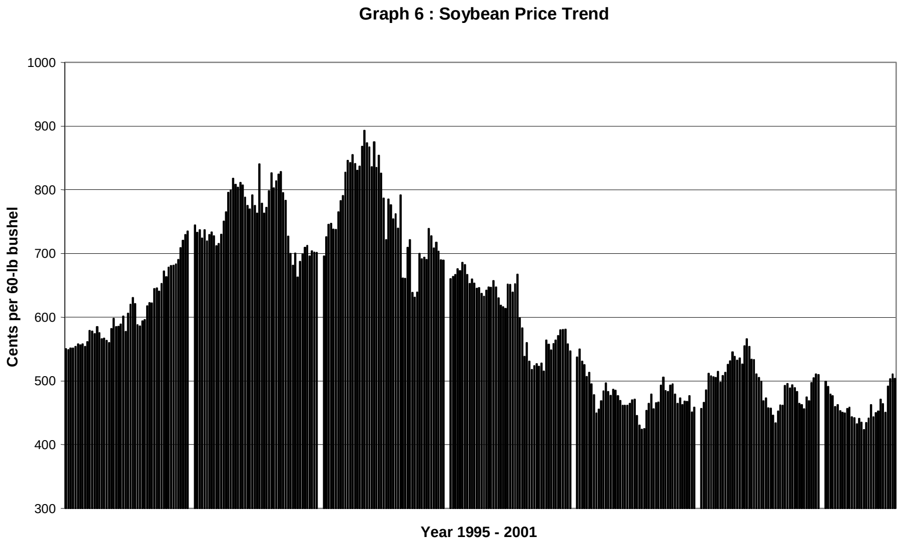
Graph 3 : Rice Price Trend

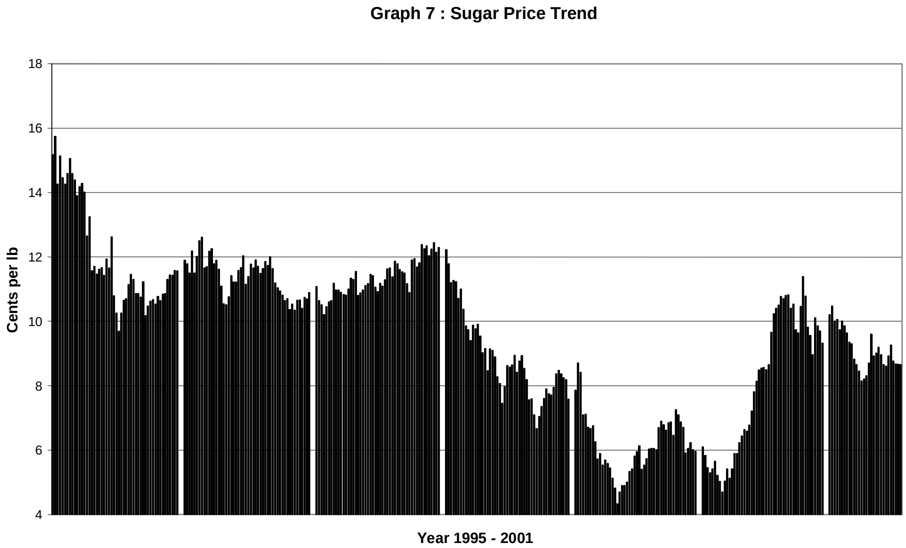


Graph 4 : Wheat Price Trend

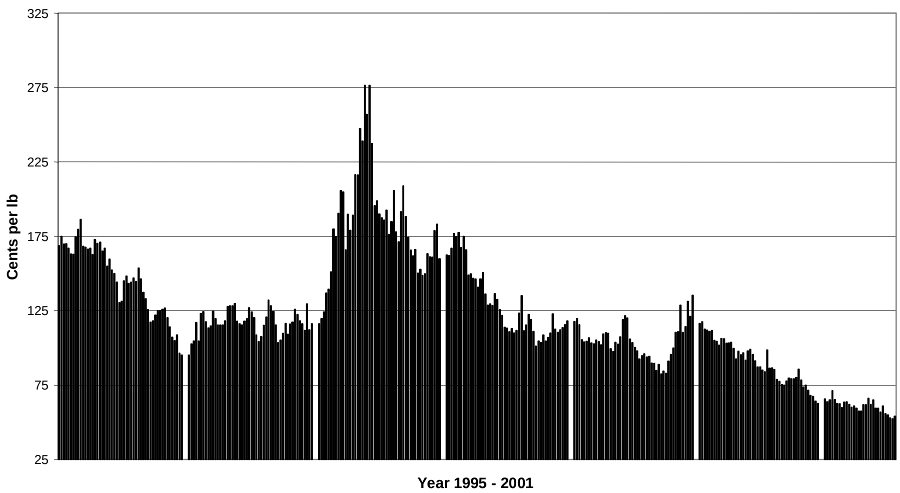



Graph 5 : Maize Price Trend
600
550
500
450
400
350
300
250
200
150
100
Cents per 56-lb bushel
Year 1995 - 2001


Graph 6 : Soybean Price Trend
1000
900
800
700
600
500
400
300
Cents per 60-lb bushel
Year 1995 - 2001


Graph 7 : Sugar Price Trend
18
16
14
12
10
8
6
4
Cents per lb
Year 1995 - 2001

Graph 8 : Coffee Price Trend



The financial crises of Asia, Russia and Brazil have wrecked the fragile agricultural commodity market through a series of devaluations. A number of developed countries have to create "competitive currency devaluations" to remain in the market. The financial crisis also affected the demand for meat and the livestock problems in Europe and elsewhere added more problems for the feed market, a significant outlet for cereals and oilseeds. In retrospect, the poor commodity scenarios appear to have a positive impact as users switch to urea for its value. In recent years, in India, for example, the changes in its fertilizer policy, had resulted in the switch-over to urea and thereby wreaking the fine N:P:K balance.

Would urea derived from natural gas face competitive threats in the immediate horizon ? The answer is an emphatic "No" on grounds of economics. Max Appl, a renown authority on ammonia production technology, pointed out that in the foreseeable future, urea production would remain linked to ammonia derived from steam reforming of natural gas due to the highly competitive economics compared with other feedstocks. (Table 13).

Table 13 : Ammonia production cost from various feedstocks in N.W. Europe – 1996 (1800t/d, new plant)

Feedstocks/Process		**Natural gas steam reforming**	**Vacuum residue partial oxidation**	**Coal partial oxidation**
Feedstock price	$ GJ	2.75	1.90	1.75
Total energy consumption	GJ/t NH_3	28.5	38	48.5
Energy cost	$/t NH_3	80	72	85
Other costs	$/t NH_3	32	42	65
Total costs	$/t NH_3	112	116	150
Capital-related costs	$/t NH_3	65	93	168
Grand total cost	$/t NH_3	177	209	318
Investment	$M	225	325	580

(For capital related costs a debt/equity ratio of 60:40 is assumed. With 6% depreciation, 8% interest on debts and 16% ROI on equity, total capital-related charges are 17.2% on investment).
(From Max Appl's 50th Anniversary of the IFA Technical Conference, 25-26 Sept. 19997, Sevilla, Spain)

There is very little effort or economic incentive for research using other processes. Over the very long term, coal has prospects. At the present consumption rates coal will cover the demand for 235 years, natural gas for 66 years and oil for 43 years.

The use of fertilizer, particularly nitrogenous products, comes under increasing scrutiny by the global community. During production, greenhouse gases : N_2O and CO_2 are released. On the other hand, it has a positive role in sequestrating CO_2 during agricultural production. There is concern that urea is an inefficient fertilizer due to its ease of volatilisation.

While the growth of fertilizer consumption is dependent on global population, the pace of growth is dependent on its financial well-being. In the developed countries only one in four units of cereals is used for human consumption. The rest are largely for animal feed. The converse is true for the developing countries. The demand for meat should increase the pace of growth for fertilizers.

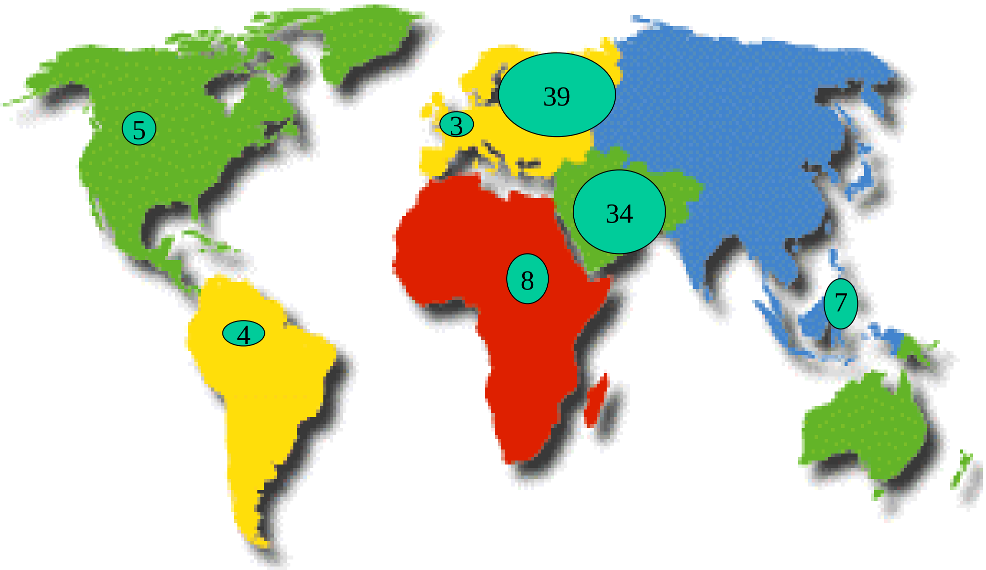
As for granular urea, it is likely to face increasing competition. With the granulation technologies readily available at attractive bargains, many new plants would opt for it. Further, these plants are likely to be erected in the low price, gas-rich regions and the Russian Federation and the Middle East are likely to be largest competitors in the export markets for prills and granules respectively. (Figure 4). If the demand for granular urea is to be sustained, efforts should be directed to greater usage of blends and improved penetration into rice cultivation.

Acknowledgments

The author wishes to thank MITCO for the opportunity to present the paper and to Mr L.M. Maene, Director General, IFA, for his fine encouragements and support.

Figure 4 : Natural Gas Reserves (Oil & Gas Journal, 2000)

Percent, reserves gas



"Precision Agriculture" (Site – Specific fertilizers application)

European agriculture (France)

Large fertilizer applicator

Large fertilizer applicator

Fertilizer section system

Computer linked to GPS

Computer with data on yield, fertility, etc...

Application at 30 km/h

European adaptation for smaller farm size