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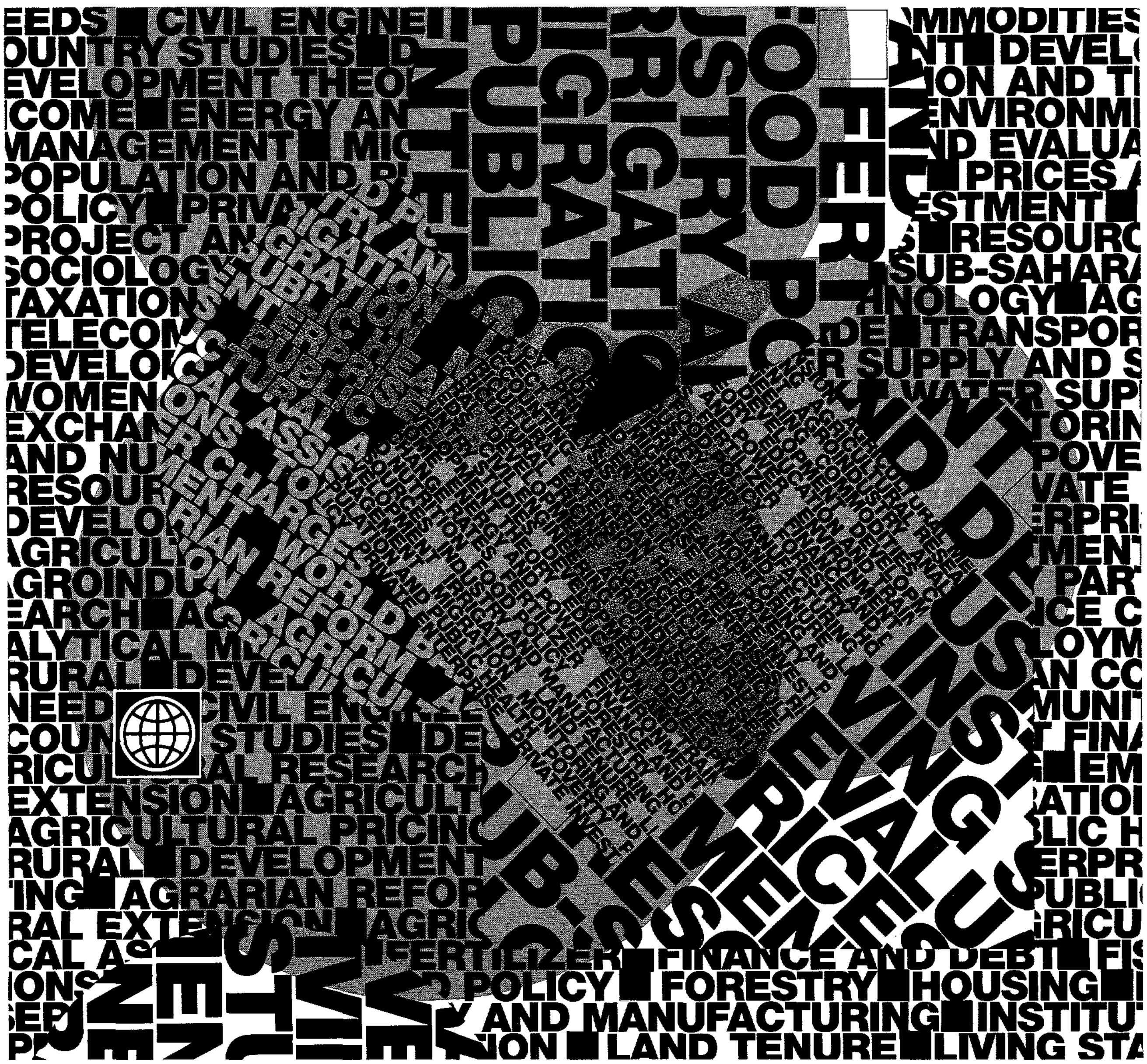
ASIA TECHNICAL DEPARTMENT SERIES

World Nitrogen Survey

Kurt Michael Constant
William F. Sheldrick



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FOREWORD

Nitrogen, which is an essential element in our life and the world around us, has become an important raw material for agriculture and industry. Almost all industrial nitrogen products are derived from ammonia, of which about 85 percent goes to fertilizer use. Thus, a good knowledge of the nitrogen sector, particularly of supply and demand, trading patterns, operational parameters and environmental aspects, is a critical input for a wide range of planning and decision making activities. These include not only considerations at macro-economic levels, such as policy reform and structural adjustment, but also at the micro-economic level, where issues must be addressed such as the need for capacity expansion, production and marketing planning as well as enterprise restructuring and reform.

This paper aims at providing a comprehensive coverage of the global nitrogen sector, including supply and demand balances, as well as the impact of such factors as the current world food supply situation, fertilizer and grain inventories, and projected population growth, on supply and demand projections. The Gulf War, recent developments in Eastern Europe, Africa, Asia and the former Soviet Union, environmental legislation relating to the manufacture and application of mineral fertilizers, energy and fertilizer pricing policies, and typical investment and operating costs of nitrogen fertilizer projects have also been taken into account.

We hope that this publication may become a useful reference for a wide audience, including international development and financing institutions, banks, government agencies, and other organizations in industry, trade, and academics.

Daniel Ritchie
Director
Asia Technical Department

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ABBREVIATIONS AND ACRONYMS

AS - Ammonium Sulfate
ASEAN - Association of South-East Asian Nations
BBL - Barrel
BCM - Billion Cubic Meters
BTU - British Thermal Unit
CAN - Calcium Ammonium Nitrate
CIF - Cost, Insurance and Freight
DAP - Diammonium Phosphate
FAI - Fertilizer Association of India
FAO - Food and Agricultural Organization of the United Nations
FOB - Free on Board
IRR - Internal Rate of Return
LNG - Liquified Natural Gas
LPG - Liquified Petroleum Gas
MM - Million
N - Nitrogen equivalent in nitrogenous materials
TFI - The Fertilizer Institute of the USA
ton - Metric Ton (1,000 kilograms)
tpd - Tons Per Day (metric unless otherwise stated)
tpy - Tons Per Year (metric unless otherwise stated)
TVA - Tennessee Valley Authority
UNIDO - United Nations Industrial Development Organization

USSR

All data used in this report with regard to consumption and production under the name of USSR, Soviet Union and Russia, refer collectively to all of the members of the former Soviet Union (FSU), unless otherwise stated.

Time Reference

Most statistical data presented in this review use the FAO fertilizer year, 1 July - 30 June. For countries that report their fertilizer statistics on a calendar year basis, data are shown under the fertilizer year, the first part of which corresponds to the calendar year, i.e. 1990 data are under 1990/91.

Tables

Summary tables in the report may not add up precisely due to rounding.

FAO REGIONAL COUNTRY CLASSIFICATION

AFRICA

Algeria
Angola
Benin
Botswana
Burkina Faso
Burundi
Cameroon
Central Afr. Rep.
Chad
Congo
Cote d'Ivoire
Egypt
Ethiopia
Gabon
Gambia
Ghana
Guinea
Guinea Bissau
Kenya
Lesotho
Liberia
Libya
Madagascar
Malawi
Mali
Mauritania
Mauritius
Morocco
Mozambique
Niger
Nigeria
Reunion
Rwanda
Senegal
Sierra Leone
Sierra Leone
Somalia
South Africa
Sudan
Swaziland
Tanzania
Togo
Tunisia
Uganda
Zaire
Zambia
Zimbabwe

AMERICA

North America
Canada
United States

Central America
Bahamas
Barbados
Belize
Bermuda
Costa Rica
Cuba
Dominica
Dominican Rep.
El Salvador
Guadaloupe
Guatemala
Haiti
Honduras
Jamaica
Martinique
Mexico
Nicaragua
Panama
St.Kitts & Nevis
Saint Lucia
Saint Vincent
Trinidad & Tobago
Virgin Islands

South America
Argentina
Bolivia
Brazil
Chile
Colombia
Ecuador
French Guiana
Guyana
Paraguay
Peru
Suriname
Uruguay
Venezuela

ASIA

West Asia
Afghanistan
Bahrain
Cyprus
Iran
Iraq
Israel
Jordan
Kuwait
Lebanon
Oman
Qatar
Saudi Arabia
Syria
Turkey
United Arab Emir.
Yemen

South Asia
Bangladesh
Bhutan
India
Nepal
Pakistan
Sri Lanka

East Asia
Cambodia
China
Indonesia
Japan
Laos
Malaysia
Mongolia
Myanmar
Korea DPR.
Korea Rep.
Philippines
Singapore
Taiwan
Thailand
Vietnam

EUROPE

East Europe
Albania
Bulgaria
Czechoslovakia
Hungary
Poland
Romania
Yugoslavia

West Europe
Austria
Belgium - Lux.
Denmark
Finland
France
Germany
Greece
Iceland
Ireland
Italy
Malta
Netherlands
Norway
Portugal
Spain
Sweden
Switzerland
United Kingdom

USSR

OCEANIA

Australia
Fiji
French Polynesia
New Caledonia
New Zealand
Papua New Guinea

TABLE OF CONTENTS

ANNEXES

TABLES

FIGURES

SUMMARY AND CONCLUSIONS

Overall Review

This report reviews the historical development of the international nitrogen fertilizer industry and the outlook for the industry through 2000, including nitrogen supply and demand balances, as well as the economics of production and transportation of ammonia and urea. The impact that new nitrogen fertilizer demand will have on ammonia and urea trading patterns and economics of trade is assessed as well as the need for growing nitrogen fertilizer consumption to meet increasing world food requirements in relation to the environmental impacts on agriculture and the fertilizer industry. Recent nitrogen fertilizer price information is presented together with price projections through 2000.

Based on information provided in this survey, matrixes have been developed as a tool in assessing the competitiveness of potential new ammonia and urea projects required to meet future nitrogen fertilizer needs.

The regional and world supply demand and balances presented in the report were prepared by the World Bank/FAO/UNIDO/Industry Fertilizer Working Group in Vienna in May 1991 and are a major basis of this publication. Country ammonia capacities have been derived from the Working Group's updated plant lists. Regional demand is assessed by the Group on a "Delphi" principle, but other contributions are based on a range of methodologies, including trend projections, econometric modeling, agricultural programs and sales forecasts. It is important to note that at the time the supply and demand balances were being prepared, many changes were occurring in the fertilizer industry in Eastern Europe and particularly in the USSR; these changes are likely to have a major long term effect on the international fertilizer sector. Although every endeavor has been made to allow for these changes in both supply and in demand, it may take some time before their full impact is known. Allowance has also been made for short and medium term changes in the nitrogen fertilizer supply resulting from the war in the Arab Gulf.

The Nitrogen Fertilizer Industry

Nitrogen in its many forms is an important element in both agriculture and the chemical industry. Almost all nitrogen products are produced from the catalytic fixation of atmospheric nitrogen as ammonia and almost 90% of the ammonia is used to manufacture nitrogen fertilizers. Nearly 80% of ammonia is produced from natural gas and this percentage will increase even more in the future.

Before 1960, the nitrogen industry was located mainly in developed countries. Plants were usually small and served local markets; there was little nitrogen trade. However, between 1960 and 1980, there was a rapid expansion in fertilizer consumption, production and trade; fertilizer consumption increased on average by almost 10% each year - mainly as a result of the introduction of high yield varieties (HYV) of cereals.

Ammonia plant capacity increased substantially in all regions and following the introduction of centrifugal compressors, ammonia plants became larger and more energy efficient; consequently the cost of producing nitrogen fertilizers dropped significantly. Many developing countries with large reserves of inexpensive natural gas built ammonia/urea complexes. Because urea can be produced easily from ammonia, transported cheaply and safely and is a good fertilizer for wet paddy, the urea market has grown rapidly and in 1990 contributed about 40% of all nitrogen fertilizer used.

During the 1970s, taking advantage of its large reserves of natural gas, the USSR built more than 40 large nitrogen plants to become the world's leading exporters of nitrogen products. China also had a rapidly increased its capacity, but mainly through small coal-based plants. Although it has built many new large plants in the last decade or so, China still relies heavily on small size plants that contribute about half of its domestic fertilizer production in terms of nitrogen.

In recent history, the structure of the international nitrogen fertilizer industry has also changed considerably. There has been a large increase in the production facilities in developing countries. World-wide, there has been a move towards state ownership and about 65% of the international nitrogen fertilizer industry is estimated to be state-controlled. In the developed countries, the fertilizer manufacturing sector has become more and more dominated by a few large companies. This is due mainly to the very large investments that are needed to obtain economies of scale in nitrogen fertilizer production.

Future Nitrogen Fertilizer Demand

In 1989/90, world nitrogen fertilizer consumption declined slightly to 79.1 million tons N from 79.7 million tons in 1988/8; of which Asia used about 45%, Europe 19%, the Western Hemisphere 19% and the USSR 13%. A further fall in nitrogen fertilizer consumption to around 77.8 million tons is expected in 1990/91, because of the problems in Eastern Europe and the USSR. However, overall nitrogen fertilizer demand is expected to increase by about 1.5% per year on average through 2000, amounting to a total of about 13.7 million tons (>17%). Asia will increase its demand by about 13.4 million tons (>37%), but in the USSR and Europe, there will be a decline in overall consumption.

Nitrogen is also used for industrial purposes, mainly in the highly developed countries, to manufacture plastics, synthetic fibers, animal feeds etc. In 1990/91, industrial nitrogen accounted for 12% of total nitrogen consumption and is expected to grow on average at less than 1% per year through the next five years.

World Ammonia Capacity

The USSR is the largest producer of ammonia followed by China, USA and India. The USSR is now also the largest exporter of nitrogen fertilizers and ammonia. Both China and India have developed capacity to meet domestic demand but they still need to import. As ammonia production capacity in the USA has declined in the last few years in the face of increasing competition from overseas, the country has become a small net importer of nitrogen. Other major producers of ammonia and nitrogen fertilizers include Canada, the Netherlands and Indonesia.

Due to the large increase in ammonia capacity that took place in the late 1970s and early 1980s, there has been a large surplus of ammonia supply that was further enlarged by improvements in ammonia plant utilization rates from about 75% in 1980 to 85% in 1990. With a decline in investments in new capacity, the average age of ammonia plants has been increasing. About 40% of all ammonia plants are now older than 15 years and 25% are older than 20 years. Many plants will be needed in the 1990s to replace old plants and also to cope with growing nitrogen needs. Most new ammonia and urea plants will be built in Asia to meet increasing demand in the region. Few plants will be built elsewhere.

Nitrogen Supply and Demand Balances

The global nitrogen supply and demand situation is expected to remain tightly balanced over the next year or two, but this will depend to a large extent on future developments in the USSR. Although as result of the Gulf War, about 0.8 million tons of nitrogen were removed from the export market, reduced consumption in East Europe and the USSR has increased the export potential of these regions. An increase in the world nitrogen surplus may be expected in the next few years, when new capacity that is currently under construction in Asia, comes on stream. Thereafter, i.e. in the late 1990s, the balance is expected to narrow again.

Nitrogen Fertilizer Trade

There are basically two markets for nitrogen fertilizers - ammonia and finished nitrogen products. In 1990, about 9.3 million tons of ammonia-N were internationally traded. The main markets for ammonia are the USA and Western Europe. Ammonia is used as an intermediate for the production of ammonium nitrate and ammonium phosphate. In the USA, there is also a significant ammonia market for direct application to the soil. The USSR is the largest exporter of ammonia with 30% of the world market; other major exporters include Trinidad, the Arab Gulf countries and Canada. The other nitrogen market involves finished nitrogen fertilizers; about 20 million tons of nitrogen fertilizers as N were exported in fertilizer year 1989/90, accounting for almost 24% of total nitrogen fertilizer production. Urea is the most widely used and traded nitrogen fertilizer, particularly in developing countries, as it is easy to produce and is a very versatile fertilizer, if used with adequate care. It is a concentrated fertilizer and offers savings in transport and handling costs compared to other nitrogen fertilizers. The USA and USSR are the two most important exporters of nitrogen fertilizers. Most of the exports from the USA are in the form of diammonium phosphate, partially based on imported ammonia. Exports from the USSR are almost entirely as urea. Other major exporters of nitrogen fertilizers include Canada, the Netherlands and Romania. The dominant importers of nitrogen fertilizers are China, followed by the USA, France and Germany.

Most new fertilizer demand will develop in South Asia and East Asia and so trade to and within the Asia region is expected to increase. About 70% of this nitrogen trade will be in the form of urea with most of the remainder as diammonium phosphate. Ammonia trade to the USA and Western Europe will depend basically on future feedstock prices. No significant increase in nitrogen demand is expected in these countries, no new capacities are envisaged, but some plant closures are expected, particularly in Western Europe. The extent of these closures will largely depend on future oil prices. Any alternative supplies required would be imported in the form of either ammonia or urea.

The Economics of Nitrogen Fertilizer Production

The cost of energy as fuel and feedstock is usually the most important component of ammonia and nitrogen fertilizer production costs. Natural gas is the preferred energy source, because less energy is required and since investment and operating costs are lower. The cost of producing ammonia has steadily declined as larger, more economic and energy efficient, plants have been developed.

Substantial new ammonia and urea capacities will be required to meet nitrogen fertilizer needs through the second half of the 1990s. To appreciate more fully the factors which influence fertilizer costs and enable more accurate projections of future fertilizer prices to be made, cost matrices have been developed for a range of different scenarios involving plant location, gas prices, plant size etc. The information obtained may be used to assess the competitive situation for potential ammonia and urea projects on both new greenfield sites and existing fertilizer plant sites.

The assessment indicates that only projects with inexpensive gas, say less than US$1.0/MMBtu, will be able to compete in overseas markets. Plants on new sites anywhere, incurring high costs of infrastructure, are not likely to look attractive. In order to be viable, new plants should preferably be built on sites with existing infrastructure.

Because the capital charges on new ammonia and urea plants are high, plants must be run at high utilization rates to reduce unit production costs. For example and as a rough guide, every one-percent reduction in operating rate increases the production cost by US$2/ton of ammonia. Provided that market conditions permit, there is almost always an advantage in producing ammonia in larger-sized plants. The total cost of producing ammonia in a 1,500 tpd plant would be about US$15/ton less than in a 1,000 tpd plant. There maybe certain situations, however, where some of the improved-design small plants may be appropriate, such as an expansion or replacement of capacity on existing sites.

Freight costs are an important part of total delivered cost, particularly in the case of ammonia and new plants will need to be situated near to existing markets to compete successfully. While urea transportation follows the dry bulk trade, ammonia transportation is more complex . It depends predominantly on a relatively small part of a fleet specially designed to carry liquified gases. Ammonia freight prices have increased significantly, as existing ships age and need replacing. As new freight capacity becomes available, ammonia freight costs are expected to decline for a few years and then increase again through the second half of the 1990s.

Nitrogen Fertilizer Prices

Ammonia and urea prices have varied widely both in absolute and relative terms in the last two decades. A large oversupply situation has persisted for many years following major investments in ammonia and urea plants in Eastern Europe, the USSR and the Arab Gulf. As a result, prices have remained low since the major exporters in Eastern Europe reduced prices to obtain markets and hard currency. The capacity surplus has now diminished considerably and plants in many parts of the world are generally working at high utilization rates. Prices had already started to increase in the spring of 1990, but following the removal of exports from Kuwait and Iraq as a result of the Arab Gulf crisis, increased significantly through early 1991, fell after the Gulf War ended and then continued their trend upwards in the second half of 1991.

In real terms, both ammonia and urea prices are expected to increase slowly through most of the 1990s. At the end of the 1990s, however, prices are expected to decline slightly as new capacity comes on stream.

Future nitrogen prices will depend largely on future oil prices. For example, if oil prices increase significantly, say from their present levels of about US$20 to US$40/BBL, many ammonia plants with feedstock prices that are related to oil prices, would no longer be competitive. Some plants would be forced to close and ammonia and urea prices would probably rise to around US$200/ton. A drop in oil prices would normally reduce nitrogen prices, but this would be counter-balanced by a tightening global nitrogen supply and demand situation and a resulting price escalation. Although an unknown factor at this time, the export potential of the USSR will consequently have a major impact on future prices.

World Food Production and Fertilizer Use

FAO is concerned about the present low level of food stocks that are regarded as barely sufficient to assure world food security, although 1990 produced a record cereal harvest. With a projected drop by 4% in 1991 world cereal production, global world food security remains to be a major issue.

There is also concern that the current low projections of fertilizer use through 2000 will not be sufficient to maintain a satisfactory growth in agricultural production that is necessary to feed a population growing at higher rates than previously encountered. The world population growth rate through the next decade is forecast at nearly 1.7% per year as compared with a nitrogen fertilizer growth rate of 1.5% per year.

Another problem now being highlighted by FAO is the prospect of diminishing food production growth in developing countries as a result of nutrient depletion or " nutrient mining" from soils. If this problem is not rectified, it could ultimately result in serious damage to agriculture and the welfare of many developing countries.

A statistical analysis has been made of cereal production and nitrogen fertilizer use over time. Although the results are only indicative, they show that nitrogen fertilizer consumption will have to increase at about 2.5% per year, rather than 1.5% in order to maintain per capita food production at the 1990 level until the year 2000, which implies the need for substantial additional production capacity.

Fertilizer Use and the Environment

During the past few years, there has been considerable concern about the social and economic aspects of environmental degradation; the use of chemical inputs in agriculture, including mineral fertilizers, has accordingly become a subject of debate and some controversy. In particular, there is concern about the run-off of nutrients causing eutrophication of lakes and rivers and contamination of ground water and drinking water by nitrates. Legislation is being introduced in Western Europe and the USA to limit the nitrate content in drinking water; such legislation may result in restricting the use of fertilizers.

Concern about environmental issues has brought with it many proposals to use alternative agricultural practices that would mean a return to natural farming conditions and a reduction in the use of pesticides and chemical fertilizers. The most publicized of these proposals in the USA is a program of "Low Sustainable Agriculture" known by the acronym of "LISA". Although efforts should be made to use mineral fertilizers in a more efficient and environmentally friendly manner, great care should be taken to ensure that such programs do not jeopardize agricultural production over the next critical decade when the world food supply and demand situation is expected to be finely balanced.

Future Outlook for the Nitrogen Fertilizer Industry

World Fertilizer demand is forecast to increase by about 14 million tons N through the next decade. Since world ammonia capacity is now working at a high utilization rate, any significant increase in supply must come from new plants. New capacity will be required after 1995 both to meet increasing demand and to replace old plants. It is estimated that up to 10 new plants may be required each year.

In order to assess the most economic projects to meet future nitrogen needs, several potential ammonia and urea projects have been compared in this report. Because freight is an important component in delivered costs, the comparison has been made on the basis of CIF marketplace. The comparisons suggest that the most competitive locations both for ammonia and urea to serve the growing large Asian market would be in the Arab Gulf and in Indonesia. For the ammonia markets in the Western Hemisphere, a favorable location would be in the Caribbean, such as in Venezuela. In order to ensure that a new plant is economically viable, it should preferably be built on a site with existing infrastructure.

In considering new capacity requirements for future nitrogen demand, it is important to point out that the projected effective nitrogen demand is likely to fall short of the actual requirements needed to provide adequate per capita food supplies at their current levels. For the first time in many decades, estimated nitrogen fertilizer growth rates will be lower than population growth rates. Based on food production and nitrogen fertilizer time series, this appears an unsustainable and dangerous situation, if the world is to maintain adequate food security.

I. INTRODUCTION

A. General

In April 1987, the World Bank published for the first time its World Nitrogen Survey (Technical Paper No. 59 in the World Bank Industry and Finance Series), which aimed at providing a comprehensive review of the nitrogen industry, with particular focus on nitrogen fertilizers.

The past four years have seen many major changes in the world, with long-lasting current and prospective impacts on the global fertilizer supply and demand situation that have to be taken into account in assessing the future outlook of the nitrogen sector. Events of particular importance are the 1989 developments in China, the Gulf War in early 1991 and the ongoing political and economic changes in Eastern Europe and the USSR. Furthermore, recent projections that world population will increase to more than 6,000 million by the year 2000 stress the need for a global increase in agricultural output, improved farm management and distribution practices, as well as increased and more efficient application of fertilizers.

Nitrogen is an important element both in agriculture and the chemical industry. It is usually regarded as the most important of the three primary nutrients. About 97% of all nitrogen products are derived from ammonia that is produced by catalytic fixation of nitrogen obtained from the atmosphere. About 88% of all ammonia produced in 1990 was used to manufacture nitrogenous fertilizers and the remainder was used in the chemical industry and processed into a wide range of different products such as textiles, explosives, plastics, animal feeds etc.

Global food production in absolute terms will have to increase at a higher rate than ever before if it is to meet the demand of the fast growing world population. A significant part of growth in agricultural production will have to come from increased and efficient use of nitrogen fertilizer considering constraints on arable land. Therefore, the availability, cost and source of new world ammonia capacity will be vitally important to the global agricultural production.

Besides a very small amount of ammonia that is produced from electrolytic hydrogen, the main feedstocks for ammonia, both as fuel and for process use, are various forms of hydrocarbons, predominantly natural gas. Both the availability and cost of energy are therefore important factors for determining the economics of ammonia production.

This updated survey is designed to provide a comprehensive overview of the nitrogen sector with particular consideration of the impact of the recent major world developments referred to above. The regional and world nitrogen supply and demand balances are based on the conclusions of the World Bank/FAO/UNIDO/Industry Fertilizer Working Group's Annual Meeting in Vienna, Austria, in May 1991. Some background information on the Fertilizer Working Group and its work is given in Annex 1.

Until early 1991, the Fertilizer Working Group followed the FAO economic classification of countries. In 1991, subsequent to major political and economic changes in many centrally planned economies, FAO revised its fertilizer country classification; the Fertilizer Working Group also decided shortly afterwards to adopt the same revised classification. This new grouping is not only compatible with the FAO geographic classification, but also with geographic classifications maintained by other major international fertilizer agencies.

The structure of this report is systematic and attempts to make each chapter self contained. Extensive annex material on supply, demand, production and investment costs is given to support the global view.

B. Historical Aspects of the Nitrogen Fertilizer Industry

Although nitrogen is a principal constituent of the earth's atmosphere comprising 78% of its volume, it is not readily available as a fertilizer. Before it can be used as a plant nutrient, it has to be fixed in the form of chemical compounds with other elements. Until the beginning of this century, the supplies of nitrogen were obtained mainly from fixed nitrogen in rain water, atmospheric nitrogen fixed by certain leguminous crops, and other natural supplies available through a system of crop rotation, which were adequate at that time to meet crop needs.

However, around the beginning of the twentieth century a faster growing population placed additional demands on agricultural production, which was expanded, to a great extent, by increasing nitrogen fertilizer use. This initiated considerable research into the development of new processes for the fixation of atmospheric nitrogen into forms that could be used for the manufacture of nitrogen fertilizers.

Three major new processes to fix atmospheric nitrogen were developed and used commercially:

(i) In 1903, the ARC-Process was commissioned in Norway. In this process, nitrogen and oxygen were combined at the high temperature of an electric arc to form nitric oxide which was then further reacted to form nitric acid and hence to the final fertilizer product, calcium nitrate ($CaNO_3$).

(ii) Another process was developed about the same time to produce calcium cyanamide ($CaCN_2$). Calcium carbide produced by a primary reaction of lime with coke in an electric furnace was subsequently converted to calcium cyanamide by reacting it with nitrogen from the air.

(iii) The most important development in nitrogen fixation, however, was the Haber-Bosch process that was introduced on a commercial scale in Germany in 1913. This process is based on the catalytic reaction of hydrogen and nitrogen at high temperature and pressure and in its basic concept is still extensively used today.

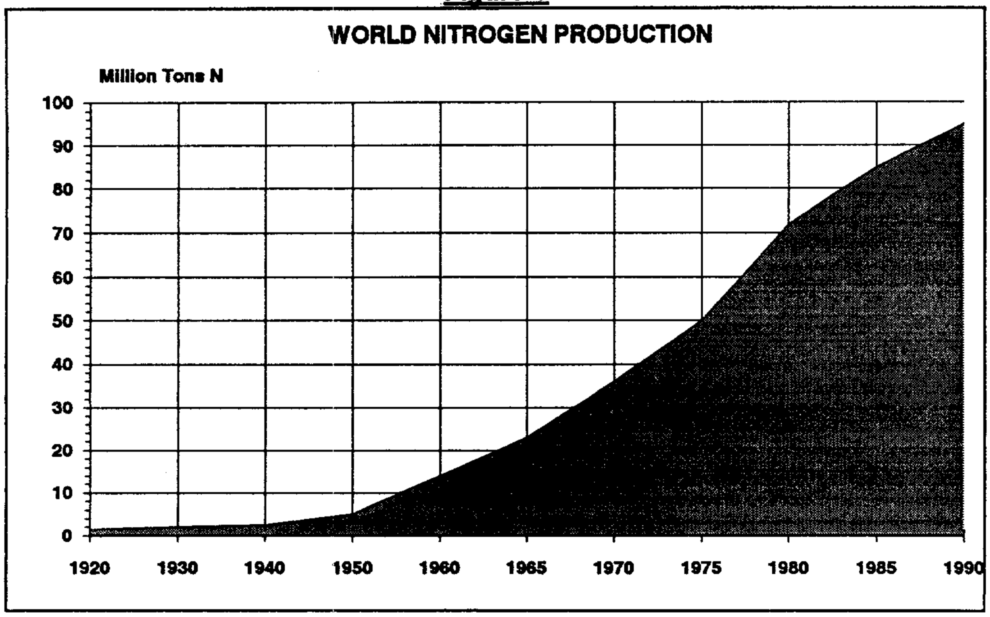
Until about 1960, most of the world's ammonia manufacturing capacity was located in developed countries, where plants were relatively small, used a variety of feedstock and served local markets. There were very few ammonia plants in developing countries and only a small amount of nitrogen fertilizer was imported by these countries.

Starting in the 1960s, several major changes took place in the industry. Although the price of naphtha and fuel oil - two major feedstocks for ammonia production, rose sharply, the availability of cheap natural gas improved, particularly for new plants in developing countries. At the same time, advances in technology resulted in larger scale plants that could use centrifugal compressors, which in turn provided lower unit costs through of economies of scale and energy savings.

The nitrogen industry expanded rapidly in the 1960s and 1970s as the demand for fertilizers and industrial nitrogen increased. Simultaneously, the structure of the industry changed with growing production and consumption of fertilizers in all regions. By 1990, the four largest producers and consumers of nitrogenous fertilizers were the USSR, China, USA and India. About 12% of the global ammonia production was used for industrial purposes, mainly in the developed market economies.

Figure 1 shows how the production of nitrogen has developed since the beginning of the century and how it has increased sharply in recent years. Until about 1950, the nitrogen production capacity grew relatively slowly and the main nitrogen fertilizer was ammonium sulfate, mainly produced by reacting sulfuric acid with ammonia synthesized or recovered from coke oven gases, or from the ammono-carbonation of gypsum (i.e. in the Merseburg Process by reacting natural or by-product gypsum with carbon dioxide and ammonia).

Figure 1



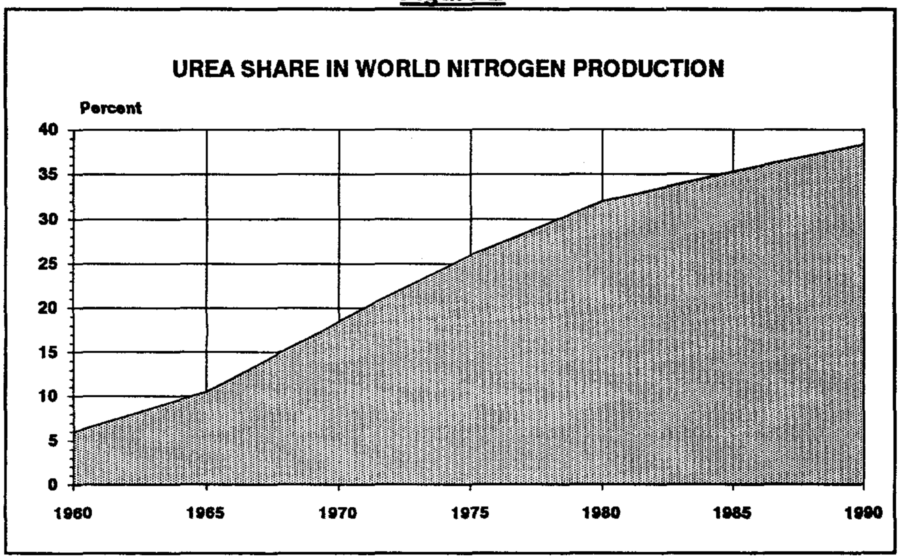
Subsequently, ammonium nitrate supplemented and partially replaced ammonium sulfate as the sole straight nitrogen fertilizer, particularly in Europe, either manufactured directly or also as a major component in the production of nitrophosphate fertilizers. Other fertilizers included sodium nitrate, calcium cyanamide and urea. In 1950, world nitrogen fertilizer production was just over four million tons N of which 75-80% were used in the developed market economies. Trade in nitrogen fertilizers was relatively small.

In the 1960s and 1970s, there was a rapid increase in fertilizer use, particularly in developing countries. The "green revolution" with the introduction and increasing use of high yield varieties of cereals and extensive irrigation schemes, accelerated the demand for nitrogen fertilizers, particularly urea. Average annual growth rates for nitrogen fertilizer reached almost 10% between 1960 and 1980. At the same time as nitrogen production and use were increasing more rapidly, major changes were taking place in the structure of the industry. One of these was the addition of new ammonia and urea production capacities in several major developing countries that had given high priority to the establishment of their domestic fertilizer industry in support of their agricultural programs. Urea manufacture, which is usually conveniently integrated with ammonia production, today frequently represents the most economic method for large scale production of nitrogen fertilizers in countries with cheap natural gas.

As a result of these developments, the production of urea has increased rapidly over the last 25 years to make it the most important nitrogen fertilizer. In 1950, world urea production was less than

100,000 tons per year and by 1960 was still only about 550,000 tpy. At that time, urea represented only about 5% of total fertilizer use. By 1990, however, more than 40% of the nearly 80 million tons of fertilizer nitrogen applied was used in the form of urea. The growth of urea production as a percentage of total nitrogen fertilizer production is shown in Figure 2.

Figure 2



Apart from a major increase in nitrogen capacity in the market economies, important changes have also taken place in the centrally planned economies during the last two decades. In the USSR, the erection of about 40 new large scale ammonia and urea plants has turned the country into the world's largest producer and exporter of nitrogen products.

In China, the growth of the nitrogen fertilizer industry was spectacular; nitrogen fertilizer use increased at an incredible rate of 30% per year on average through the 1960s and 1970s, based mainly on increased domestic production. This was achieved by the construction of about 1200 small ammonia plants using mainly local anthracite as a feedstock; some plants were based on coke, fuel oil or natural gas. The main products were crystallized ammonium bicarbonate with about 17% nitrogen content and, to a lesser extent, some ammonia liquor. About 19 large ammonia and urea plants have now been built in China and some 7-8 are under construction or in an advanced state of planning. Small plants, however, still account for about half of the local nitrogen production.

Country nitrogen fertilizer consumptions over the last decade are given in Annex 2 and are summarized on a world and regional basis in Table 1. In most of the developed countries, there was little growth and about 80% of increased demand evolved in the developing countries of Asia where consumption growth averaged more than 6% per year. Nitrogen fertilizer consumption in the USSR increased by 3% per annum, probably due to the large increase in the supply of nitrogen fertilizers during this period.

Table 1:

NITROGEN FERTILIZER CONSUMPTION AND GROWTH RATES

1979/80 - 1989/90

	CONSUMPTION (Million Tons N)		AVERAGE GROWTH RATE (%)	TOTAL GROWTH
	1979/80	1989/90	1979/80 - 1989/90	Million Tons N
WORLD TOTAL	57.17	79.08	3.30	21.91
AFRICA	1.50	2.15	3.67	0.65
AMERICA	13.84	15.12	0.89	1.29
North America	11.18	11.24	0.06	0.06
Central America	1.36	2.08	4.38	0.73
South America	1.30	1.80	3.28	0.50
ASIA	19.53	35.93	6.29	16.40
West Asia	1.21	2.53	7.67	1.32
South Asia	4.57	9.60	7.69	5.02
East Asia	13.74	23.80	5.65	10.06
EUROPE	14.56	15.36	0.54	0.80
East Europe	4.23	4.38	0.36	0.15
West Europe	10.33	10.97	0.60	0.64
USSR	7.47	10.04	3.01	2.58
OCEANIA	0.28	0.47	5.16	0.19

C. The Structure of the International Fertilizer Industry

The structure of the international fertilizer industry has changed considerably over the past two decades. In 1970, out of a total production of about 32 million tons of nitrogen fertilizer, more than 60% originated in the developed market economies and only about 8% in the developing market economies. The remaining 32% was in the centrally planned economies of China, the USSR and Eastern Europe. For the same period, the relative consumptions recorded for the three economic groupings were 50%, 17% and 33%, respectively. By 1990, nitrogen fertilizer production had increased almost threefold with a simultaneous major change in both production and consumption patterns. The relative shares of production for the developed, developing and centrally planned economies were 34%, 23% and 43%, respectively, and of consumption 35%, 20% and 45%.

In parallel to this shift in production and consumption, there was a major change in ownership patterns in the nitrogen subsector from private to state control over the last 20 years. In Eastern Europe, the Soviet Union, China and other centrally planned economies, fertilizer production was controlled wholly by the state. In many major ammonia producing countries such as India, Indonesia, Mexico, Brazil, Venezuela, etc. there is a major state involvement in the fertilizer sector. State ownership of the nitrogen fertilizer industry also plays a major role in Western Europe[1]. It is estimated that more than two thirds of the world's nitrogen industry is currently state controlled.

In many developing and centrally planned economies, the economics of fertilizer production has become very complex due to specific national interests such as subsidies on food production, employment policies and foreign exchange considerations. This has sometimes resulted in continuing operation of state owned uneconomic plants over extended periods. This situation also exists in some developed countries, (e.g. Japan), where domestic fertilizer production is controlled by state planning or e.g. several West European countries, where state ownership, and sometimes legislation on employment can have a major impact on operating policies.

The strong influence of the public sector in the nitrogen fertilizer industry has had a major impact on fertilizer prices, in both domestic and international markets, and plant operations. In numerous countries fertilizer manufacture is government subsidized as production costs are well above international levels. Furthermore, international prices have been greatly influenced by low-priced products, particularly from East Europe, that have frequently been below cash production costs in order to secure markets and earn hard currency. Thus, international fertilizer trade has been far from perfect in the last decade or so which has lead to a large number of ownership changes in the industry as well as plant closures.

Nitrogen fertilizer companies are becoming larger in size and fewer in number. The main reasons relate basically to the economics of large scale ammonia production from cheap feedstock and the ability to compete in international markets. Typically, large ammonia plants have a major economic advantage over small plants and, as natural gas is usually the most economic feedstock, it is important to build new plants near gas reserves. Due to policies that have not encouraged private sector participation in certain developing countries, and investment costs in new projects are high with only low return, it is often only the government that has been in a position to establish nitrogen fertilizer projects. However, this situation has recently been changing and public sector restructuring and privatization are either already under implementation (e.g. Mexico) or in the planning stage in several countries, as governments recognize the vital role of the private sector in the economy, including the fertilizer industry.

As a result of past political and economic developments, a substantial share of the world nitrogen industry has been taken over by a few large companies, which are often state-owned. For

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[1] For more details on the current situation in Western Europe please refer to the first paragraph on this following page.

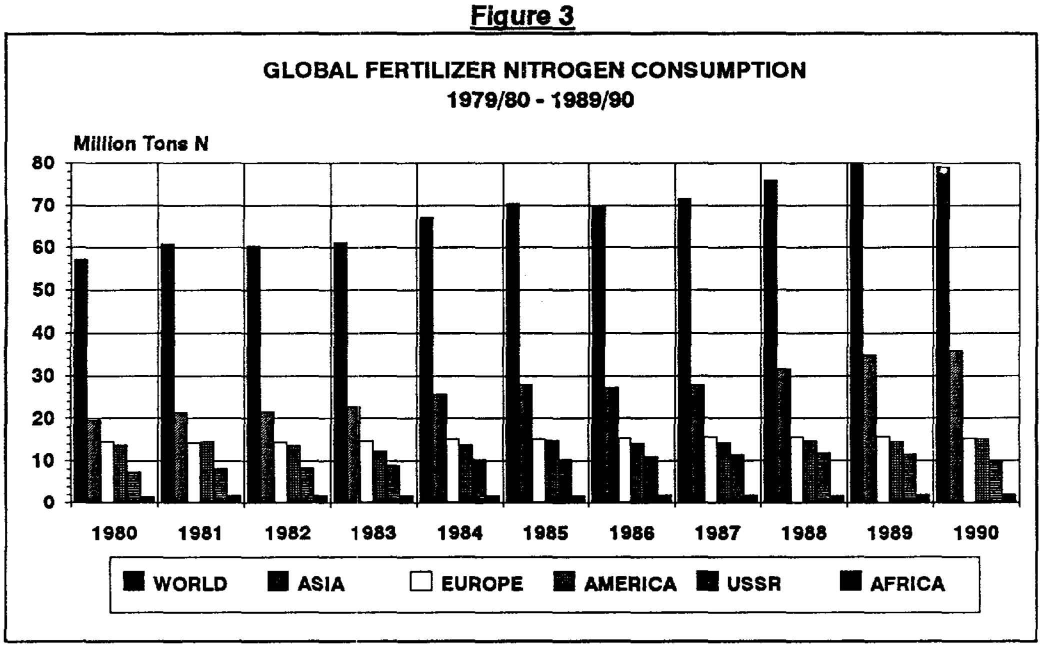
example, in Western Europe, four companies - Norsk Hydro (Norway), Kemira (Finland), BASF (Germany) and ENI (Italy), own more than 60% of the region's ammonia capacity and only one of these three companies is solely privately owned. Kemira and Norsk Hydro also have considerable fertilizer activities outside Europe.

II. CURRENT NITROGEN FERTILIZER SITUATION

A General

Between 1979/80 and 1989/90, world nitrogen fertilizer consumption increased on average by 3.3% per annum. As can be seen from Figure 3, most of this growth resulted from increased consumption in Asia. Elsewhere, geographically as well as in absolute terms, there has been little growth. Apparent world consumption of nitrogen fertilizers declined by 1.7% from 79.1 million tons in 1989/90 to 77.8 million tons in 1990/91. A growth of about 1% is expected in 1991/92.

Figure 3



Fertilizer consumption in Eastern Europe and the USSR in 1989 and 1990 is estimated to have declined by about 15% and 20%, respectively. Some sources feel that the drop in consumption may be even higher. Asia is the only geographic region to show any significant increase in fertilizer consumption

- in 1989/90, nitrogen fertilizer consumption increased by about 2.6% and estimates for 1990/91 indicate a further growth of 3.8%.

B. Africa

Considering the size of the continent and the need for fertilizers, consumption in Africa is very low. With about 12% of the world population, it accounts for only about 3% of world fertilizer use. For agricultural and fertilizer statistics, Africa is often classified into three different regions, namely North Africa, Sub-Saharan Africa and the Republic of South Africa. Nitrogen fertilizer use in the sub-regions and in major countries is given in Table 2.

Table 2:

FERTILIZER NITROGEN USE IN AFRICA

1989/90

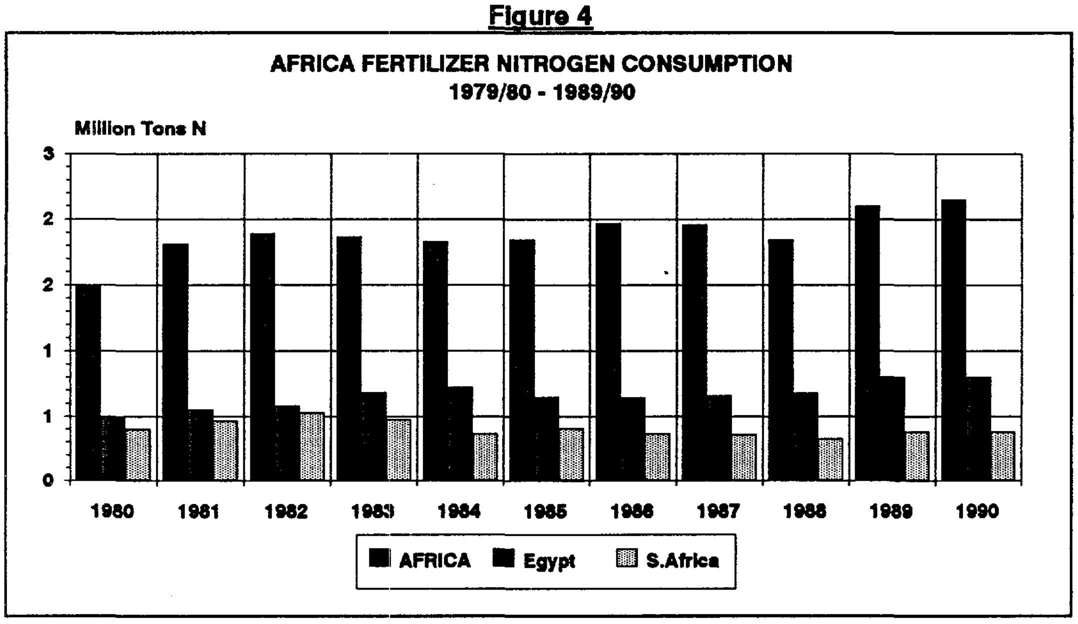
REGION/COUNTRY	CONSUMPTION (000s Tons N)	SHARE IN REGION (%)	APPLICATION (kg/ha)
AFRICA	2,146		11
North Africa	1,114	100	
Egypt	800	72	309
Morocco	151	13	16
Others	163	15	
Sub Saharan Africa	660	100	
Nigeria	197	30	5
Zimbabwe	89	13	29
Kenya	45	7	28
Others	329	50	
South Africa	372	100	
Republic of South Africa	372	100	29

The North African region is dominated by Egypt, where fertilizer application rates are very high on limited land resources along the Nile. The lowest use of nitrogen fertilizer is in Sub-Saharan Africa, which consumes only 1% of world fertilizer use but covers more than 40 countries with about 9% of the world's population. Although much attention has been given by the international agencies to boost fertilizer consumption and despite optimistic projections of future growth, fertilizer consumption has not taken off in this area as it has done in most other developing parts of the world. The main problems include poverty, lack of political stability, and inadequate infrastructure resulting in excessive distribution costs.

The only country in the Sub-Saharan area that seems to have any real prospects of meeting its nitrogen fertilizer needs from domestic sources is Nigeria. The country has a high demand for increased application of nitrogen fertilizers to meet the food requirements of its growing population and restore a once prosperous agricultural export business. Nigeria has now become an important producer of nitrogen fertilizers based on large domestic resources of natural gas and its capacity is being increased for both domestic needs and export markets. In 1989/90, nitrogen fertilizer consumption increased by about 12% and a similar improvement is expected in 1990/91.

After Egypt, South Africa is the largest nitrogen market in continental Africa. Consumption increased rapidly during the 1970s and declined during most of the 1980s due to drought, depressed agricultural markets and political problems. Consumption fell slightly in 1989/90 and no significant change is expected in 1990/91.

Figure 4



Nitrogen fertilizer consumption in Africa over the last decade is shown in Figure 4. During most of the 1980s, fertilizer consumption in Africa stagnated, but in the last two years has shown signs of growth. In 1989/90 nitrogen fertilizer consumption increased by about 2.4% to 2.15 million tons. In 1990/91 an increase of about 5% is expected although from a low base.

Most African countries rely, in part or total, on imports to meet their nitrogen needs. However, Nigeria, Libya and Algeria are net exporters of nitrogen.

C. America

The geographic region of America comprises three sub-regions, North America, Central America and South America. As can be seen in Figure 5, consumption in the region is dominated by North America, essentially the USA. Major country consumption is shown in Table 3.

Figure 5

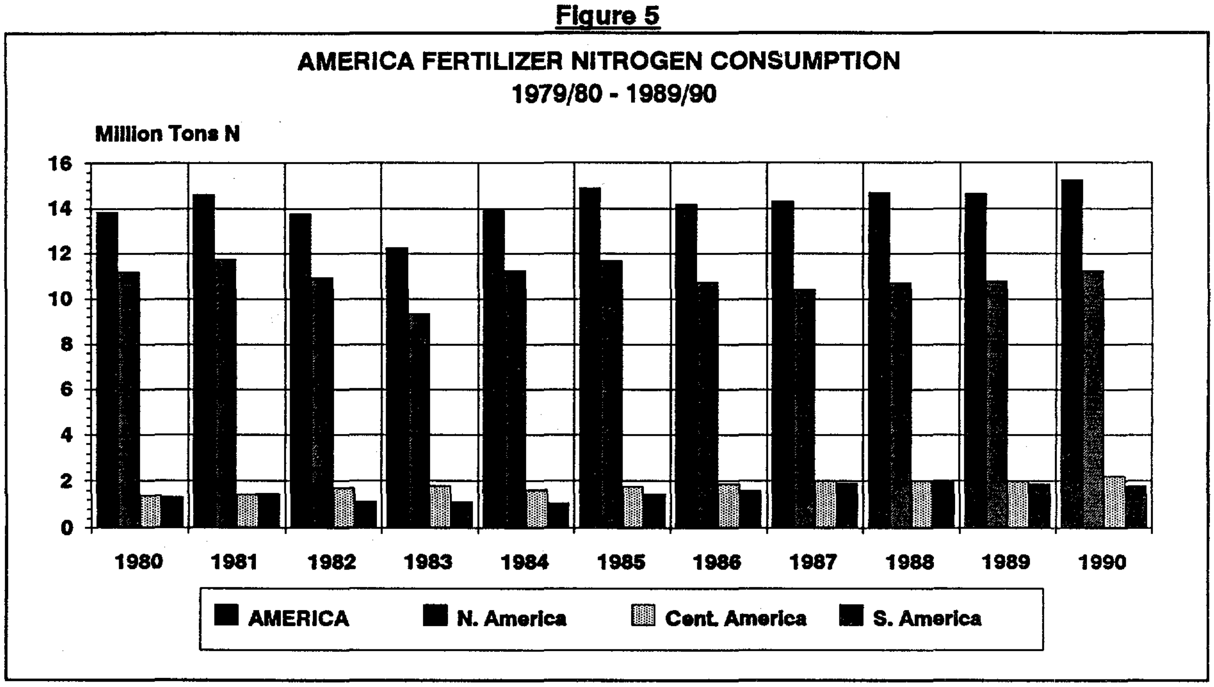


Table 3:

FERTILIZER NITROGEN USE IN AMERICA

1989/90

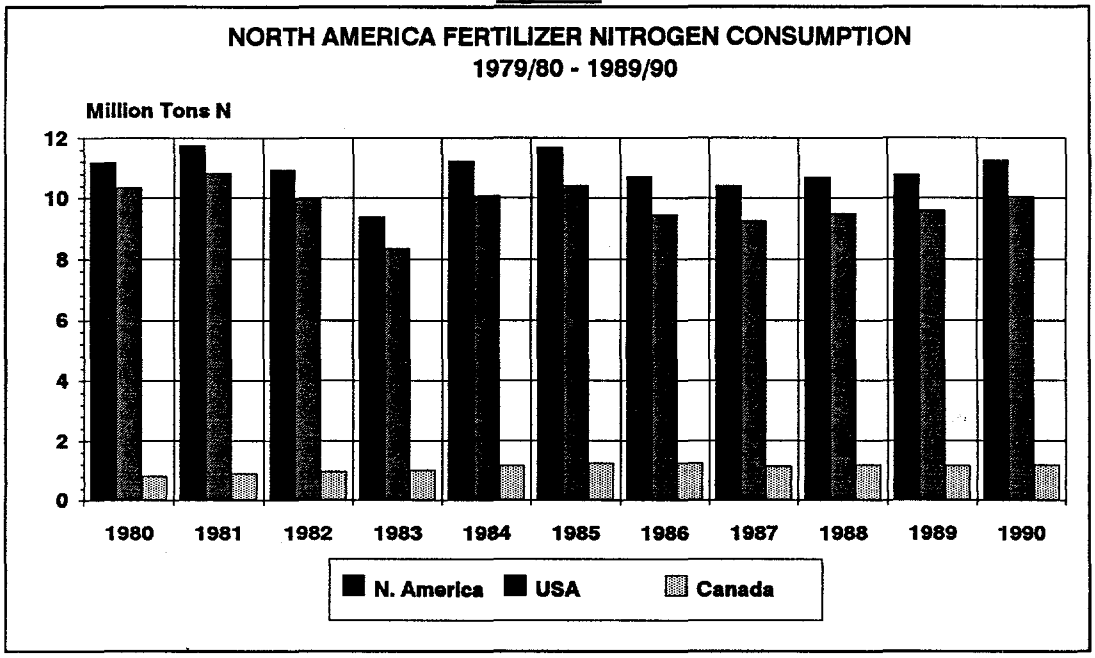
REGION/COUNTRY	CONSUMPTION (000s Tons N)	SHARE IN REGION (%)	APPLICATION (kg/ha)
AMERICA	**15,124**		
North America	**11,244**	**100**	
USA	10,048	89	51
Canada	1,196	11	26
Central America	**2,083**	**100**	
Mexico	1,335	64	51
Cuba	368	18	91
South America	**1,797**	**100**	
Brazil	823	46	10
Columbia	234	13	49
Venezuela	241	13	78

NORTH AMERICA

Nitrogen fertilizer consumption increased rapidly in the 1970s, peaked in the early 1980s and has since stagnated as shown in Figure 6. This region comprises only two countries, the USA and Canada, where the USA contributes almost 90% of total demand. Generally, under prevailing local and international trade requirements, the North American market can be regarded as mature, although it has the potential for growing significantly should the demand for American grain exports increase. This could happen, if a GATT agreement resulted in agricultural trade liberalization. Currently, yearly fertilizer demand depends mainly on government policy and farm programs apart from climatic considerations.

In 1988/89, a large increase in nitrogen fertilizer demand had been forecast due to an increase in USA crop plantings of about 30 million acres. However, there was very little increase in consumption and although plantings increased, application rates fell. Analysts blamed the poor spring weather and nutrient carry over from the drought in the previous year for the disappointing season. Subsequently in 1898/90, nitrogen fertilizer consumption increased by about 4%. Although original projections for 1990/91 indicated a small fall in consumption of around 1%, preliminary results suggest that there may in fact have been a small gain. The rather flat nitrogen use in the USA over the last decade combined with increased specific yields indicates a "dynamism" in nutrient usage, which is frequently not fully recognized as statistical data are usually based on static key parameters.

Figure 6

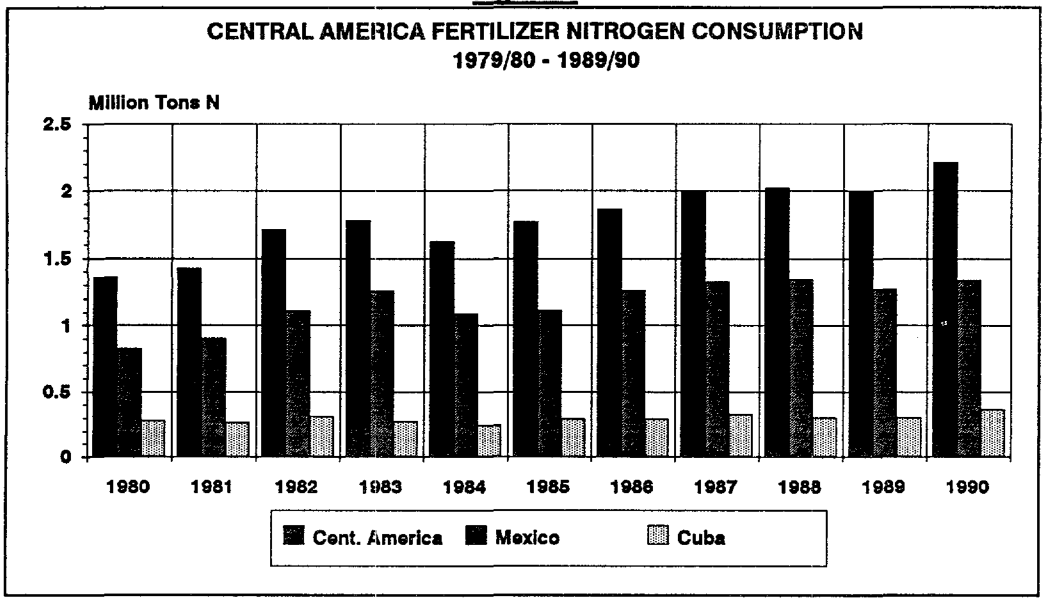


Most fertilizer use in North America is in the USA, where agricultural production and hence fertilizer application has shown an increasing relationship to government policies; overall plantings may therefore be affected by such programs as "Acreage Reduction", "Environmental Reserve", "Conservation Reserve" and "Export Subsidy". These programs vary from year to year. For example, current projections expect that both plantings and fertilizer use will increase as the wheat acreage reduction program for 1991/92 was cut from 15% in the previous year to 5% in the current year. However, nitrogen demand in the USA has generally matured at around 10 million tons of N and its fluctuations from year to year will mainly depend on the weather and crop prices.

CENTRAL AMERICA

Regional nitrogen fertilizer consumption has increased on the average by about 4% per year over the last decade although adverse economic conditions in the last several years have caused some stagnation and even declines in several countries as indicated in Figure 7. The region is dominated by Mexico, which accounts for about 60% of all consumption, followed by Cuba with almost 20%. The 20% balance is shared among the remaining 20 countries in the region. The nitrogen nutrient application rate averages about 50 kg per hectare of arable land, which is a relatively high compared with many other developing countries. Nitrogen fertilizer consumption has been encouraged by the availability of ample supplies of nitrogen fertilizers in the region from plants in Mexico, Venezuela, and Trinidad; subsidized fertilizer prices have also been a factor.

Figure 7



With a population growth of more than 2% per year and a significant part of GNP contributed by the agricultural sector, there is a further need for increased agricultural production. In 1988/89, nitrogen fertilizer consumption in the region fell by nearly 4%. This was caused mainly by a fall of 5.5% in consumption in Mexico, where removal of subsidies and restructuring of the industry resulted in increased fertilizer prices that are more in line with actual production costs and the international market. Although the immediate effect of the higher prices was a fall in demand, the situation should improve as agricultural product prices are liberalized.

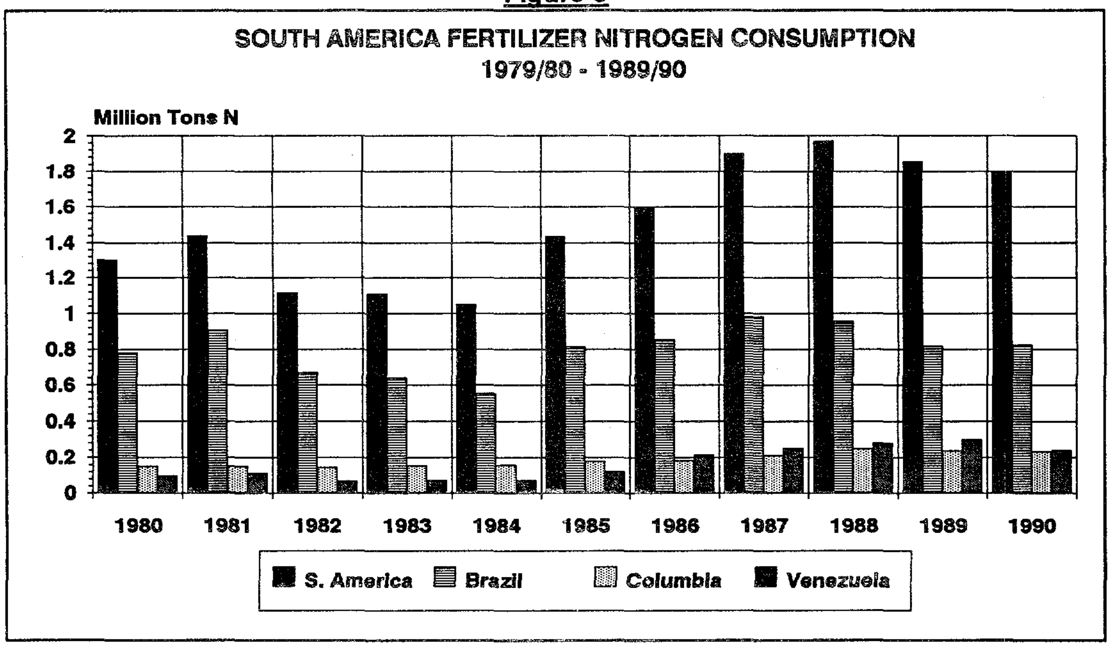
In 1989/90, fertilizer demand in Central America improved slightly and a further small gain is expected in 1990/91, but depends largely on developments in the Mexican agricultural and fertilizer sectors. Overall, due mainly to exports of ammonia from Trinidad, Mexico and Trinidad, the region is a net exporter of nitrogen products.

SOUTH AMERICA

Over the last decade, fertilizer consumption in South America has increased on average by 3.3% per year. Until 1987/88, when consumption peaked, the average growth rate was much higher, but due to economic problems and reductions in fertilizer subsidies it has since declined. Brazil accounts for almost half the nitrogen fertilizer consumption in the region although its share has been declining. The economic problems of Brazil had a strong impact on its agricultural and fertilizer sectors within the last few years. Fertilizer consumption in Brazil has generally declined although there was a slight improvement in 1989/90, when nitrogen consumption improved by about 1% after a fall of 15% in the preceding year.

Venezuela, the second largest consumer of nitrogen fertilizers in the region, has also seen a significant fall in consumption during the last year or two, following the reduction of subsidies. Consumption in Colombia, the third largest consumer, has also declined. Fertilizer consumption in the region and by major producers over the last 10 years is shown in Figure 8.

Figure 8



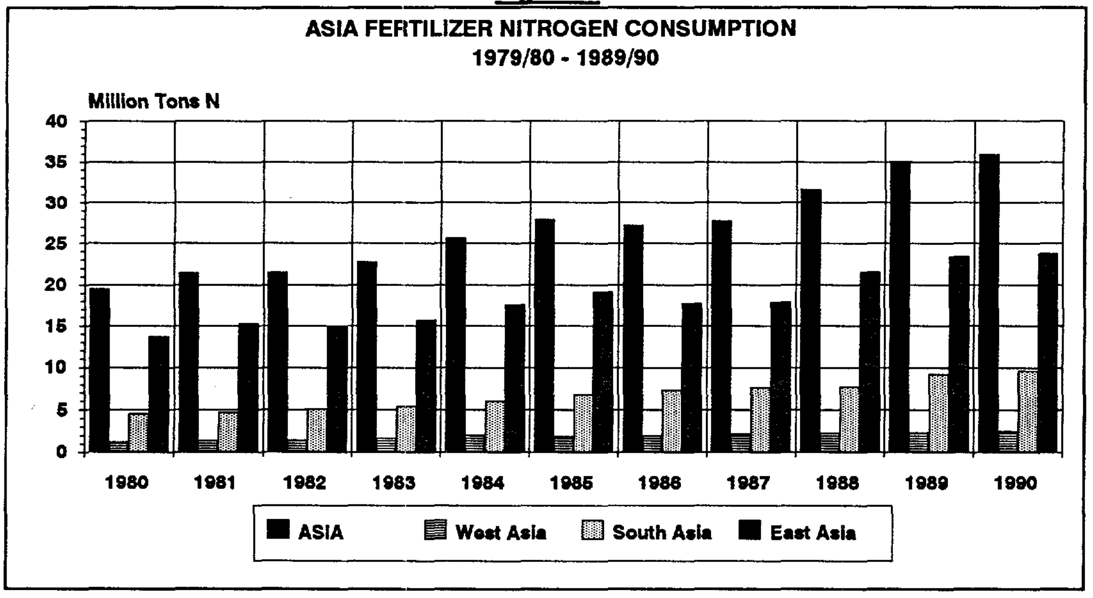
The prospects for improved economic conditions and increased agricultural production and hence in fertilizer use look brighter for the next few years and a slight increase in nitrogen fertilizer consumption is expected for the period from 1990/91 through 1995/96.

Nitrogen fertilizer application rates in South America are very low at an average of only 13 kg per ha. It is the only region listed, where nitrogen use is less than that of the other two main nutrients P_2O_5 and K_2O. This is mainly a result of unique nutrient application ratios in Brazil, where climatic, soil and crop needs require a high use of potash and phosphates. However, in addition there are also other countries, e.g. Argentina, - a major producer of wheat, which use low levels of nitrogen fertilizers.

D. Asia

Asia comprises more than 35 countries that vary widely in agricultural practices and fertilizer use. In 1988/89 fertilizer consumption in Asia increased by 10% and by a further 2.6% in 1989/90. In 1990/91 fertilizer consumption is expected to increase by 3.8%. Expansion of nitrogen fertilizer consumption in Asia has dominated world growth in recent years and seems likely to do so over the next decade. Overall, average yearly growth has exceeded 6% since 1979/80 and was high in all of the three Asia regions although from different bases, as indicated in Figure 9.

Figure 9



Nitrogen fertilizer consumption in the region has been strongly influenced by long term government policies to the agriculture sector; particularly the maintenance of stable and favorable farm gate pricing policies. The introduction of high yield varieties of cereal and irrigation facilities further promoted higher fertilizer use. In many countries in Asia, the availability of cheap natural gas made economic development of a domestic supply of nitrogen fertilizers feasible.

Table 4

FERTILIZER NITROGEN USE IN ASIA
1988/89

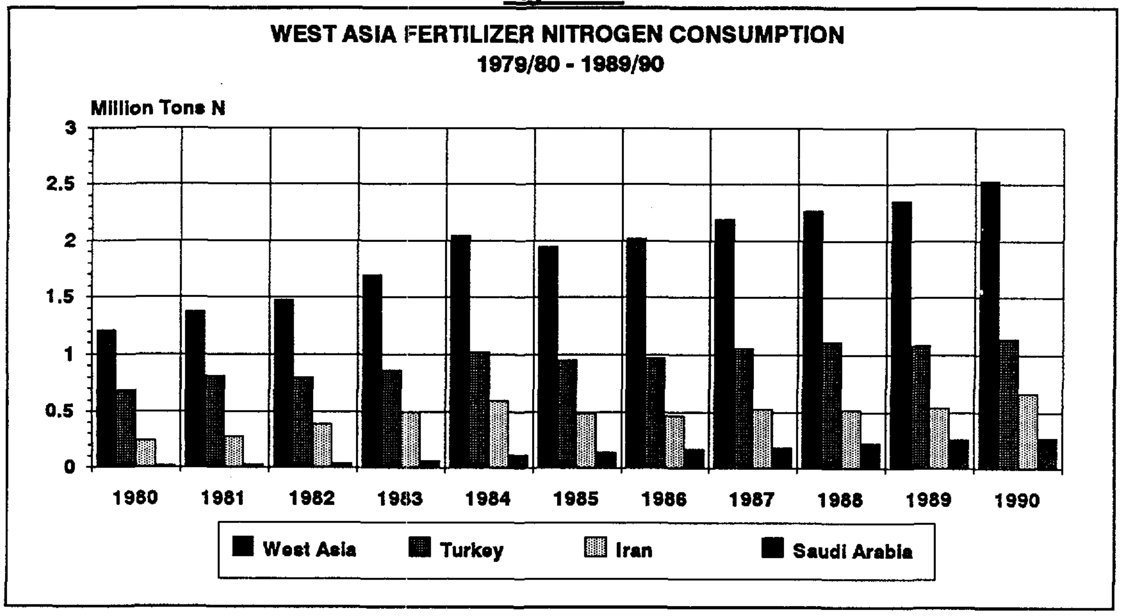
REGION/COUNTRY	CONSUMPTION (000s Tons N)	SHARE IN REGION (%)	APPLICATION (kg/ha)
ASIA	35,929		77
West Asia	2,529	100	
Turkey	1,140	45	39
Iran	669	26	34
Saudi Arabia	265	10	216
South Asia	9,596	100	
India	7,396	77	43
Pakistan	1,422	15	63
East Asia	23,804	100	
China	18,855	79	192
Indonesia	1,559	7	70
Japan	641	3	134

Between 1980 and 1990, Asia's share in world nitrogen consumption increased from 34% to 45%. In the West Asia region, consumption is dominated by Turkey and Iran, in South Asia by India and Pakistan, and in East Asia by China and Indonesia. Application rates for nitrogen fertilizers in Asia vary significantly, even among the larger consumers, as illustrated in Table 4. China has a high nitrogen application rate similar to developed countries in the region such as Japan and South Korea. In other countries like India, Indonesia and Turkey, application rates are at a much lower level.

WEST ASIA

In nitrogen fertilizer consumption, West Asia showed, with a rate of 7.7%, one of the highest average annual growth rates in the world in the decade between 1980 and 1990, although from a relatively low base. In 1989/90, consumption increased by 7.6%, but is estimated to be lower in 1990/91 as result of the Gulf War and other factors. Turkey and Iran are the major nitrogen fertilizer users in this sub-region as shown in Figure 10.

Figure 10



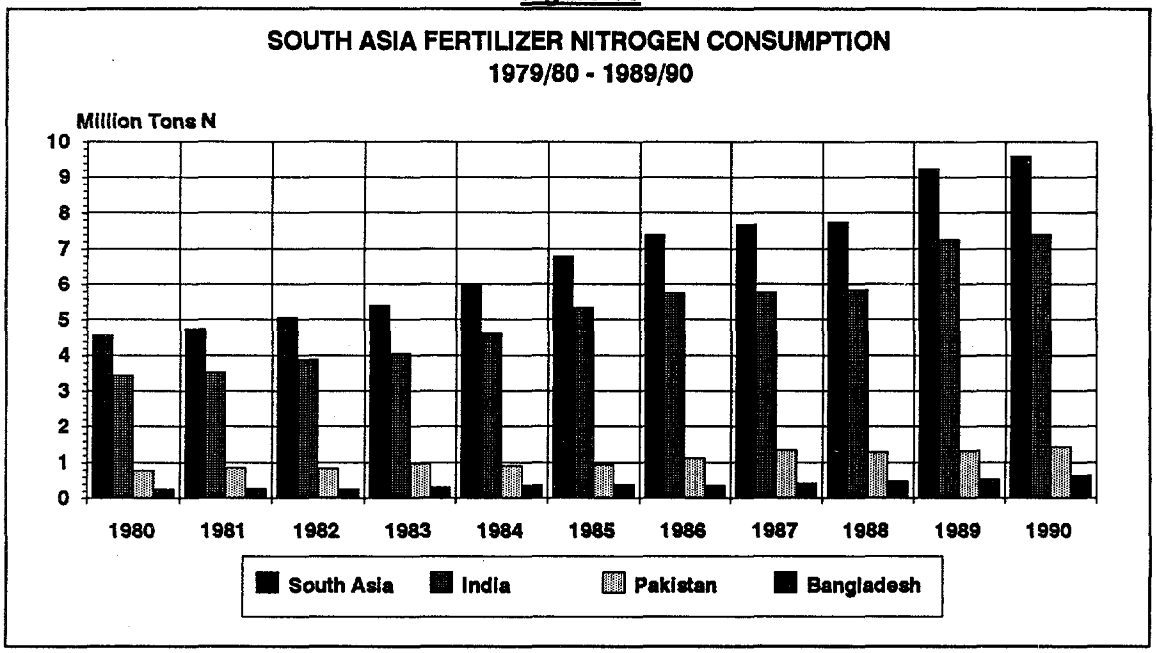
In 1988/89, Turkey's nitrogen fertilizer application declined by 2.5% as a result of drought, followed by an increase of 5.4% when weather conditions turned more favorable for cereal production. However, another decline may be expected for the year 1990/91 as conditions will be less favorable with increased fertilizer prices and poorer credit terms.

Nitrogen fertilizer consumption in Iran, which had fallen as a result of the war with Iraq, has been recovering and in 1989/90 increased by more than 20%. A further increase in consumption is expected in 1990/91. Saudi Arabia has experienced a major increase in nitrogen fertilizer use with a favorable domestic supply situation and government policies encouraging domestic agricultural production. In Jordan and Iraq, however, consumption is believed to have declined as result of the war.

SOUTH ASIA

With an average annual growth of 7.7%, South Asia has been one of the fastest growing areas for nitrogen fertilizer consumption in the past decade, both in absolute and relative terms. As shown in Figure 11, India accounts for nearly 80% of the consumption. Nitrogen fertilizer use in India has doubled during the last decade and food grain production rose by more than 30%, while cultivated area increased only by about 2.5%. Other countries in the region, such as Pakistan and Bangladesh, have also significantly increased food production in parallel with higher fertilizer application rates.

Figure 11



Fertilizer consumption in South Asia increased by nearly 4% in 1989/90 after a substantial expansion of nearly 20% in the preceding year. In 1990/91, a growth in nitrogen consumption of around 5% is expected.

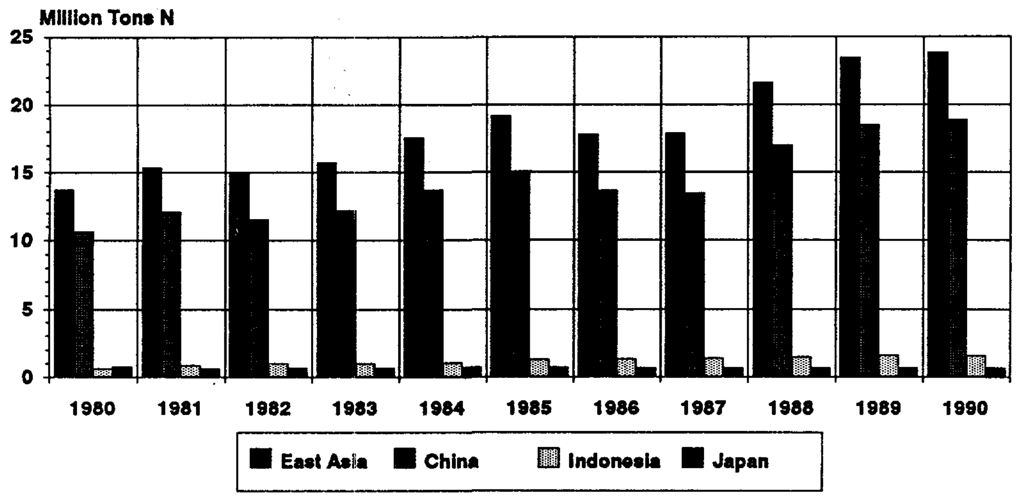
EAST ASIA

East Asia has been the major growth area over the last decade in absolute terms and now accounts for about 30% of total world consumption of nitrogen fertilizer. China's consumption including that of Taiwan (China) amounts to almost 80% of the whole of East Asia. Annual growth in the region has averaged about 5.6% over the last 10 years and represents about one half of the increase in total world nitrogen fertilizer consumption. China is well on its way to its target annual consumption of 20 million tons of N by the year 2000.

As can be seen in Figure 12, nitrogen fertilizer use in China dropped in the mid 1980s as a result of a change in grain pricing policies; but consumption has since resumed its upward trend. About one quarter of Chinese nitrogen supply is imported, predominantly as urea.

Figure 12

EAST ASIA FERTILIZER NITROGEN CONSUMPTION
1979/80 - 1989/90



Indonesia, the Philippines and Thailand have all seen a rapid growth in fertilizer consumption in the last few years, but consumption in 1990/91 may have been depressed by low agricultural prices and, in some cases, by adverse weather conditions.

In the case of Korea and Japan, where fertilizer use is traditionally high, there has been little growth in the last decade and in the case of Japan there has been a decline. No increase in nitrogen fertilizer consumption is expected in these countries in 1990/91.

E. Europe

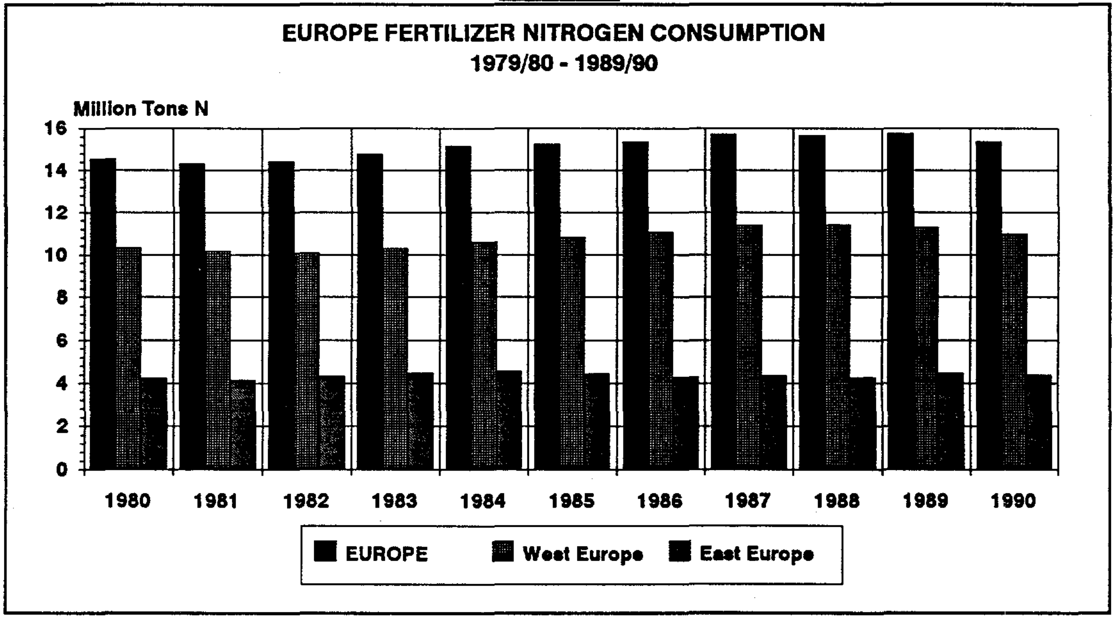
Both West and East Europe use high application rates of nitrogen fertilizers and are regarded as mature markets. Over the last decade, consumption increased at only 0.5% per year, on average. Within the last two years, there has been a sharp downwards turn in nitrogen fertilizer consumption in both West and East Europe. Major country details are given in Table 5 and consumption trends in Figure 13.

Table 5:

FERTILIZER NITROGEN USE IN EUROPE 1988/89

REGION/COUNTRY	CONSUMPTION (000s Tons N)	SHARE IN REGION (%)	APPLICATION (kg/ha)
EUROPE	14,922		113
West Europe	10,973	100	
France	2,660	24	135
Germany (United)	2,254	21	190
United Kingdom	1,421	13	209
East Europe	3,949	100	
Poland	1,274	32	103
Romania	778	20	67
Czechoslovakia	704	18	125

Figure 13

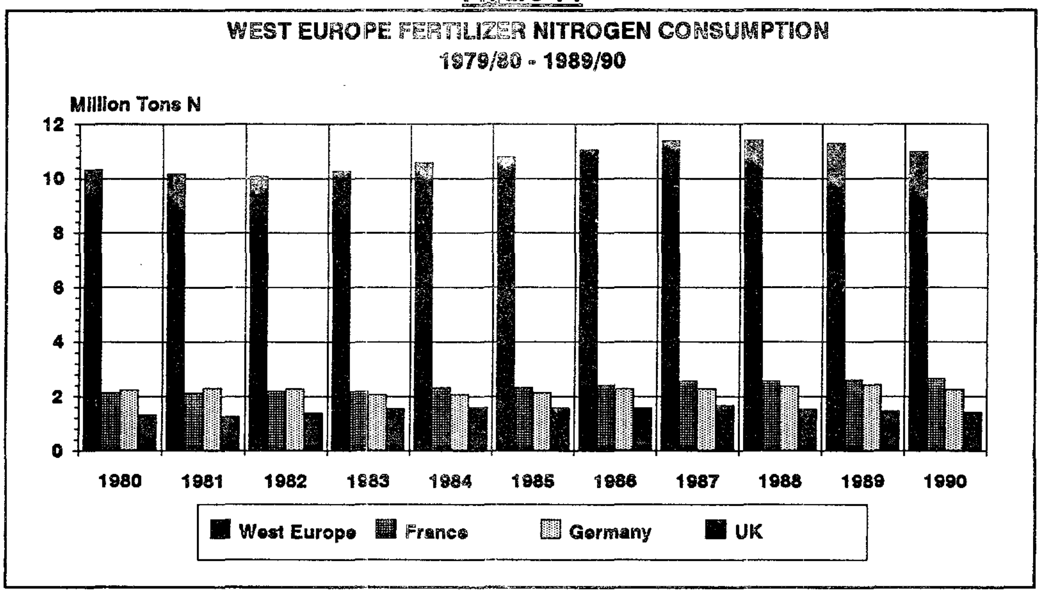


WEST EUROPE

In 1990/91 France accounted for about 29% of the fertilizer consumption in West Europe, Germany (United) for about 19%, the UK for 12%, Spain for 10% and Italy for 9%. Nitrogen fertilizer consumption decreased by about 3% in 1989/90 and a further decrease of 5.5% is estimated for 1990/91. These falls are related to efforts to reduce agricultural surpluses, declining prices of agricultural products and unfavorable weather conditions. Although the prospects for some growth exists in some South European countries, the overall downward trend in consumption is expected to continue.

Fertilizer consumption rates are high in West Europe with no single country dominating, as indicated in Figure 14.

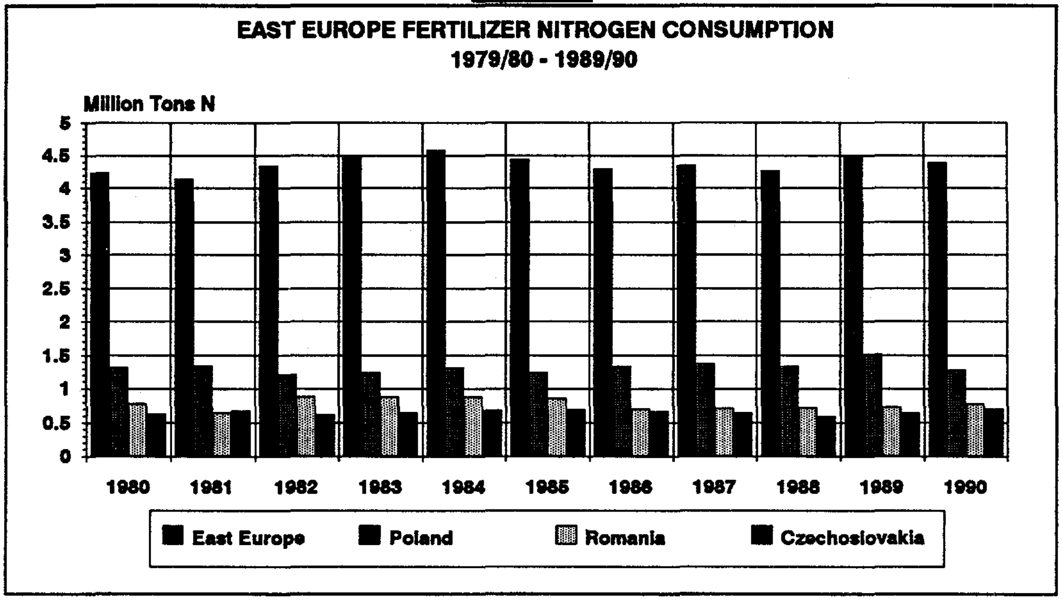
Figure 14



EAST EUROPE

Figure 15 shows that fertilizer consumption in East Europe has remained relatively stable over the last 10 years. However, the recent dramatic political and economic changes in East Europe have now created a major impact on the agricultural and fertilizer sectors. In 1989/90 fertilizer consumption fell by about 6% and in the following year the drop has been much greater. The Fertilizer Working Group estimates a decrease of 20% in 1990/91 and a further decline of 15% in 1991/92. Some analysts suggest an even greater drop.

Figure 15

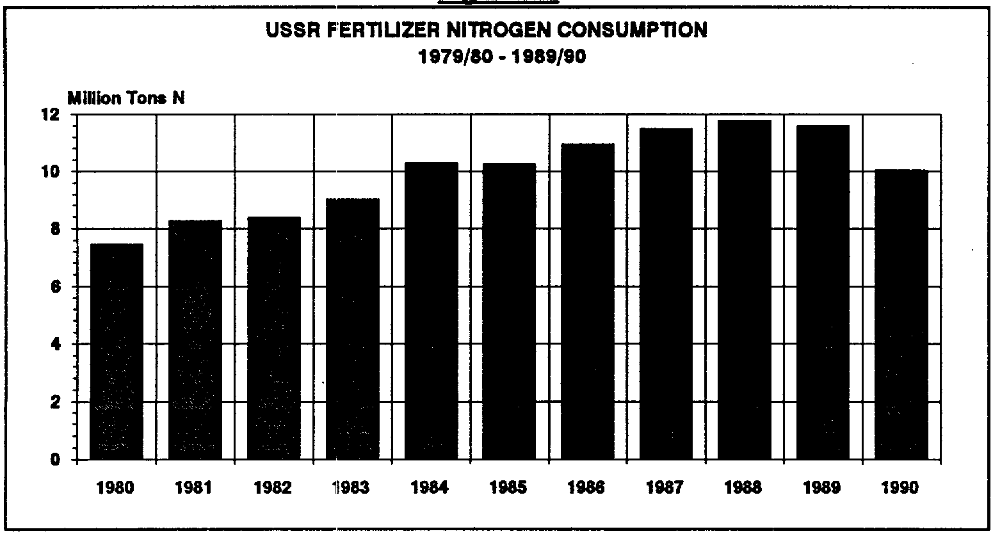


Major structural changes in the agricultural sector, such as the reduction of subsidies, have resulted in a negative growth in fertilizer use that was further aggravated by increased production costs of nitrogen fertilizers as result of higher priced natural gas from the Soviet Union. Poland, the largest consumer of fertilizers in the region, suffered a major setback in nitrogen fertilizer use in 1990, when consumption fell by more than 50%; this was mainly due to the collapse of the distribution and credit system, and the price increase of natural gas in early 1991.

F. USSR

As indicated in Figure 16, fertilizer consumption in the USSR increased steadily through the 1990s and averaged a yearly growth rate of about 3%. However, following the initiation of major political and economic changes in the country, nitrogen fertilizer consumption fell in 1989/90 and 1990/91 by 13% and 14%, respectively. With higher priced fertilizers and drastic changes in the distribution and procurement system, a further decline in consumption is expected in 1991/92. Nitrogen fertilizer consumption in the USSR is on average about 50 kg per ha of arable land, which is significantly lower than in most countries in East Europe. In view of a good domestic supply capability for nitrogen fertilizers and an urgent need for food production, nitrogen consumption is expected to recover in a few years time.

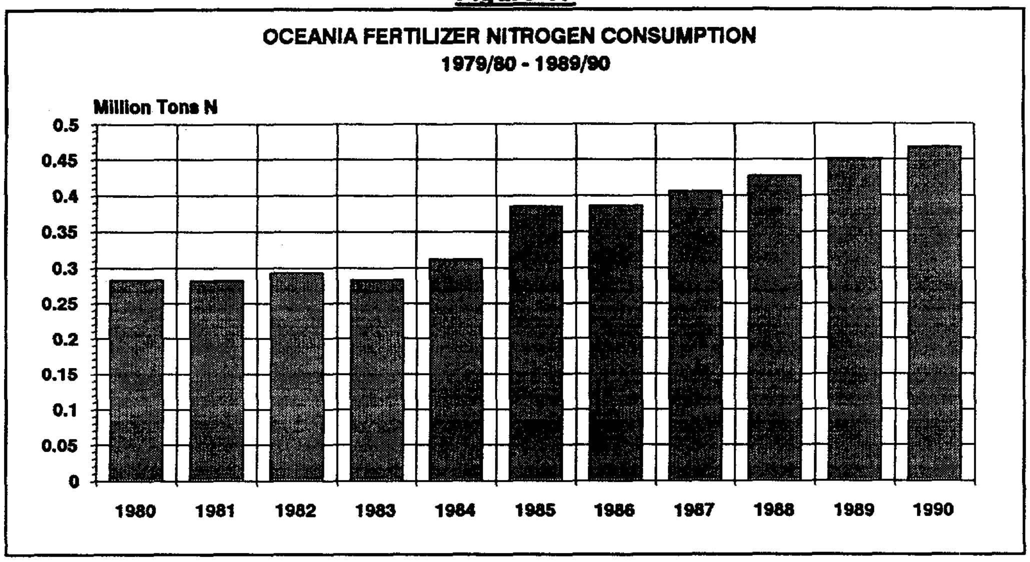
Figure 16



G. OCEANIA

This region comprises essentially Australia and New Zealand, where consumption of nitrogen has traditionally been relatively low due to nitrogen inputs through clover and other legume-based pastures. However, the situation has recently started to change and, as shown in Figure 17, the second half of the 1980s has seen a sharp increase in nitrogen fertilizer consumption as transformation in farming practices has resulted in a marked expansion in production of cereals and other crops with more dependence on chemical fertilizers. Although agriculture has remained depressed in the region due to poor crop prices, nitrogen consumption increased by 5% in 1988/89 and by 3.8% in 1989/90. An increase of 5-6% is expected in 1990/91.

Figure 17



III. FUTURE NITROGEN DEMAND

A. Fertilizer Nitrogen Demand

Regional and world nitrogen fertilizer demand and growth rates through 2000/01 as projected by the Fertilizer Working Group in May 1991 are given in Annex 1. Because of the recent major international events such as the Gulf War as well as major economic and political changes in the USSR and Eastern Europe, current forecasts are significantly different from the projections made by the Fertilizer Working Group in 1990. Although the drop in the supply capability resulting from the Gulf War may be regained in a few years, the changes in the USSR and Eastern Europe are likely to have a long term impact on both nitrogen fertilizer supply and demand.

A summary of future regional and world nitrogen fertilizer demand and growth rates is given in Table 6 that indicates an average yearly growth in world consumption of 1.3% through 1995/96 and of 1.5% through the year 2000/01, respectively. These figures are lower than those estimated by the Group in May 1990, when the corresponding growth rates were 1.9% and 1.8%.

Almost all new nitrogen fertilizer demand will develop in Asia where growth is estimated to be about 3.3% per year over the next five years and 2.9% over the next 10 years. The highest growth rate, in relative terms, may be expected in South Asia, as India, Bangladesh and Pakistan target for increased food production.

The major increases in absolute terms are expected in East Asia, mainly in China, and, to a much lesser extent, in Thailand, Vietnam and Indonesia. In order to meet its food targets by the year 2000, China will have to increase its nitrogen fertilizer consumption by at least 2% per year. Japan and South Korea already have a mature fertilizer market and will show little growth.

In West Asia, the major growth is expected to occur in Turkey and Iran.

Table 6

NITROGEN FERTILIZER AVERAGE YEARLY GROWTH RATES

Actual and Projected

	Consumption (Million Tons N)			Average Growth Rate (Percent)			Total Growth (Million Tons N)
	1989/90	1995/96	2000/01	89/90 - 95/96	89/90 - 2000/01	89/90 - 95/96	89/90 - 2000/01
WORLD TOTAL	79.08	85.37	92.80	1.28	1.47	6.29	13.72
AFRICA	2.15	2.61	3.00	3.28	3.07	0.46	0.85
AMERICA	15.12	15.97	16.80	0.91	0.96	0.85	1.68
North America	11.24	11.25	11.50	0.01	0.21	0.01	0.26
Central America	2.08	2.46	2.70	2.84	2.40	0.38	0.62
South America	1.80	2.26	2.60	3.87	3.40	0.46	0.80
ASIA	35.93	43.61	49.30	3.28	2.92	7.68	13.37
West Asia	2.53	3.05	3.30	3.16	2.44	0.52	0.77
South Asia	9.60	12.31	14.00	4.23	3.49	2.71	4.40
East Asia	23.80	28.25	32.00	2.90	2.73	4.45	8.20
EUROPE	15.36	13.50	13.50	-2.13	-1.17	-1.86	-1.86
East Europe	4.39	4.00	4.50	-1.54	0.23	-0.39	0.11
West Europe	10.97	9.50	9.00	-2.37	-1.78	-1.47	-1.97
USSR	10.05	9.00	9.50	-1.82	-0.52	-1.05	-0.55
OCEANIA	0.47	0.68	0.70	6.35	3.69	0.21	0.23

In Central America, a growth rate of about 2.4% per year is expected over the next decade sustained mainly by Mexico and in South America, a growth of 3.4% will depend on the expected upturn in Brazilian agriculture in the next few years.

In North America, little overall change is expected, although there will be some variation from year to year depending on government policies, as mentioned earlier.

In both East and West Europe, forecasts indicate a steady downward trend in the next five years. In many East European countries, the removal of fertilizer subsidies and increases in fertilizer prices have caused a dramatic fall in fertilizer use in the last year. So also has the change in the distribution and planning systems. Although the situation is expected to improve through the second half of the 1990s, little overall growth is expected. In West Europe nitrogen fertilizer consumption will diminish steadily by about 2.0 million tons from 11 million tons in 1989/90 to around 9 million tons in 2000/01. Increasing pressures to reform the Common Agricultural Policy by reducing the subsidies on cereal production and new environmental legislation could bring about a further reduction in fertilizer use.

For Africa and Oceania, average annual growth rates of more than 3% are forecast for the regions , however, these are both from a small base and will not significantly influence overall new fertilizer demand.

The changes in regional percentage shares of world fertilizer demand through 2000/01 are shown in Figure 18. Asia will increase its share from 45% to 53%, Europe and the USSR will decline, while overall, there will be little change in America.

Figure 18

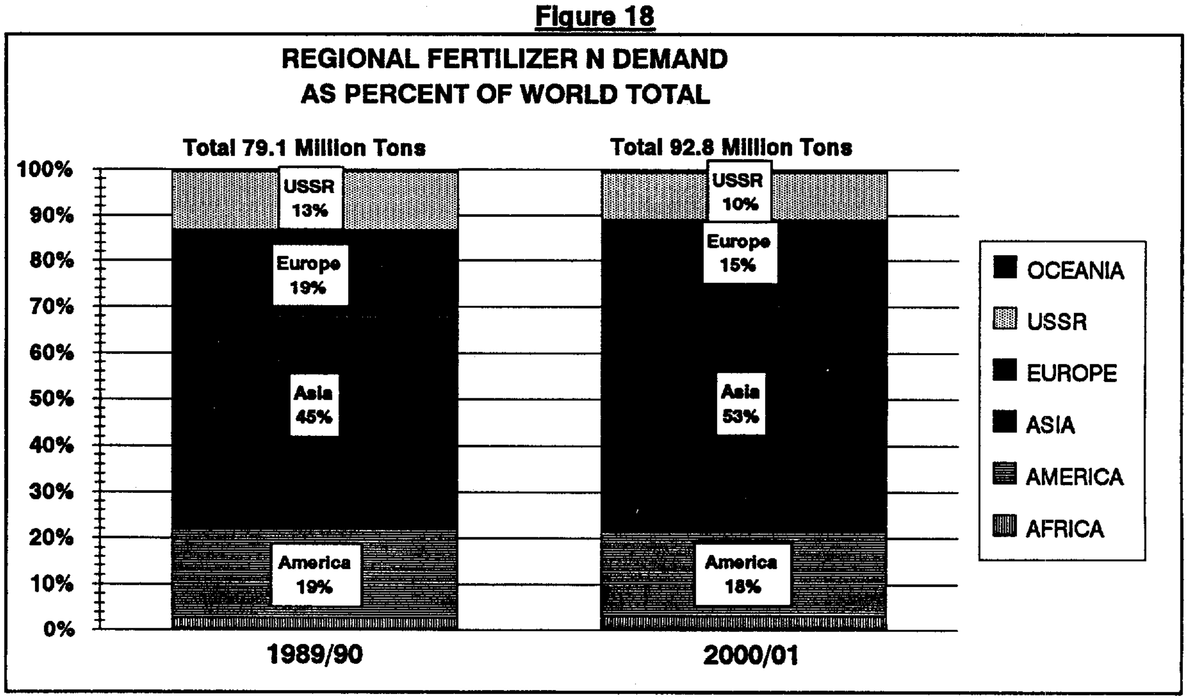
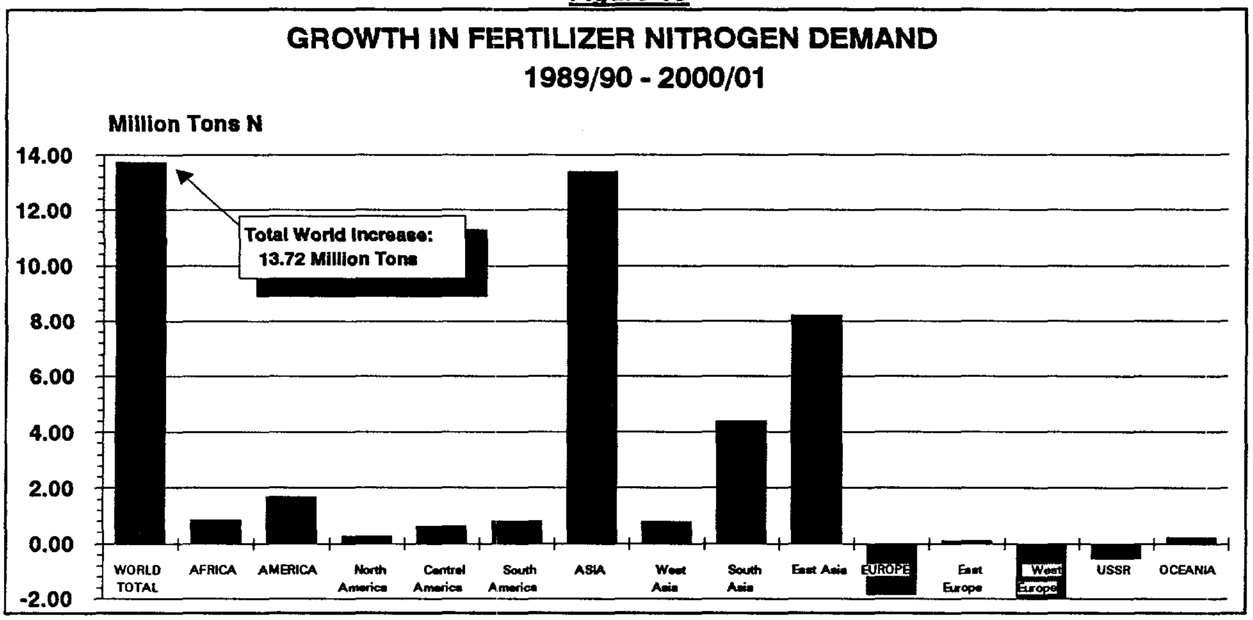


Figure 19 illustrates the absolute change in nitrogen fertilizer demand in each sub-region. There will be little overall movement in most sub-regions, except in South Asia and East Asia, where a significant increase in demand is forecast.

Figure 19



B. Industrial Nitrogen Demand

Industrial nitrogen demand is expected to grow only slowly, at 1% per year or less, through the next decade; details are given in Annex 1. Industrial nitrogen includes all non-fertilizer nitrogen compounds, such as plastics, synthetic fibers, explosives, livestock feeds and a host of other products.

Some ammonia is used to produce nylon and acrylics, but in most developed countries, the market for these products is mature and little growth is expected. The industry recovers part of the ammonia used in the process as ammonium sulfate which is usually used as fertilizer material. The nitrogen that comes from non-fertilizer operations, but is eventually used in agriculture, is accounted for in the fertilizer nitrogen consumption forecasts by applying the net industrial nitrogen consumption (i.e. total nitrogen input minus fertilizer nitrogen output). The share of industrial nitrogen demand as a percentage of total nitrogen consumed has been declining slowly. In 1989/90, it accounted for about 12% of total nitrogen use, predominantly in the industrialized countries.

Apart from the USA and Japan, little information is available on the break-down of industrial nitrogen use. It is estimated that about 50% of industrial N is processed into fibers and plastics, about 15% into explosives, 10% into livestock feed and about 25% into other uses. One of the main nitrogen intermediates in industry is nitric acid, which is used to manufacture ammonium nitrate (partially used as an explosive), adipic acid (used in the manufacture of nylon and engineering plastics) and many other significant chemical intermediates, such as isocyanates and nitrobenzene. Urea is also used in the production of urea-formaldehyde resins, melamine and animal feeds. Some ammonia is utilized in the manufacture of industrial chemicals, such as acrylonitrile and hexamethylene diamine, and also for ammonium phosphates that are used as animal feed and in fire-control products.

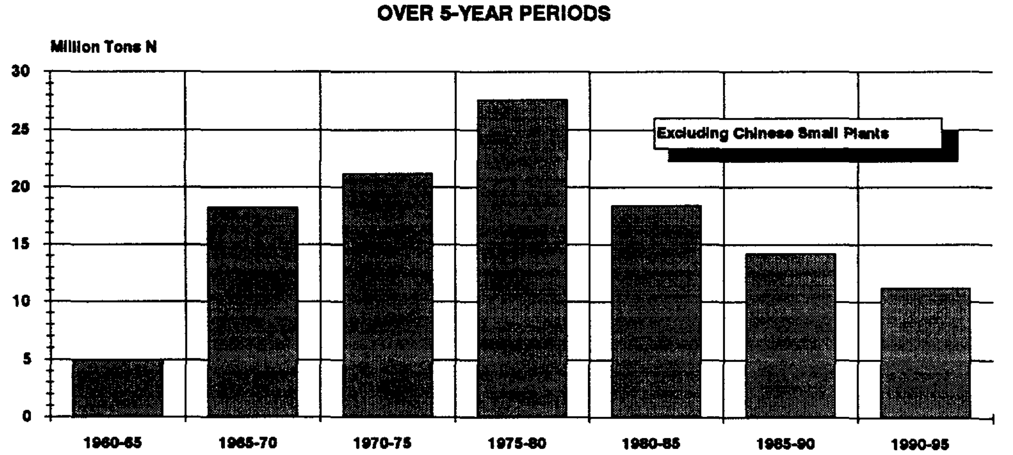
IV. WORLD AMMONIA CAPACITY AND SUPPLY CAPABILITY

A. General

The development of world ammonia capacity over the last three decades is shown in Figure 20. There was a major increase in ammonia capacity in the period 1975 to 1980 when about 28 million tons of new capacity came on stream of which almost half was established in the centrally planned economies of East Europe, the USSR and China. With the exception of a few countries in the Asia region, construction has slowed down considerably. Estimates of new ammonia plants, either under construction or planned to come on stream in the period 1990-95, indicate that addition of new capacity will be lower than during any period since 1960-65.

Figure 20

DEVELOPMENT OF WORLD AMMONIA CAPACITY OVER 5-YEAR PERIODS



Country ammonia capacity for the last 10 years is given in Annex 3 and summarized in Table 7. This information shows that most development has taken place in Asia, Eastern Europe and the USSR.

In North America and Western Europe ammonia capacity has been declining steadily over the last decade. In 1990/91 world ammonia capacity declined by about 1 million tons, mainly due to capacity losses in the Middle East, but there was also a drop in capacity in the USSR and Western Europe as result of plant closures.

Table 7:

WORLD AND REGIONAL AMMONIA CAPACITY

(Million Tons N)

	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91
WORLD TOTAL	94.28	95.03	97.53	100.63	104.76	96.56	109.25	109.83	112.28	114.25	114.64	113.68
AFRICA	1.70	2.11	2.38	2.71	2.62	2.62	2.62	2.91	3.23	3.40	3.35	3.42
AMERICA	22.05	21.78	21.73	21.79	22.27	22.13	22.39	22.13	22.45	21.91	21.78	21.73
North America	18.12	17.82	16.76	16.50	16.73	16.59	16.90	16.37	16.32	15.78	15.65	15.51
Central America	2.53	2.53	3.54	3.54	3.54	3.54	3.49	3.76	4.13	4.13	4.13	4.13
South America	1.40	1.43	1.43	1.75	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.09
ASIA	29.71	30.28	31.47	32.05	32.76	33.62	35.99	36.56	38.54	41.01	41.83	41.30
West Asia	3.10	1.74	2.01	2.32	2.59	2.90	3.17	3.49	4.41	4.95	5.69	4.87
South Asia	5.08	6.19	6.75	7.39	7.46	7.59	9.14	9.14	9.58	10.68	10.72	10.72
East Asia	21.53	22.35	22.71	22.34	22.71	23.13	23.68	23.93	24.55	25.38	25.42	25.71
EUROPE	24.27	24.02	23.63	23.79	24.68	14.72	25.01	24.85	24.56	24.34	24.00	23.78
East Europe	8.24	8.16	8.16	8.44	9.06	9.44	9.58	9.79	9.99	9.99	10.16	10.15
West Europe	16.03	15.86	15.47	15.35	15.62	5.28	15.43	15.06	14.57	14.35	13.84	13.63
USSR	16.10	16.39	17.87	19.77	21.91	22.95	22.72	22.86	22.90	22.98	23.07	22.84
OCEANIA	0.45	0.45	0.45	0.52	0.52	0.52	0.52	0.52	0.60	0.61	0.61	0.61

B. Profile of Major Ammonia Producer Countries

World ammonia production is dominated by several major producing countries as shown in Table 8. In view of the importance of these countries as potential nitrogen exporters, a short profile of the nitrogen industry in each of these countries is given below.

Table 8:

MAJOR COUNTRY AMMONIA CAPACITIES

(Million Tons per Year)

Country	1973/74	1980/81	1985/86	1990/91	1995/96
USSR	10.2	16.4	22.7	22.8	23.7
China	6.3	16	17.2	19.2	21.2
USA	12.8	15.7	13.7	12.6	12.6
India	2.2	4.9	7.2	8.4	10.8

C. Major Ammonia Producer Countries

USSR

In 1987 the USSR overtook the USA and became the world's largest ammonia producer. It is estimated that the capacity of the USSR will be almost twice that of the USA by 1996. As part of a scheme to earn hard currency with nitrogen exports based on its large natural gas resources, the USSR has increased its capacity significantly in the last decade, whereas USA capacity has declined. During the 1970s, the Soviet Union ordered a total of more than 40 large ammonia plants, which came on stream in the early 1980s, making the USSR the largest producer and exporter of nitrogen fertilizers and ammonia. The construction policy has been to develop very large chemical complexes and there are now several sites - Cherkassy, Gorlovka, Grodno, Nevinnomyssk, Novomoskovsk, and Togliatti, that each have a capacity of more than one million tons N as ammonia. At Togliatti, the capacity is more than two million tons N. More than 90% of the Soviet Union's ammonia production is based on natural gas. In 1990 the USSR exported more than 2.3 million tons of nitrogen as urea and about 3.3 million tons N as ammonia.

Soviet ammonia export commitments grew as a result of barter and buy-back deals with West Europe and the USA. Facilities were constructed for exporting ammonia at Ventspils in the Baltic and at Odessa in the Black Sea. The main facility at Odessa receives ammonia by pipeline from plants at Togliatti and Gorlovka. The USSR gas deposits are estimated to exceed 36,000 billion cubic meters and represent the largest natural gas resources in the world. About 75% of Russian explored gas reserves are located in Western Siberia and a major pipeline has been built to bring this gas to the West. Other gas developments are taking place in Turkmenia and Astrakhan. The USSR has considerable potential to increase its ammonia production significantly and is expected to remain the world's leading nitrogen products exporter through the year 2000, at least.

The nitrogen industry of the USSR has, however, received a significant set back as a result of the political and economic changes taking place in the country. The large fall in fertilizer demand combined with increased feedstock costs and general unrest in 1990/91, seriously affected production, which is estimated to have fallen by about 8% or 1.5 million tons.

CHINA

In 1949, China's only fertilizer capacity was about 6,000 tpy of N as ammonium sulfate. By 1960, domestic N production was still less than 0.2 million tons. In 1962 the Nanjing Chemical Fertilizer Company introduced a process to produce ammonia and ammonium bicarbonate from coal. Although ammonium bicarbonate is a low grade and inefficient nitrogen fertilizer, it satisfied a need that China was at the time not otherwise able to meet. By 1965, 40 of these small plants were operating, by 1972 about 700, and in 1979 the number peaked at almost 1,200. Today, about 1,000 of these plants are in operation and provide about half of China's nitrogen production, as indicated in Table 9. The plants which produce typically between 5,000 - 20,000 tpy of N as ammonia and convert it predominantly into ammonium bicarbonate, some ammonia liquor and, more recently in a few cases, ammonium nitrate or urea. During the 1970s, China purchased thirteen large scale ammonia plants based on a variety of feedstocks, but mainly natural gas. In addition, about 54 medium-size plants were designed and built using domestic know-how during the last two decades or so.

Table 9:
AMMONIA PRODUCTION IN CHINA
(000s Tons Ammonia)

Year	1988	1989	1990	1989-1990 Increase (%)
All Plants	19,794	20,691	21,289	2.9
Large Plants	4,144	4,643	4,820	3.9
Medium Plants	4,379	4,433	4,804	8.3
Small Plants	11,271	11,616	11,664	0.4

Source: Shanghai Chemical and Fertilizer Research Institute

Ammonia production in China is based on a wide range of feedstocks. China has abundant resources of coal, but is restrained as regards the availability of oil and natural gas. The choice of feedstock for future ammonia production will depend on the plant location and may be any of the three.

Currently, four large size plants are under construction and about 6-8 are in the planning phase. Original plans included the addition of around four million tons of new ammonia capacity during the 1990s, but project funding and construction have been seriously delayed due to shortage of local and foreign funds and other constraints that followed the political developments in 1989. However, even if these original plans had been realized on time, local capacities would still not be sufficient to keep up with domestic consumption needs.

USA

The production of ammonia grew rapidly in the USA during the 1960s and 1970s. The availability of very cheap natural gas, and relatively low investment costs resulted in low production costs. The introduction of high yield varieties of corn together with an export boom in agricultural products during the 1970s stimulated the growth of the USA nitrogen fertilizer industry. Between 1960 and 1980 ammonia capacity increased from four million tons to almost 16 million tons N per year.

Since 1980, several factors have adversely affected further growth of the USA nitrogen industry. A world recession during the first half of the 1980s reduced the demand for agricultural products, while, at the same time increasing production costs, due to rising gas prices, made it difficult to compete with ammonia imports. The very low prices and intense competition from the USSR and East European producers led to idling of nearly five million tons N of USA ammonia capacity in the early 1980s and subsequently, more than 3 million tons remained permanently closed. Within this period, the USA changed from a net exporter to a net importer of nitrogen.

The USA has been a net importer of ammonia for several years, but most of this ammonia is processed and exported as diammonium phosphate. Main sources of imported ammonia are Canada, the Caribbean countries, Mexico and the USSR. It seems likely that the USA will continue to cover increasing needs for ammonia mainly by importing, rather than building new capacity, although some existing plants will be refurbished to conserve energy and expand capacity. In 1991, there were forty producers of ammonia with a total name plate capacity of about 12.6 million tons N. Over 50% of this capacity is now owned by four major companies:

Agricultural Minerals Corporation	**0.94 million tons N**
Arcadian	**1.57 million tons N**
Farmland Industries	**1.81 million tons N**
International Minerals and Chemicals	**1.57 million tons N**

INDIA

India has made significant progress in developing nitrogen fertilizer production and, with nearly forty plants in operation, ranks as the world's fourth largest nitrogen producer. In 1990, Indian ammonia capacity was 8.4 million tons; with several more plants planned to come on stream, this capacity should reach 10.8 million tons by 1995. Currently about 50% of the nitrogen fertilizer industry in India is in the public sector, 30% is in the private and 20% in the cooperative sector.

Before 1960, India had only a small nitrogen fertilizer industry with a capacity of about 100,000 tpy N. The 1960s saw a rapid development, when almost one million tons of new capacity was built. Initially, coke oven gas was the main feedstock, however, by 1970 naphtha had become the most widely used raw material. With the emergence of substantial amounts of natural gas associated with off-shore oil fields near the coast of Bombay (Bombay High and Bassein), a chain of large gas-based ammonia/urea plants was established near Bombay - Surat and inland, along the Hazira - Bijaipur - Jagdishpur (HBJ) pipeline.

A wide range of feedstocks is still used in India, but gas holds the largest share by now. Most of the older capacity is still based on naphtha; in 1983, about 46% of total ammonia capacity was using naphtha and about 14% natural gas. Following the development of the Bombay High associated gas field, most new plants were gas-based. By 1991, the percentage of gas-based ammonia capacity reached 50%, naphtha contributed 27%, oil 13%, and coal including other feedstocks 10%. Of the 11 new plants either recently commissioned, under construction or in the planning stage, 10 are based on natural gas from the Bombay High field.

Because India's fertilizer consumption has steadily out-paced its local supplies, the country has imported large amounts of ammonia and urea and will continue to do so until addition of new capacities will catch up with demand. However, with current trends, this may take some time and India is therefore expected to remain one of the major importers of nitrogen fertilizers in the foreseeable future.

OTHER COUNTRIES

Other countries with a major nitrogen fertilizer industry include Canada, the Netherlands, Indonesia and Romania.

Canada is a principal producer and exporter of ammonia and urea. There are twelve companies in Canada producing about 3 million tons N as ammonia with gas supplied mainly from the large gas reserves in British Columbia and Alberta. Nearly 90% of Canadian ammonia and 95% of its urea capacity is in Western Canada with 10% in Eastern Canada. A newly established company, SASKFERCO, is building a plant at Belle Plain, Saskatchewan, with a capacity of 0.4 million tons per year N as urea; this plant is expected to come on-stream in 1992.

The Netherlands has large reserves of natural gas and the Dutch nitrogen fertilizer industry has developed into the major nitrogen fertilizer producer and exporter in West Europe. The country has a capacity of more than 3 million tpy N of ammonia and much of this production is exported either as ammonia or as down-stream products. In 1990, about 0.9 million tons N of ammonia were exported, mainly to other Western European countries. As a result of a major restructuring of the Dutch nitrogen industry in recent years involving several large takeovers, the industry is now dominated by Norsk Hydro, Kemira and DSM.

Romania, with 3.5 million tons of N annual output, has the largest installed ammonia capacity in Eastern Europe after the USSR. Thus Romania has, until recently, been one of the world's largest exporters of nitrogen fertilizers. Originally based on domestic natural gas, Romania now imports natural gas from the USSR to meet its needs. As result of political developments and increasing economic difficulties, the beginning of 1990 saw a significant drop in ammonia production and the country was forced to declare Force Majeure on many of its overseas contracts. Although ammonia output is expected to recover somewhat in the future, the increase in USSR gas prices is unlikely to encourage recovery to its former production and export levels.

Indonesia has developed a large nitrogen fertilizer industry based on domestic natural gas resources. At present, the Indonesian nitrogen fertilizer industry comprises six government-owned companies with a total installed capacity of about 2.8 million tpy N mainly as urea. Most of the production is used in the domestic market, although Indonesia is also a significant exporter of ammonia and urea. Indonesia has three large plants under construction and will increase its capacity by nearly one million tons N within the next five years or so.

D. Future World and Regional Ammonia Capacity

Projected ammonia capacity through 1995/96 is shown in Annex 1. and summarized in Table 10. Regional incremental capacity over the next five years is shown in Figure 21. The data are aggregated on a company and country basis and include all plants under contract and potential projects that are likely to be realized in the near future and take account of the following factors:

(i) The recent political problems in China that have resulted in a delay of several major nitrogen projects in China, particularly those under the deferred Japanese Third Yen Credit.

(ii) Revised information from USSR sources on existing plants and anticipated capacity changes in the next five years.

(iii) It was assumed that ammonia plants in Kuwait would not be rehabilitated in the foreseeable future; however, most recent reports indicate that the ammonia plants in Kuwait survived the war with relatively little damage and one plant was re-commissioned in January 1992; the overall capacity is still severely constrained by shortage of gas. Plants in Iraq are likely to operate at reduced capacity in the next few years, and a new ammonia/urea project under construction in Iraq will be delayed two years.

Table 10:

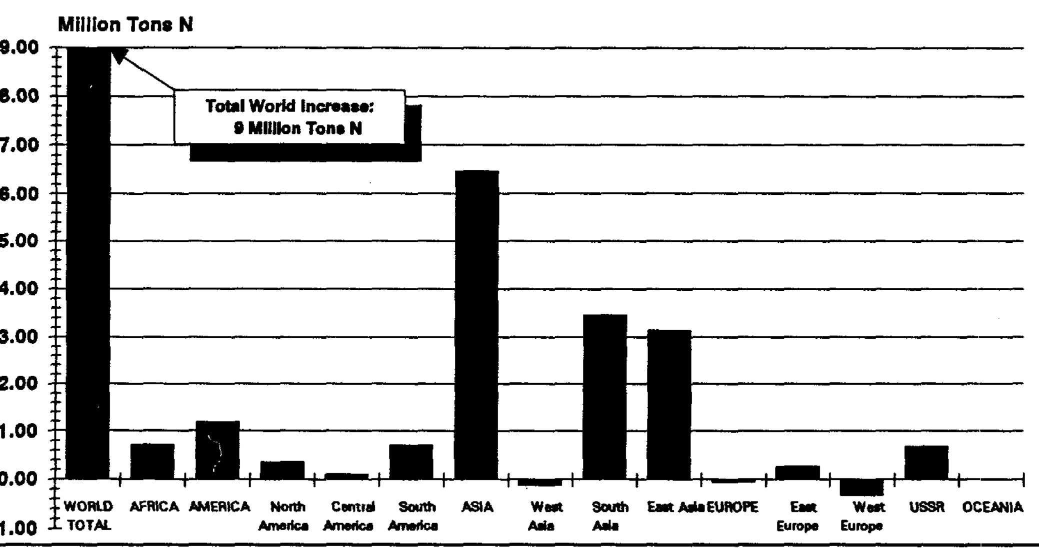
ACTUAL AND PROJECTED WORLD AND REGIONAL AMMONIA CAPACITY

(Million Tons N Per Year)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
WORLD TOTAL	114.64	113.68	114.70	116.84	120.05	122.34	123.64
AFRICA	3.35	3.42	3.42	3.69	3.80	4.07	4.07
AMERICA	21.78	21.73	21.89	22.36	22.49	22.49	22.97
North America	15.65	15.51	15.56	15.97	16.02	16.02	16.02
Central America	4.13	4.13	4.24	4.24	4.24	4.24	4.24
South America	2.00	2.09	2.09	2.15	2.23	2.23	2.71
ASIA	41.83	41.30	42.02	43.32	45.92	47.66	48.30
West Asia	5.69	4.87	5.14	5.55	5.55	5.55	5.55
South Asia	10.72	10.72	10.97	11.50	13.07	13.82	14.19
East Asia	25.42	25.71	25.91	26.27	27.30	28.29	28.56
EUROPE	24.00	23.78	23.84	23.75	23.88	23.94	23.94
East Europe	10.16	10.15	10.21	10.20	10.43	10.43	10.43
West Europe	13.84	13.63	13.63	13.55	13.45	13.51	13.51
USSR	23.07	22.84	22.92	23.11	23.35	23.57	23.75
OCEANIA	0.61	0.61	0.61	0.61	0.61	0.61	0.61

Figure 21

GLOBAL AND REGIONAL INCREASE IN AMMONIA CAPACITY
1989/90 - 1995/96



AFRICA

In Egypt, a small ammonia plant has been constructed to replace the existing plant at Suez. A large nitrogen complex is being constructed at Abur Kir and will come on stream in 1992/93. Although there are plans to close the ammonia/ammonium nitrate plant at Kima which is based on electrolytic hydrogen, no decision has been taken as regards location and feedstock supply for a replacement capacity.

The Nigerian Government in collaboration with the M.W.Kellogg Company is planning NAFCON II in the form of a duplication of the NAFCON I plant at Port Hartcourt. NAFCON II may be commissioned in the mid 1990s. In addition, a NAFCON III project is under consideration.

In Tanzania, Mozambique and Libya, plans for new nitrogen fertilizer plants based on indigenous natural gas resources have been discussed for some time, but there are no firm plans at this stage to implement any of these projects.

The South African company Sasol Ltd. is replacing its existing ammonia plant at Sasolburg which processes hydrogen and nitrogen from its coal-based Sasol-1 operations. The annual capacity of the new plant will be 240,000 tons of ammonia and after its planned start-up in 1993/94, the old plant at Sasolburg will be closed.

AMERICA

North America

There are currently eleven ammonia producers in Canada and a large plant is now under construction at Belle Plaine, Saskatchewan, that will be operated by the Saskatchewan Fertilizer Company (SASKFERCO); owned jointly by Cargill and the Saskatchewan provincial government. In December 1989, CIL closed its 270,000 tpy N ammonia plant at Courtright, Ontario.

After considerable restructuring of the USA nitrogen industry, no new plants are currently planned. As no major closures are expected, ammonia capacity is expected to remain steady in the next five years or so. In total, there are about 40 sites for producing ammonia in the USA with individual capacities ranging from 1.6 million tons/year (Arcadian) down to several sites with an annual output of only about 50,000 tons. All USA ammonia capacity is owned by the private sector.

Central America

Since 1981, when its last new capacity was added, Mexico has remained the largest ammonia producer in the region with 2.4 million tpy N. Construction work on a large plant at Lazaro Cardenas commenced several years ago, but seems unlikely to be completed within the next five years as result of insufficient funding. Another large plant planned for Camargo is also considerably delayed. Currently, many uncertainties affect the Mexican fertilizer industry, which may delay further investment in the near future. These include insecure future gas supplies and the difficult consolidation of the nitrogen fertilizer activities of PEMEX and FERTIMEX. A major restructuring of the industry, including privatization, is under implementation.

The proposed increase in ammonia production at Point Lisas in Trinidad is unlikely to materialize before 1995.

South America

The only project assumed to go forward in the region is the export-oriented Nitroriente project at Puerto Cruz, Venezuela, that would have an ammonia capacity of 1500 tpd and may involve international partners.

Although other projects in Argentina, Chile, Colombia, Ecuador and Brazil have been under discussion, none are developing in a way that indicates any firm commitments.

ASIA

West Asia

West Asia is one of the regions with the highest potential for future development of new ammonia/urea capacities due to its large resources of inexpensive natural gas and a favorable location in respect to the growing markets in Asia. Although several projects are planned or already under construction in countries such as Saudi Arabia and Qatar, it is difficult at this stage to ascertain the impacts of the Gulf War on these projects, but one large ammonia/urea complex now under construction in Qatar, may come on stream in 1993. However, in the case of Iraq, a major delay in the execution of nitrogen projects is very likely. Latest reports indicate that one of the four ammonia plants in Kuwait was re-commissioned in January 1992, but there is no information on the status of the other plants.

South Asia

As result of current and further increasing demand, South Asia shows potential for considerable growth in new ammonia/urea capacities, particularly in India, Pakistan and Bangladesh and mainly in the private sector.

In India, completion of three projects based on gas from Bombay High is expected for, respectively, 1993 Bindal Agro (Shajahpur); 1993 Chamal Fertilizers and Chemicals (Kota, Rajasthan); and 1994 Tata Chemicals (Babrala, Uttar Pradesh). Nagarjuna Fertilizers and Chemicals is building an ammonia and urea complex at Kakinada based on gas from the Godavari Basin that may be completed in 1992. The Gujarat State Fertilizer Company intends to replace its two small plants at Baroda, Gujarat, by one large plant in 1995. India plans to increase its ammonia capacity by 3.6 million tons within the next five years and add several more million tons before the end of the decade.

In Bangladesh, the ammonia/urea plant of the Bangladesh Chemical and Fertilizer Company at Jamalapur is scheduled for commissioning in 1992 and the ammonia/urea plants of the Karnaphuli Fertilizer Company at Chittagong in 1993, at the earliest.

Two new plants are proposed to be established within the next five years in Pakistan, one at Goth Machi (Fauji) and the other at Daudkhel (National Fertilizer Company). ENGRO Chemicals (formerly EXXON) plans to increase its existing urea capacity from 270,000 tpy to 600,000 tpy by relocating an ammonia plant from the USA and a urea plant from the United Kingdom.

East Asia

China is the dominant country in this region and has been promoting a major investment program to increase its indigenous fertilizer capacities based on a variety of feedstocks. As this program requires substantial foreign aid, it heavily relies on the support from the international communities and has lately suffered from major delays. Despite the establishment of large scale operations, China currently still depends on small plants for almost half of its domestic nitrogen production. Although ambitious plans exist for the revamping of a large number of these small plants focusing mainly on upgrading production (substitution of ammonium bicarbonate, ABC, by high grade products such as urea or ammonium phosphates), conserving energy and controlling pollution, the major portion of additional production capacity required is expected to come from new large plants. After the installation of 16 ammonia/urea plants, each with a nominal capacity of 1,000 tpd ammonia, during the 1970s and earlier 1980s, a coal-based ammonia plant designed by Lurgi and integrated with a 900 tpd ODDA nitrophosphate (26-13-0) complex at Lucheng, Shanxi, was commissioned in 1988/89. This plant was followed in 1990 by another standard size oil-based complex at Puyang, Henan, built by Uhde. A 200,000 tpy ammonia plant that was jointly designed by China and Kellogg and built at Chengdu, Sichuan, has reached the commissioning stage. Two more plants at Fuling, Sichuan, and Jinxi, Liaoning, engineered by Tecnip, are under construction with project completion expected for 1992/93. An ADB-financed oil-based ammonia/urea plant was recently announced for Jilin and may be completed before 1995. A project that has been planned for some time at Heijiang, Sichuan, has still not obtained the required bilateral funding and its implementation has therefore been stalled. Three further plants to be financed by OECF have been confirmed, but are unlikely to be completed within the review period. Three to five more ammonia/urea projects are in the planning stage and may be realized in the late 1990s provided funds timely become available.

Indonesia will increase capacity by more than one million tons in the next five years based on current plans. These include a new ammonia/urea plant for Petrokemia at Gresik (Java), and optimization projects at Kujang (Java), Pusri, PIM, ACE (Sumatra) and Kaltim (Kalimantan).

In Japan, where a major part of ammonia is used for industrial purposes, no significant changes in ammonia capacities are anticipated. However, several small plants will be closed in accordance with a fertilizer restructuring law.

EUROPE

Eastern Europe

The fertilizer situation in Eastern Europe has recently been changing dramatically; therefore it is currently very difficult to forecast future capacity trends in the region. The reduction in subsidies and the increase in fertilizer prices have caused a significant fall in the regional demand for fertilizers which has also affected production. An increase in Soviet natural gas prices pushed up production costs and has made ammonia manufacture for export uneconomic in many plants. Since a substantial part of the East European capacity is old and technically inefficient, it seems likely that some plants will be closed down in the next few years. Only one new plant in the region at Slobozia in Romania was scheduled to come on stream in 1993, but is likely to be delayed.

Western Europe

Over the last decade, there have also been many changes in the West European fertilizer industry, including several major take-overs and company rationalizations that have led to the closure of several plants. Two companies, Norsk Hydro of Norway and Kemira of Finland, have played a major role in these take-overs and have acquired substantial production and marketing facilities in Holland, Germany, France, Belgium, the UK and elsewhere. As both these companies are predominantly state owned (as is the French nitrogen sector), a major part of the European fertilizer industry is today either directly or indirectly government controlled.

The only new plant under construction in Western Europe is being built by Uhde for BASF at Antwerp, Belgium. Several plant closures either have already been effected or are planned for the near future. In the UK, following its decision to quit the fertilizer industry, ICI will close one of the two plants operating at Billingham. The remaining plant will produce ammonia for industrial use. At one time, it looked as if ICI's plants at Sevenside would be taken over by Kemira, but the British Monopolies and Mergers Commission vetoed the acquisition. In Italy, Enimont will close two plants with a total capacity of 240,000 tons N per year.

The next five years will see a decline in West European ammonia capacity. West European ammonia producers find it increasingly difficult to compete with imported ammonia because of relatively high gas prices that are linked to oil prices. Any escalation of oil prices is likely to lead to more closures of ammonia plants. It is thus unlikely that any new plants will be built other than that referred to above and a reduction of regional ammonia capacity by about 1-2 million tpy N may be expected during the second half of the 1990s.

USSR

Reliable data on Soviet ammonia capacity and production have in the past been very difficult to obtain and have been limited to figures published in Comecon handbooks and information obtained from international engineering firms involved in the construction of new plants.

Fortunately, the recent participation of USSR representatives in meetings of the Fertilizer

Working Group has made more reliable and comprehensive information available. Although actual production figures estimated by the Group compared favorably with the Soviet records, the revised plant lists indicate that nominal ammonia capacity is about 10% lower than assumed, thus implying higher utilization rates than expected. As a significant part of the older capacity has recently been closed down, existing capacity, built predominantly by overseas companies, can be regarded as modern and technically efficient. In its attempt to enlarge the capacity of many of its plants, the USSR has contracted Toyo Engineering Company of Japan for the revamping of four large plants to conserve energy and increase capacity by 20%. In addition, the USSR had planned to revamp another twelve plants by itself, but at least some of these revamps may now be delayed. Forecasts indicating a capacity increase in the USSR by about 0.9 million tons N (about 4%) over the next five years may now be considered optimistic, as the increase largely depends on the addition of several new plants that originally were scheduled to come on stream towards the end of the review period, but which are now likely to be either delayed or even canceled.

OCEANIA

No change in ammonia capacity is expected within the forecast period, although several ammonia plants have been under consideration in Australia over the last few years based on domestic natural gas; however, unfavorable nitrogen fertilizer prices have delayed indefinitely further consideration of these projects. At one time, it looked likely that CSBP of Perth in partnership with Norsk Hydro would build a large nitrogen complex at Kwinana in Western Australia utilizing off-shore gas, but it now appears unlikely that this project will materialize.

E. Ammonia Plant Supply Capability

Future supply capability as a percentage of the nominal or name plate capacity denotes the production available without any market constraints. Historical plant utilization rates are based on actual production as a percentage of nominal capacity. In calculating future supply capability, consideration is given to the historical performance of plants and specific market conditions during the period. Supply capability is assessed on a country basis and is aggregated to obtain regional and global totals.

A major increase in ammonia capacity in the period 1975 to 1980 - when about 28 million tons N of new capacity were commissioned, resulted in a large surplus capacity prevailing over many years.

The decline of this surplus was fairly slow in spite of increased nitrogen consumption, due mainly to a steady improvement, particularly in developing countries, of average plant utilization, that has increased from about 73% in 1974 to about 85% in 1988/89 as shown in Figure 22. For example, the Indian 1980/81 utilization of the nitrogen industry capacity of 4.6 million tons was only about 53%, whereas by 1988/89, a capacity of 8.1 million tons operated at 83% utilization. Based on country by country estimates for 1989/90, a world ammonia supply capability at about 85% was derived, which, however, is predicted to decline to 83% for the next two or three years due to the decline in production in the USSR and East Europe. Significant further increases in world utilization rates will mainly depend on plant performances in China, USSR and Eastern Europe which seem unlikely to improve on a short to medium term under present conditions. It may therefore be expected that most contributions toward the increase of future supply capabilities will come from new plants. Regional plant utilization rates that were assumed for calculating ammonia supply capabilities over the next five years are given in Table 11.

Figure 22

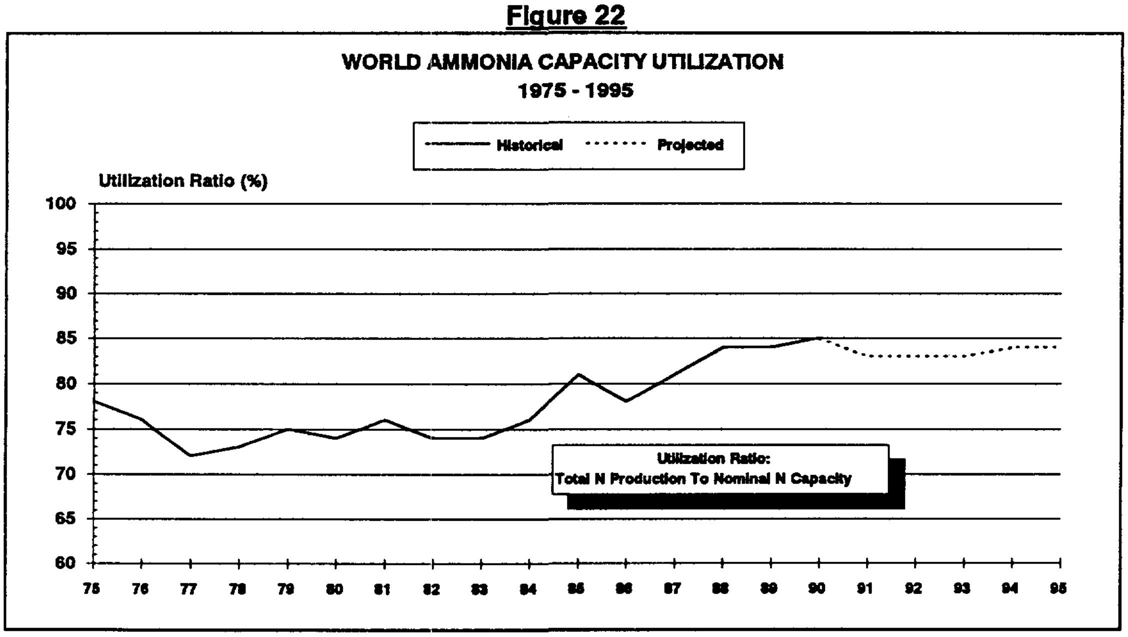


Table 11:

ACTUAL AND PROJECTED WORLD AND REGIONAL AMMONIA CAPACITY UTILIZATION

Percent Of Nominal Capacity

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
WORLD TOTAL	85	83	83	83	83	83	84
AFRICA	64	68	69	67	68	68	72
AMERICA	93	95	95	95	95	96	94
North America	96	99	98	98	99	99	99
Central America	89	89	88	90	90	90	90
South America	82	81	83	81	81	82	73
ASIA	84	83	83	84	82	83	85
West Asia	80	76	75	83	89	91	93
South Asia	81	83	81	81	77	79	81
East Asia	85	85	85	85	84	83	85
EUROPE	83	76	78	79	78	78	79
East Europe	70	60	61	63	62	63	64
West Europe	93	88	90	91	91	90	91
USSR	83	80	80	79	79	79	79
OCEANIA	91	9	91	91	91	91	91

It should be noted that discontinuity in utilization rates through a time period is usually caused by a capacity that idled for a year or so for technical reasons. Alternatively, it may also be due to allowances made for the phasing-in of new plant capacities in the first years of operation. Based on past experience, developed countries usually operate established and new ammonia plants at high utilization rates expected to be in the order of 94%, if oil prices remain relatively low and without market constraints. In the USA utilization may be even close to 100%.

In Africa, the operating rate is expected to be low due to poor plant performances in Algeria, Zambia and Libya. The plant in Nigeria is expected to operate at design capacity.

Anticipated operating rates in Latin America are depressed by expected low performances in Cuba, Colombia and Peru. Based on past performance, Trinidad is expected to achieve production of more than 100% of design capacity.

Plants in West Asia have usually operated at high utilization rates, but allowance has been made for reduced capacity in Kuwait and reduced operating rates in Iraq in the next few years. A speedy reconstruction would naturally result in a faster increase in supply capability, but currently this seems doubtful. Regional figures are also depressed by the Syrian plants, which historically have shown a poor performance.

The utilization of plants in South Asia has improved steadily to more than 80% due to continued good performance in Pakistan and improved performance in India. However, a drop in plant utilization is projected for the mid 1990s which is due mainly to the phasing-in of a large number of new plants in the region that are scheduled to start commercial production during that period.

The figures for East Asia mainly reflect the situation in China. In recent years, based on published production data and Working Group estimates of ammonia plant capacity, an average utilization of 86% has been achieved and is assumed to be maintained through the next few years.

Currently, it is difficult to forecast future performance of ammonia plants in Eastern Europe although a major decline has already taken place and is expected to continue. In Romania, for example, production rates have fallen sharply and the country has had to declare "Force Majeure" on overseas contracts. A conservative allowance has also been made for reduced output in the Soviet Union, that may, however, require further downwards adjustment. It is appreciated that these regions represent the highest degree of uncertainty in the projections.

Western Europe is forecast to operate on average above 90% utilization. Many large producers such as the Netherlands will produce close to design capacity, but the average for the region will be reduced by lower performers such as Portugal, Yugoslavia, and Germany following the reunification.

F. Ammonia Plant Age by Region

A survey that is summarized in Table 12 has been made to assess the world and regional age distribution of ammonia plants utilizing the data base and the ammonia plant list maintained by the Fertilizer Working Group. The results do not account for about 12 million tons N of small and medium ammonia plant capacity in China. No accurate data on commissioning dates, design capacities and expansions are available for these plants, but it is known that most of them were erected during the 1970s and 1980s.

Table 12:

PERCENTAGE OF CURRENT AMMONIA CAPACITY IN OPERATION BEFORE 1990

	1965	1970	1975	1980	1985	1990
WORLD TOTAL	**5**	**23**	**38**	**66**	**85**	**100**
AFRICA	**4**	**7**	**19**	**48**	**83**	**100**
AMERICA	**5**	**35**	**45**	**79**	**93**	**100**
North America	5	42	53	86	93	100
Central America	1	16	26	58	91	100
South America	8	19	22	72	100	100
ASIA	**3**	**13**	**22**	**51**	**72**	**100**
West Asia	1	7	22	32	50	100
South Asia	1	16	24	47	70	100
East Asia	5	14	18	67	85	100
EUROPE	**7**	**29**	**59**	**77**	**87**	**100**
East Europe	15	37	59	77	86	100
West Europe	2	24	60	77	86	100
USSR	**7**	**17**	**31**	**64**	**90**	**100**
OCEANIA	**4**	**81**	**81**	**88**	**100**	**100**

About 25% of the world ammonia capacity is now twenty years old and almost 40% has reached an age of fifteen years. Plants in the developed industrialized countries are generally older on average than those in the developing countries. It is of interest to note the high degree of old plants in Eastern Europe. Generally, these plants have not been well maintained or revamped to make them more energy efficient. Their economic viability and export potential has depended on receiving cheap natural gas from the Soviet Union; with upward adjustments of the gas price, some of these plants may have to close.

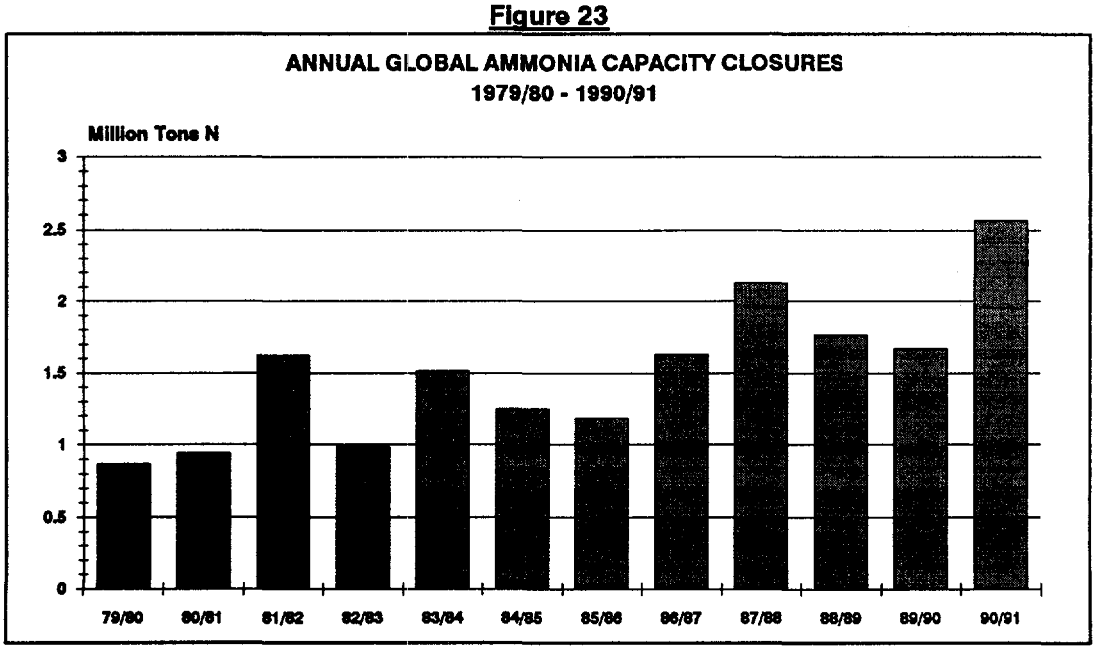
It is difficult to obtain precise statistical information on the average life of ammonia plants, as some plants have been in operation for 30 years or more, while others have closed down after 15 years of operation. Sometimes, ammonia plants close for economic reasons such as uncompetitive feedstock costs or unfavorable market conditions or because of technical obsolescence. Although a plant life can be significantly extended by thorough maintenance and high operating standards, technical obsolescence would normally require a major refurbishing after about 25 years. Such a life extension would, however, depend to a large extent on the advances in technological developments affecting energy consumption and investment cost. Annex 16 provides an assessment of ammonia plant viability in relationship to expected project life time.

G. Ammonia Plant Closures

After its peak around 1980, ammonia plant construction has declined and a further drop is expected over the next five years. However, with increasing average age of ammonia plants, the need for replacement of these plants is growing. Before 1960, ammonia capacity was relatively small, while between 1960 and 1980 plant construction grew steadily from about 1 million tons per year to five million tons per year. As a rough indication of replacement needs, an average plant life of 25 years may be assumed, implying that replacement capacities would increase from about 1 million tons per year in 1985, peak to about five million tons per year around 2005 and then decline somewhat after that. With nitrogen fertilizer consumption increasing at only 1.5 % per year (equivalent to about 1.2 million tons of N), the main need for new ammonia capacity will be for replacement of old plants rather than for the growing nitrogen demand.

The current and historical ammonia plant closure rates have been extracted from the Fertilizer Working Group plant lists and are given in Annex 4 and summarized in Figure 23; they seem to correlate satisfactorily with the assumptions made above.

Figure 23



V. WORLD AND REGIONAL NITROGEN SUPPLY AND DEMAND BALANCES

A. General

The methodology used for calculating the regional balances is explained in Annex 1, which also shows the world and regional nitrogen supply demand balances that are summarized in Table 13 and Figure 24 and indicate a fairly tight world nitrogen balance over the next few years. The evolution of a more balanced situation had already been expected for this period, even before the recent unexpected developments in the Middle East, Eastern Europe and the USSR. To some extent, the changes in Eastern Europe and the USSR may lead to an increase in global nitrogen supplies, at least in the near future, as the drop in local consumption is expected to be larger than the decline in supply capability. However, potential further major plant closures in Eastern Europe or production problems in the USSR may call for a revision of this assumption.

As result of the Arab Gulf crisis, exports from the region were reduced by about 0.8 million tpy of urea and ammonia; it appears that exports will not recover throughout the review period.

Escalation of oil prices during the Arab Gulf crisis could have seriously affected the viability of ammonia production from oil or on gas priced relative to oil. This would in particular have affected the nitrogen industry in West Europe. As oil prices dropped again and since then have remained reasonably stable, while nitrogen fertilizer prices increased, the prospects for the nitrogen industry have somewhat improved.

The balances as shown in Table 13 indicate a particularly tight nitrogen supply situation between 1991 -1993, which is expected to improve thereafter, as several large plants are scheduled to come on stream in India, the Arab Gulf, Indonesia and China. However, based on currently known plans for new capacity, the supply situation may tighten again after 1995.

Table 13

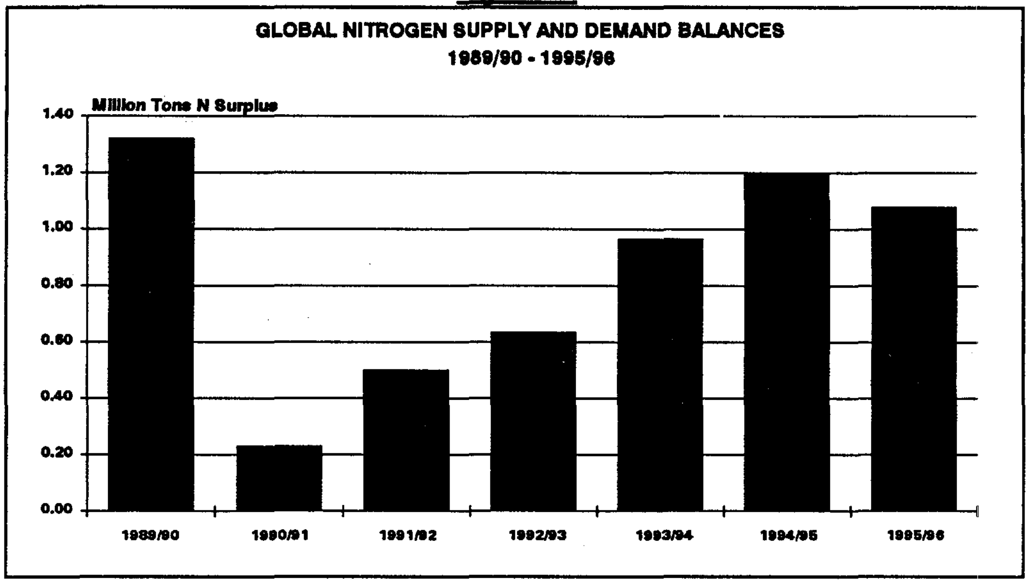
ACTUAL AND PROJECTED WORLD AND REGIONAL NITROGEN SUPPLY AND DEMAND BALANCES

(Million Tons N Per Year)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
WORLD TOTAL	1.32	0.23	0.50	0.63	0.97	1.19	1.08
AFRICA	-0.41	-0.36	-0.41	-0.41	-0.26	-0.24	-0.16
AMERICA	0.24	0.52	0.42	0.59	0.68	0.63	0.61
North America	-0.56	-0.14	-0.16	0.05	0.23	0.28	0.25
Central America	1.21	1.15	1.11	1.12	1.06	0.99	0.93
South America	-0.42	-0.49	-0.53	-0.58	-0.61	-0.65	-0.57
ASIA	-5.43	-7.30	-8.22	-8.27	-7.99	-7.61	-7.79
West Asia	1.56	0.62	0.63	1.15	1.47	1.55	1.61
South Asia	-1.67	-2.08	-2.49	-2.53	-2.29	-1.89	-1.87
East Asia	-5.32	-5.83	-6.36	-6.89	-7.18	-7.27	-7.53
EUROPE	0.26	0.12	1.08	1.20	1.16	1.10	1.24
East Europe	1.63	1.63	2.28	2.19	1.99	1.77	1.69
West Europe	-1.37	-1.52	-1.21	-0.99	-0.84	-0.67	-0.45
USSR	6.74	7.36	7.78	7.69	7.60	7.56	7.46
OCEANIA	-0.07	-0.10	-0.13	-0.17	-0.20	-0.24	-0.28

The global situation is still very dependent on the situation in Eastern Europe and the USSR, where a major nitrogen surplus remains. However, the problems of gas availability and transport problems in the Soviet Union could deteriorate further in the next few years and reduce export potential. In East Europe, the export potential may decline as plants are forced to close down for economic and environmental reasons.

Figure 24



B. Africa

Overall, Africa will remain a region with a nitrogen deficit, even though several countries, such as Nigeria, Algeria and Libya export ammonia and urea overseas. With new capacity planned in Egypt, Nigeria and South Africa, the regional deficiency may somewhat decline.

C. America

Due mainly to the dominating influence of North America, the combined Americas will remain more or less in balance. North American net nitrogen import needs will be relatively small, with very little increase in new demand or capacity planned other than the new plant of SASKFERCO in Canada. However, nitrogen trade is expected to be high because large quantities of ammonia will be imported to produce DAP for exports. Urea will be exported from Alaska to the Far East, while, at the same time, urea will be imported into the continental USA from other sources, such as Canada and Central America. Although the balance and overall import needs may fluctuate slightly from year to year depending on the weather and incentive programs, no major changes are expected.

Central America will continue to maintain a surplus of about one million tons N and continue its exports from Trinidad and Mexico. The surplus will slowly diminish in the absence of new capacity additions.

Overall, South America will maintain a deficit, although new capacity is expected to come on stream in Venezuela.

D. Asia

The major deficit that has prevailed in this region over many years will continue to dominate world nitrogen trade. The overall deficit in 1989/90, estimated at about 5.4 million tons N, is expected to increase to about 7.8 million tons by 1995/96.

The only part of this region with a surplus is West Asia, where the large nitrogen import needs of Turkey and Iran are far outweighed by the large supply capability of the plants in the Arab Gulf. Although supply capability in the Gulf was seriously reduced by the Gulf War and will remain so for some time, new plants may come on stream during the period under review and will help restore exports to former levels.

South Asia which basically represents the countries on the Indian sub-continent will remain a deficit area. Much will depend on the situation in India itself. Recent studies by the working group of the Department of Fertilizers in India indicate that the nitrogen deficit will increase to 1.4 million tons by 1994/95. Without additional new capacity, this would rise to 3.8 million tons by the year 2000.

East Asia has the world's largest deficit, mainly because China cannot meet its vast nitrogen needs by domestic production. The net import needs in East Asia are just over five million tons N per year (of which about 90% goes to China) and are expected to increase to about 7.5 million tons by 1995/96. Most of the growth, in absolute terms, will be in China, although Thailand, Vietnam and the Philippines will also increase their imports of nitrogen, however, on a much smaller scale.

Though China has a long term plan for becoming self-sufficient in nitrogen, delays in its investment program mean that China is likely to increase its imports in the short to medium term and remain a major importer through the year 2000 and probably beyond.

E. Europe

Currently, Europe's nitrogen situation is more or less balanced, with East Europe in surplus and West Europe in deficit. As consumption is declining in both East and West Europe, an overall surplus situation may develop. However, this situation will change with the closing down of capacity in the region due to relatively high feedstock costs and environmental constraints. Therefore, East Europe's role as a major exporter of nitrogen fertilizers will decline steadily, although its short term export potential may increase.

F. USSR

Although there are likely to be many changes in the nitrogen fertilizer industry in the USSR, it will undoubtedly remain the world's largest producer and exporter of ammonia and urea. With a finely balanced world nitrogen situation, it only needs relatively small changes in the Soviet Union to upset this balance. The data shown in Table 23 assume that in the next few years consumption in the USSR will decline at a higher absolute rate than supply capability, some small increase in capacity over the next five years will occur and plants continue to operate around the 80% utilization level. With the prospect of gas shortages, transportation and environmental problems, as well as further major political changes, the projected supply situation may represent an optimistic scenario. On the other hand, it seems likely that the USSR will continue to promote nitrogen fertilizer exports as a priority for earning foreign exchange. The developments in the USSR will need to be monitored very carefully as the main factor in assessing the prospects for the world nitrogen industry in the next decade.

VI. OUTLOOK FOR UREA

A. General

Urea has become the most widely used and traded nitrogen fertilizer and the rapid development of its use during the 1970s was a major factor in the "green revolution". Two decades ago, urea production and trade were dominated by the industrialized countries in Europe and Japan, but since then, most investments have been in the developing counties of the Far East, in Eastern Europe, the USSR and in China.

Although urea was already synthesized in the early 19th century, its development as a fertilizer took off slowly and comparably late. Early urea technology was expensive and urea was originally not considered the most economic nitrogen fertilizer under the agricultural and climatic conditions prevailing in the industrialized countries, where nitrogen fertilizers were first used in larger quantities.

Major agricultural developments in the developing countries after 1960 led to a substantial increase in both the production of urea and its use as a fertilizer. There were several good reasons for this:

(i) The development of new large scale process technologies based on cheap natural gas for producing ammonia at low cost and integration with urea manufacture to improve process economics, reduce energy consumption and use by-product carbon dioxide from ammonia manufacture as a feedstock.

(ii) Agronomically, urea is a good fertilizer for rice and considered to be more efficient than ammonium nitrate for paddy rice. As the major demand for fertilizers in developing areas mainly evolved in the rice growing countries of the Far East, production and consumption of urea increased sharply. A revived interest in urea in those areas that were previously regarded as unsuitable for its use, indicated that urea is a competitive fertilizer in almost all conditions, if properly applied.

(iii) Urea is a highly concentrated fertilizer, containing 46% of nitrogen, as compared with ammonium nitrate (typically around 34% N) and calcium ammonium nitrate (nitrogen content usually 26 - 29% dependent on legislation and diluent/additive content). This facilitates significant savings in transport, handling and application costs -a factor of particular importance in those countries that have to import their nitrogen fertilizers. Furthermore, the strict safety regulations on the storage and transport of ammonium nitrate, including bulk handling, do not apply to urea. With most developing countries depending on imports to meet their needs, it is not surprising that urea rapidly became the most popular nitrogen fertilizer.

(iv) Interest in urea as a non-fertilizer material has also grown steadily. Besides its use as a cattle feed supplement, the major industrial use is in the manufacture of plastics and resins. In 1988, out of a total production of about 33 million tons of urea, 2.8 million tons (approximately 8.5%) were processed as non-fertilizer.

B. World Urea Capacity

As accurate data on nominal urea capacities prior to 1976 are not readily available, ammonia and urea production figures were used to estimate 1961 urea capacity at about 1 million tons; most of it was located in the industrialized countries of Western Europe, the USA and Japan. By 1970, world urea capacity had risen to about 7 million tons with a significant increase in capacity in all economic regions. In the developing countries, the main developments were taking place in India, where in 1970 urea production exceeded 1 million tons of product. World and regional urea capacities from 1976 onwards and projections through 1995/96 are given in Annex 5 and are summarized on a regional basis in Table 14.

Table 14:

REGIONAL INSTALLED UREA CAPACITY 1976/77 - 1995/96

(Million Tons N)

	1976/77	1980/81	1985/86	1990/91	1995/96
WORLD TOTAL	**20.93**	**31.27**	**39.14**	**44.40**	**51.87**
AFRICA	**0.27**	**0.64**	**1.19**	**1.34**	**1.54**
AMERICA	**4.17**	**5.27**	**6.67**	**6.72**	**7.22**
North America	3.14	4.05	4.37	4.40	4.80
Central America	0.32	0.47	1.14	1.09	1.09
South America	0.71	0.75	1.16	1.23	1.33
ASIA	**7.87**	**14.78**	**18.33**	**22.17**	**28.64**
West Asia	1.09	2.18	2.54	3.05	3.95
South Asia	2.55	4.40	6.92	8.55	11.97
East Asia	4.23	8.20	8.87	10.57	12.72
EUROPE	**5.99**	**6.63**	**7.60**	**7.93**	**8.00**
East Europe	2.24	2.43	3.52	4.41	4.41
West Europe	3.75	4.20	4.08	3.52	3.59
USSR	**2.55**	**3.84**	**5.17**	**6.01**	**6.24**

About half of the world urea capacity has been established in Asia, mainly in China and India; however, other countries, such as Indonesia, Pakistan and Bangladesh, have also developed significant capacities. There was a major growth in urea capacity in the second half of the 1970s, mainly in the developing countries of Asia, to supply growing domestic demand. Almost all urea produced in Asia is consumed there, but as there is still a deficiency, the region is also a major importer of urea.

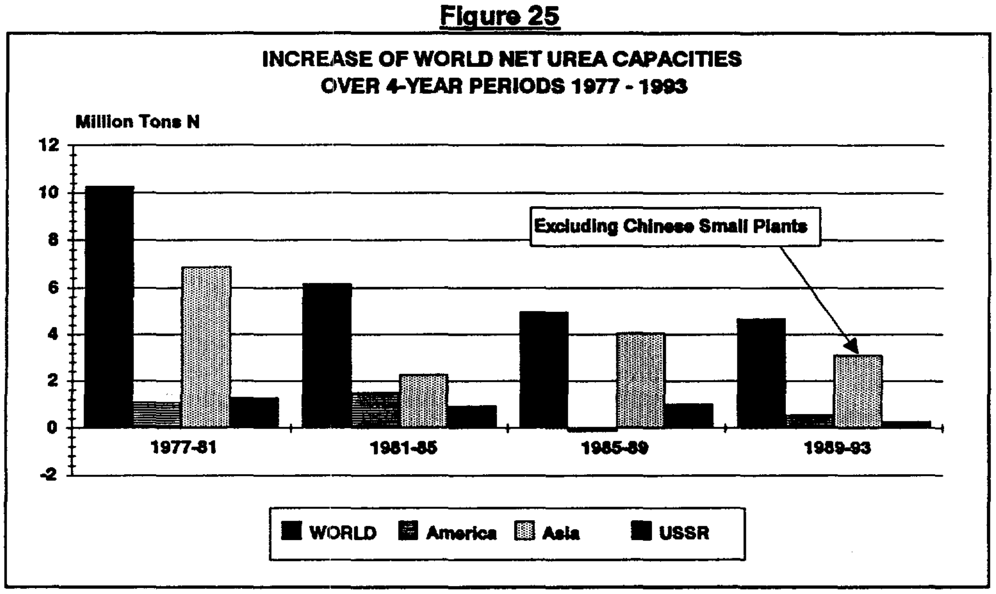
Significant investments in urea capacity were also made in Eastern Europe and the USSR; however, much of this capacity was export oriented.

There has been very little increase in capacity in West Europe, reflecting the fact that urea was not in high demand in the region and a good part of production went to the export market.

In Latin America, urea capacity has been growing steadily in Brazil, Mexico and Trinidad.

The development of global and regional urea capacities since 1977 is shown in Figure 25.

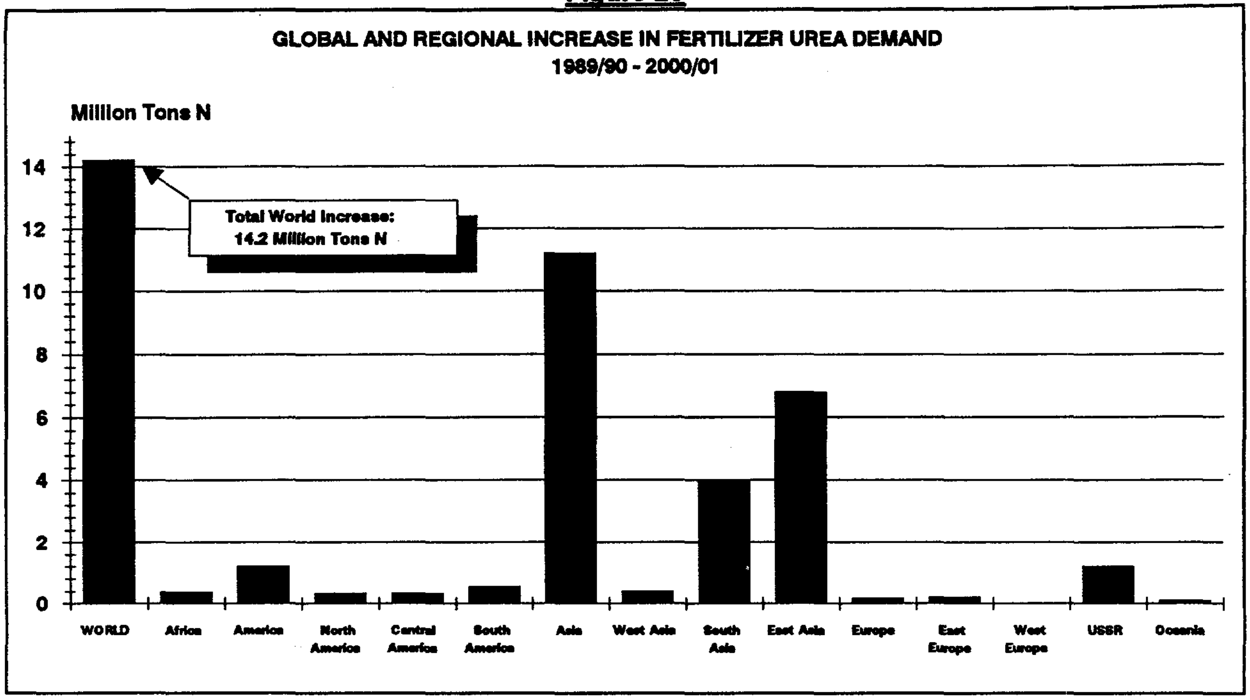
Figure 25



C. World Urea Demand

Based on information available on nitrogen demand, urea production and trade, some estimates have been made of urea consumption in 1989/90. According to future demand estimates for the different regions and considering individual fertilizer preferences as well as the fact that some nutrients will be supplied as compound fertilizers and diammonium phosphate, projections have been made of regional and world urea demand through the year 2000. The results are given in Annex 6 and summarized in Figure 26. The data show that more than half of the current world urea fertilizer consumption of 32 million tons is in Asia, representing nearly 40% of all nitrogen fertilizer consumption.

Figure 26



During the next decade, nitrogen fertilizer consumption is expected to continue growing significantly in Asia, both in absolute and relative terms, as the developing countries of the Far East strive to feed their growing populations. About 85% of all incremental nitrogen fertilizer use is expected to develop in the region, predominantly in South and East Asia. This increase in urea consumption in Asia will obviously have a major impact on both urea trade and investment patterns. By the year 1995/96, Asia is expected to consume about 27.3 million tons or 67% of an estimated world urea fertilizer consumption of 40.5 million tons.

Although no increase in nitrogen fertilizer consumption is expected in North America and in Europe, urea is likely to become more popular in these regions which should lead to a slight increase in urea consumption patterns.

D. The Future Structure of the World Urea Market

The last two decades have seen some major changes in the urea export market; the most important have been (i) the relative decline in the near-monopoly that prevailed on exports from the developed countries, and (ii) the ascendancy of the USSR as the world's major exporter. It is forecast that the USSR will maintain its position as the leading exporter of urea throughout the 1990s and that exports of urea from East European countries will decline during the same period, as they will find it increasingly difficult to compete under free market conditions, particularly in view of the escalating gas prices from the USSR. The Soviet Union has sufficient supply surplus to remain the largest exporter for many years to come and the world will become increasingly dependent on these exports as the export potential of Eastern Europe diminishes.

The Chinese market for imports will remain strong through the next five years and possibly the next decade. With delays in its investment plans for new urea plants, it now appears unlikely that China will achieve its objective of self-sufficiency in nitrogen by the year 2000. With increasing popularity of urea as a fertilizer, most new nitrogen fertilizer capacity will be as urea. Plans for converting a substantial part of the existing small ammonium bicarbonate plants to urea are under consideration and may lead to the phasing-out of ammonium bicarbonate as a fertilizer. The establishment of small-size urea plants is, however, not expected to significantly increase China's nitrogen output, as some existing ammonia capacity in small size plants will be phased out where revamping is unviable.

The steadily increasing demand for urea in developing countries of the Far East will probably be met by producers in the Near East who have comparative advantages of inexpensive gas, an established infrastructure in many countries and a freight advantage compared to East and West European producers. In future, much will depend on Chinese purchasing policies and the ability of the major export regions to come to long-term trading arrangements with China.

E. Granular vs. Prilled Urea

One of the major considerations facing investors in new urea plants is whether or not to incorporate facilities to granulate urea or to produce as prills in the conventional process. The main advantage of granular urea is that it may be sized to be compatible with other fertilizers and thus is well suited for bulk blending. It is also a much stronger product and stores and handles well. Investment costs to granulate urea in a large nitrogen complex may increase the total project cost by up to US$20 million and there are additional operating costs. However, the additional costs may be offset by agronomical advantages of granular product and increasingly stringent requirements for pollution abatement in prilling plants. In the USA, the current premium for granular urea is about US$10/ton. Generally, the decision on the urea finishing process will depend on market requirements and destination. The best markets for granular urea are the major bulk blending areas such as the USA, Latin America and, to an increasing extent, West Europe. At this stage, bulk blending has not been developed significantly in Asia and therefore prills are usually most common in the region. If urea is used for the manufacture of liquid and suspension fertilizers, such as UAN, or as an ingredient for a rotary granulation process, non-granular urea will normally be preferred.

F. Recent Developments in the Global Urea Market

International developments over the last one or two years had and will continue to have a major impact on the world urea market, both in the short and long term. However, it is difficult to predict the overall effect quantitatively, as some of the changes are likely to counter-act with others.

In the very short term, the most important factor in the international urea market was the removal of Iraq's and Kuwait's nitrogen exports (about 1.6 million tons product) from the world market. Particularly for urea, the supplies have tightened and prices increased. If China and India had not carefully controlled their imports, the situation would be considerably worse. Until recently, India has had very large inventories of urea amounting to about 30% of annual consumption and, with pressure to reduce stocks, it has had no great need for major imports in 1990 and 1991. However, this situation is now expected to change and imports of urea to India are likely to increase to two million tpy in the next two or three years.

Although the Chinese demand for urea is still high, purchases in 1990 and 1991 have been lower than in the two preceding years. China has reportedly accumulated a large fertilizer inventory and, with a possible stagnation in demand due to a bumper harvest and low agricultural prices, does not require to make large purchases of fertilizers in 199;, this will have a restraining effect on international urea prices.

The major unknown factor in international nitrogen trade is the supply situation in Eastern Europe. With increased gas prices and technical problems, production in the region is known to have deteriorated. At present, diminishing supply appears to match reduced domestic consumption with little change in exports. Significant increases in international urea prices may generate a marked incentive for increasing exports from Eastern Europe despite higher energy costs.

Overall, it appears that the Gulf War has not had an overriding impact on international urea prices due to a relatively small overall increase in urea demand in 1991, particularly in the USSR, where local demand is forecast to deteriorate further for several years. On the other hand, supplies from the region may recover, probably resulting in an increased export potential. This may help to moderate the escalation of urea export prices as demand increases.

G. World Urea Supply and Demand Balances

Urea has become the most important fertilizer in the world with an estimated share in 1989/90 of 40% of about 79 million tons of nitrogen produced in total, i.e. more than 32 million tons. Urea also constituted nearly half of the 20 million tons nitrogen traded in the international fertilizer market. Recent world events and likely changes in the structure of the urea market require a careful review of the longer term prospects for urea supply and demand. However, such a review is not easy to conduct for the following reasons:

(i) Although the most important commodity, urea is only one of several major nitrogen fertilizers. The markets for different nitrogen fertilizers vary considerably and in many cases products are not always regarded as comparable for agronomic and other reasons. Although ammonia is almost always the main nitrogen source for fertilizers, there is a variety of processing alternatives and capacities down-stream. This means that a situation may develop, where there is a surplus of one type of nitrogen fertilizer and a shortage of another one.

(ii) The process for making urea is unique in that it is almost always integrated with ammonia production to use byproduct carbon dioxide. Other down-stream processes are not necessarily integrated and can use ammonia either produced locally or imported. This makes urea production normally independent of the ammonia market and the relative prices of the two materials may vary considerably.

The projections of urea demand given in Annex 6 take into account regional preferences and also future changes in the structure of the market. Urea supply capability has been derived from urea plant capacities. As urea plant utilization to a large extent depends on the performance of the upstream ammonia plant, the same regional utilization rates have been used for urea and ammonia capacity. Capacity utilization is shown in Table 11 and regional supply capabilities are given in Annex 7.

Industrial urea requirements have been subtracted from the available supply to derive the urea available for fertilizer use. Consistent with the main nitrogen balances calculated by the Fertilizer Working Group as described in Annex 1, urea available at farm level is assumed to be 95.5% of fertilizer urea supply capability, to account for transport and distribution losses and stock changes. The urea balances are presented in Table 15.

Table 15:

WORLD UREA BALANCE

(Million Tons N)

Year	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
Urea Capacity	43.916	44.382	45.554	46.977	49.758	51.487	51.870
Urea Supply Capability	36.586	36.538	37.590	39.143	41.511	42.781	43.835
Urea Industrial Use	2.600	2.620	2.630	2.640	2.650	2.660	2.670
Urea Available As Fertilizer	33.986	33.918	34.960	36.503	38.861	40.121	41.165
Urea Fertilizer Demand	31.950	32.632	33.969	35.764	37.369	39.141	40.484
Urea Balance Before Losses	2.036	1.286	0.991	0.739	1.492	0.980	0.681
Losses	1.529	1.526	1.573	1.643	1.749	1.805	1.852
Urea Balance	0.507	-0.240	-0.582	-0.904	-0.257	-0.825	-1.171

The balances in Table 15 show that world urea supply/demand balances have moved from a surplus of about 0.5 million tons in 1989/90 to a deficit of 0.24 million tons in 1990/91. The deficit is projected to increase through 1995/96 and possibly beyond. In the short term, the reason for the deficit is mainly the halt of urea production in Kuwait and Iraq. The regional supply deficiency is somewhat counterbalanced by the export potential of East Europe and the USSR, which is expected to increase in the short term.

However, even before the Gulf War, the industry was moving to a tighter urea supply situation. The main and overriding reason is the growth in world nitrogen fertilizer demand, particularly in Asia but also in Latin America, although to a much lesser extent. This demand is mainly for urea and expected to increase faster than new urea production capacity.

In some areas of the world, such as Europe and the USSR, where nitrogen fertilizer demand is decreasing, downstream surplus capacity is mainly ammonium nitrate-based, which often is inappropriate for meeting growing nitrogen demands elsewhere, as ammonium nitrate-based materials are usually expensive to transport over long distances due to safety and concentration considerations. This means that surplus nitrogen fertilizer that might become available in Europe would not necessarily be suitable for export to deficit areas like Asia.

The total incremental increase in world urea demand will be about 8.5 million tons between 1989/90 and 1995/96, and more than 85% of this will evolve in Asia. Only about 7 million tons of new capacity will come on stream in the same period. Plans for new ammonia and urea production capacity through the next five years indicate that Asia will meet most of its increasing demand for urea through production in the region and this pattern is likely to continue also through the remainder of the decade. Through 1995/96, up to about 6.5 million tons of new capacity is anticipated in Asia, but imports will still need to increase. About 20 new urea plants have been proposed in Asia after 1995/96, including four in China, four in India, five in the Near East and two in Indonesia. Not all of these plants are likely to be built, but even if they were, Asia would still continue to be a major importer of urea throughout this decade and probably thereafter.

H. Non-Urea Nitrogen Fertilizer Supply and Demand Balances

Non-urea fertilizers amount to about 60% of all nitrogen fertilizers and comprise ammonium phosphates (mainly DAP and some MAP), ammonium sulfate, ammonium nitrate, nitrophosphates and anhydrous ammonia, and most of these are produced and used in North America, the USSR and Eastern Europe. In many cases, the production of these materials depends on imported ammonia, so the balance for non-urea fertilizer to some extent reflects the balance for ammonia.

The demand for non-urea nitrogen fertilizers is derived from subtracting urea demand from the total demand for nitrogen fertilizers. The supply potential for non-urea based nitrogen fertilizers is calculated by subtracting the nitrogen required for urea manufacture from the total nitrogen fertilizer supply potential. This has been calculated in Annex 1 and accounts for losses and industrial uses. Normally, the nitrogen to meet urea demand is assumed to be the nitrogen supply need for urea demand, but when urea supply capability is less than urea demand, the former is used. The balances are given in Table 16.

Table 16:

WORLD NON-UREA FERTILIZER NITROGEN BALANCE

(Million Tons N)

Year	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
N Fert. Supply Potential	80.40	77.99	78.77	80.76	82.66	84.75	86.45
Urea-N Demand	32.46	32.39	33.38	34.86	37.11	38.32	39.32
Non-Urea Fert. N Supply Potential	47.94	45.60	45.39	45.90	45.55	46.43	47.13
Non-Urea Fert. N Demand	47.13	45.13	44.30	44.36	44.32	44.15	44.89
Balance	0.81	0.47	1.09	1.54	1.23	2.28	2.24

The balances indicate that there will be a surplus of non-urea fertilizers, or ammonia designated for non-urea fertilizers, respectively, through the next five years. This is in contrast to a urea deficit that will prevail through the same period.

VII. INTERNATIONAL TRADE IN NITROGEN FERTILIZERS

A. General

The Food and Agricultural Division of the United Nations (FAO) regularly publishes detailed information on international fertilizer trade (FAO Fertilizer Yearbook) and Table 17 quotes some summary information on the major exporters and importers from the most recent Yearbook. In 1989/90, about 52% of the international nitrogen trade was in the form of urea, about 10% as diammonium phosphate, and the remainder as ammonium sulfate, ammonium nitrate or ammonium nitrate based products, such as calcium ammonium nitrate and ammonium sulfate nitrate. Ammonium nitrate is produced and traded mainly in Europe. So also is calcium ammonium nitrate, which is usually also associated with nitrophosphate manufacture.

In 1989/90, the USA was the largest exporter of nitrogen fertilizers in the form of very large quantities of diammonium phosphate and most of the urea from the large plant in Alaska. The USSR was the second largest exporter of nitrogen fertilizers, mainly as urea. At the same time, the USA imported urea and also large quantities of ammonia both for fertilizer use and processing. China was the largest net importer of nitrogen and the USSR the largest net exporter.

Table 17:

INTERNATIONAL FERTILIZER NITROGEN TRADE 1989/90

(Million Tons N)

Country	Exports		Country	Imports	
USA	2.83	14.0%	China	4.36	21.6%
USSR	2.77	13.7%	USA	3.51	17.4%
Canada	1.70	8.4%	France	1.50	7.4%
Netherlands	1.59	7.9%	Germany (FR)	0.95	4.7%
Romania	1.20	6.0%	India	0.52	2.6%
Others	10.07	50.0%	Others	9.38	46.4%
Total	**20.16**	**100.0%**	**Total**	**20.22**	**100.0%**

Source: FAO Fertilizer Yearbook

B. International Ammonia Trade

Preliminary world anhydrous ammonia trade figures for 1990 are presented in Annex 8 and summarized in Table 18. As a result of the massive investments at the end of the 1970s to exploit its rich natural gas reserves, the USSR now dominates the anhydrous ammonia export market and seems likely to do so for many years. The USSR has currently about 30% of the market with a wide range of

Table 18:

INTERNATIONAL AMMONIA TRADE 1990

(Million Tons N)

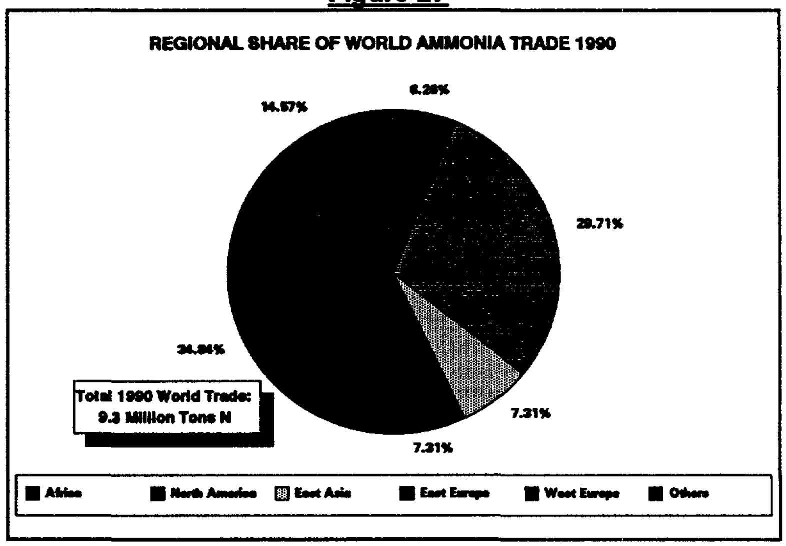
Country	Exports		Country	Imports	
USSR	3.28	32.9%	USA	3.01	30.2%
Trinidad	1.32	13.2%	Belgium	0.62	6.2%
Arab Gulf	0.98	9.8%	Turkey	0.59	5.9%
Netherlands	0.96	9.6%	Spain	0.50	5.0%
Canada	0.93	9.3%	France	0.40	4.0%
Others	2.50	25.1%	Others	4.85	48.6%
Total	**9.97**	**100.0%**	**Total**	**9.97**	**100.0%**

Source: IFA

customers. As might be expected, Eastern and Western Europe are large customers and the USA also imports large quantities of ammonia from the region. The main use of imported ammonia is to produce ammonium nitrate or diammonium phosphate. In addition to the USA, other large importers of ammonia include phosphate producers in Morocco, Tunisia and Jordan. The Arab Gulf states are also large exporters, mainly to India, Turkey and countries in the Far East.

The regional distribution of ammonia trade is shown in Figure 27. About 65% of all ammonia imports are into North America and Western Europe. About 40% of trade in Western Europe is inter-regional. A significant part of imports, particularly in the case of the USA, is re-exported as finished product. The USA is also a large consumer of ammonia for direct application. Africa is also a major importer of ammonia to countries such as Morocco, Tunisia, and South Africa. Much of this is re-exported in the form of ammonium phosphates. The prospects for future ammonia trade will depend to a large extent on natural gas prices in the USA and in Europe. In the USA, gas prices have been relatively low in the last few years and well below equivalent oil prices, allowing domestic consumption to compete with imports. In Europe, gas prices are linked to oil prices and so the industry has had a harder time to compete with low-priced ammonia imports. With the nitrogen fertilizer market expected to decline in Europe, ammonia trade is not expected to increase much in the next few years unless oil prices increase significantly. If energy prices escalate substantially, more nitrogen capacity in West Europe will be forced to close and more ammonia will need to be imported. Outside the phosphate fertilizer producing countries of North Africa and the Near East, ammonia trade is expected to grow only slowly, as most nitrogen imports will be in the form of urea or ammonium phosphates.

Figure 27



C. International Urea Trade

Preliminary results of world urea trade for 1990 are given in Annex 9 and summarized in Table 19. The growth of urea trade since 1980 is given in Annex 10.

Table 19

INTERNATIONAL UREA TRADE 1990

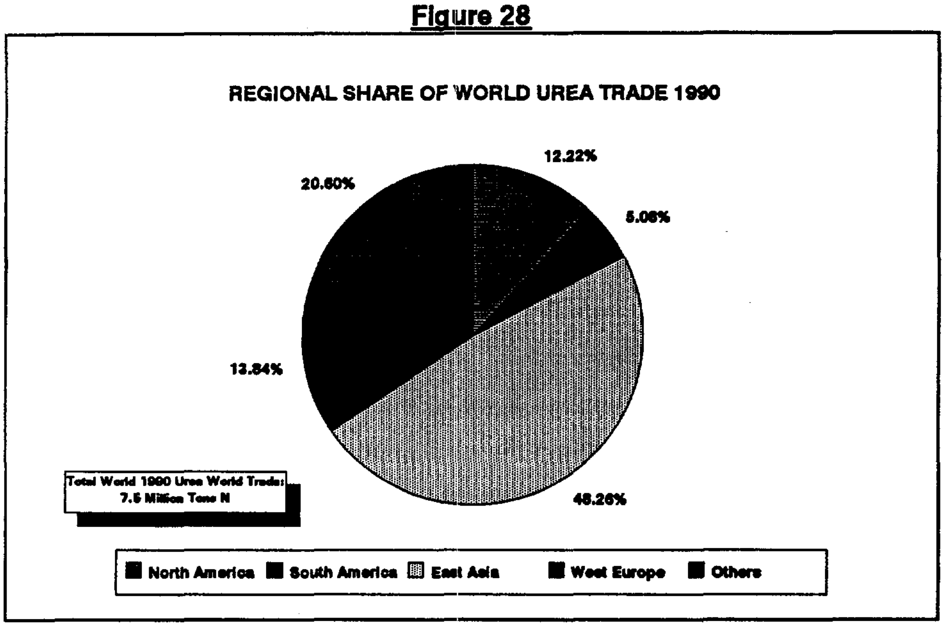
(Million Tons N)

Country	Exports	Share	Country	Imports	Share
USSR	2.31	30.7%	China	2.47	32.8%
Arab Gulf*	0.91	12.1%	USA	0.82	10.9%
Indonesia	0.72	9.6%	Vietnam	0.26	3.5%
Canada	0.67	8.9%	UK	0.26	3.5%
Netherlands	0.46	6.1%	Philippines	0.25	3.3%
USA	0.39	5.2%	Thailand	0.21	2.8%
Others	2.07	27.5%	Others	3.26	43.3%
Total	**7.53**	**100.0%**	**Total**	**7.53**	**100.0%**

* Excludes exports from Iraq and Kuwait

Source: IFA

Figure 28



The USSR is the largest exporter of urea and China is the major importer. The Arab Gulf area is the second largest exporter. Although the 1990 export figures for Kuwait and Iraq are not available. In 1989, these two countries exported 0.73 million tons. World urea exports dropped during 1990 due mainly to a decline of Chinese imports by more than 25%. In the same year, urea exports to Europe decreased by 0.46 million tons, or 26% compared with 1989. The regional distribution of urea imports in 1990 is shown in Figure 28.

VIII. ECONOMICS OF AMMONIA AND NITROGEN FERTILIZER PRODUCTION

A. General

The two main factors determining the cost of ammonia and nitrogen fertilizer production are feedstock and investment costs (capital charges) and these can vary significantly for different locations. Together, these two components normally make up about 90 - 95% of the total cost of production. Sometimes, raw materials are available at very low cost, but this advantage may be offset by higher investment costs, if plants have to be built in remote locations and bear the cost of expensive infrastructure.

B. Ammonia and Urea Technology

There have been considerable improvements in ammonia manufacturing technology in recent years, mainly in enhanced energy recovery, higher conversion efficiencies and advanced materials of construction.

There are now five major companies that offer ammonia process technology: C.F. Braun, M.W. Kellogg Co., Haldor Topsoe A/S, Imperial Chemical Industries (ICI) and Uhde GmbH. All these companies have many years of experience in the field and can offer reliable large scale plants. It would be difficult to demonstrate that any one process is significantly better than the others. Each one now claims low overall energy usage, in practice in the range 6.6-7.2 Gcal, (26-29 MMBtu)/ton of ammonia. The processes are basically very similar, with differences mainly in the configuration and design of vessels, energy recovery systems and drives.

Recently, however, ICI have developed a process which offers some novel features including a major simplification of the steam and power cycle. This process is operating on a relatively small scale (2 plants @ 450 tpd each at Billingham, UK), but in principle there is no reason why the same improvements could not be incorporated into plants with different capacities.

It seems unlikely that there will be any further major breakthrough in ammonia technology in the near future, but rather that there will be a steady progress in improving catalyst performance and design to reduce investment costs, as energy use is already approaching theoretical requirements and no major advance is possible in this area. Reductions in investment will be obtained by more integrated process units that will also reduce instrumentation and interconnecting piping. In particular, improved equipment and processes will be developed for waste heat recovery.

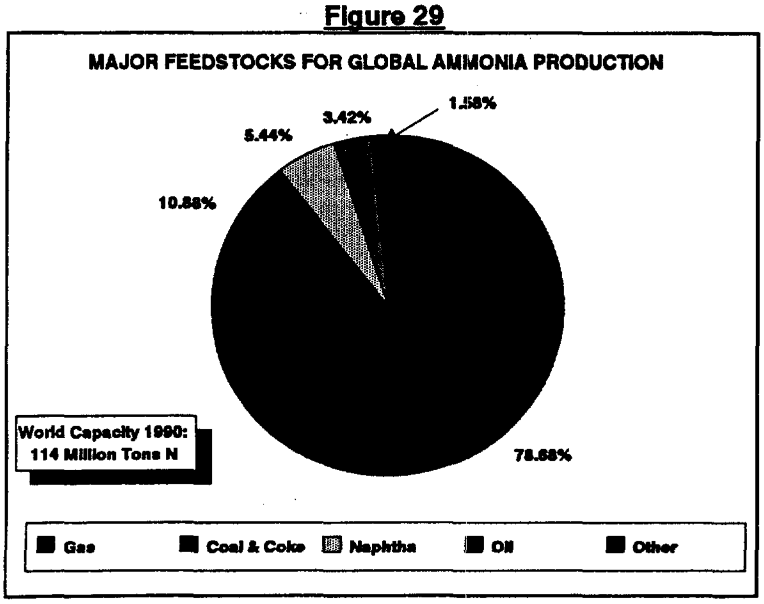
New ammonia plants are usually very reliable and in many cases a 16 - 18 months operating period between scheduled turnarounds is guaranteed; improved instrumentation and catalysts may facilitate further extension of this operating period. Although ammonia plants are normally not causing environmental concern, further attention is being given to improving the quality of discharges, such as the use of low sulfur fuels or removal of sulfur from fuels and oxidation of NO_x gases.

Recent technical developments are summarized in Annex 11.

C. Feedstock for Ammonia Production

Before World War II, coal and coke accounted for more than 90% of the 3 million tpy of nitrogen produced as ammonia. By 1960, world ammonia capacity had increased to about 10 million tpy N and natural gas had overtaken coal and coke as the main feedstock due mainly to the availability of cheap gas in the USA. In many other developed countries, some new capacity was based on fuel oil, but naphtha was usually the most preferred feedstock, as it represented the cheapest available oil fraction. The development of the ICI steam reforming process for naphtha led to the establishment of many new plants around the world, not only for ammonia, but also for methanol and town gas. However, the resulting growth in naphtha demand combined with the 1973 oil crisis increased the relative price of naphtha compared with other feedstocks, making it economically less competitive. Many plants idled or were closed permanently. Since 1975, most new plants have been based on natural gas, apart from the special situation in China, where coal still continues to be a major feedstock.

Figure 29



About 73% of the world ammonia capacity is based on natural gas as shown in Figure 29. When using natural gas, total energy needs and investment costs are usually much lower than for other feedstocks. Based on the present projections for reserves and opportunity costs for gas, particularly in developing countries, it seems highly likely that natural gas will continue to increase its position as the preferred feedstock for ammonia production.

D. Energy Requirements for and Costs of Ammonia Production

The cost of energy in the form of fuel and feedstock is usually the most important component of ammonia and nitrogen fertilizer production costs. This is clearly indicated by information obtained from surveys carried out periodically by the Fertilizer Institute (TFI) of the USA. Some information from the 1988 survey that covered more than 30 USA and Canadian plants is given in Table 20. The TFI study is useful, as it relates to actual operating experience rather than engineering company estimates on "battery limits consumption" obtained under optimal conditions. Furthermore, it aggregates all types of units and energy into equivalent units for comparison.

Unfortunately, energy needs in other cases are not always presented on a consistent basis, often because of difficulties in defining the boundaries for energy use in systems where energy imports and exports exist. Sometimes, emphasis and comparisons are made only of process energy needs and often total energy needs are expressed as a mixture of different units which makes comparisons difficult. Under normal operating conditions, total average energy needs, including energy for operating offsites and handling facilities, for shutdowns, startups and due to maloperation, may exceed the guaranteed battery limit figures by 10 - 15%.

The TFI figures for total energy use may appear high compared with consumptions quoted for new plants, because about 70% of USA plants operating today were constructed before 1975, using technology with specific energy consumption exceeding 40 MMBtu/ton ammonia. A further 25% of existing USA capacity was constructed between 1975 and 1980, when energy consumption averaged about 35 MMBtu/ton of ammonia. A few plants have recently been refurbished to expand capacity and conserve energy, but, as a result of the relatively low gas prices in the USA in the last few years, these upgrades have not been widespread.

Table 20:

AVERAGE SPECIFIC ENERGY CONSUMPTION FOR USA AMMONIA PRODUCTION IN 1988 (000s Btu Per Metric Ton Of Ammonia)

I. RECIPROCATING PLANTS

	Natural Gas	Electricity	Steam	Total
Feedstock Energy	24,074			24,074
Reformer Process Energy	8,272	419		8,691
Other Process Energy	5,070	3,631	-396	8,305
Total Energy Consumption	**37,416**	**4,050**	**-396**	**41,070**

II. CENTRIFUGAL PLANTS

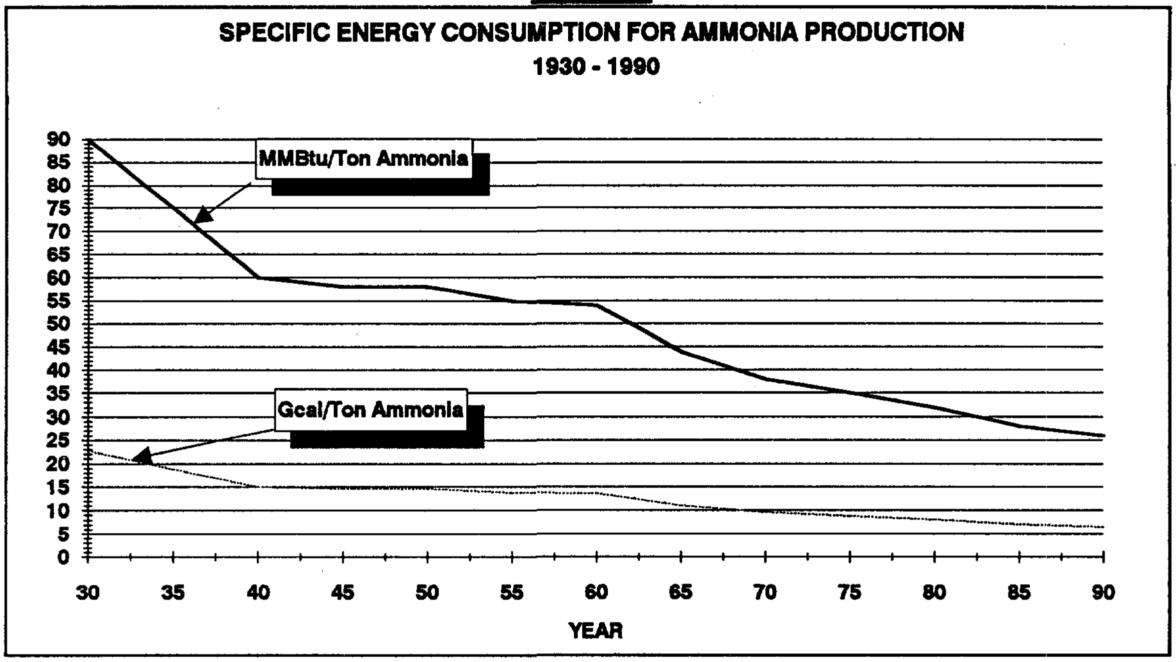
	Natural Gas	Electricity	Steam	Total
Feedstock Energy	23,929			23,929
Reformer Process Energy	12,672	4		12,676
Other Process Energy	2,373	712	-360	2,725
Total Energy Consumption	**38,974**	**716**	**-360**	**39,330**

Source: TFI

With increasing energy prices, a great deal of attention has been focused on reducing the energy needs of ammonia plants. The overall effect of process developments on reducing energy consumption is shown in Figure 30. Specific energy consumption per metric ton of ammonia has fallen from about 75 MMBtu in the early 1940s to less than 30 MMBtu for plants built after 1985. Most of the major ammonia process designers now offer low energy designs that are likely to result in energy consumptions in practice within the range 28 - 32 MMBtu/metric ton or even less.

Such designs are not the result of technical "break-throughs", but rather of an integration of a number of energy conservation features. The introduction of most of these new features does, however, increase the plant costs and also makes the plant more complex to operate. Where gas price are low, e.g. less than US$1.0/MMBtu and likely to stay so, the benefits of some of the new energy saving design features become marginal. Further major decreases in energy consumption may no longer be achievable since energy consumption for the most recent process schemes are approaching the

Figure 30



theoretical and practical levels.

E. Production Costs for Ammonia and Urea

In order to compare the economics of building and operating ammonia and urea plants under a variety of conditions, some cost models have been developed. These models are in principle the same as the IRR model that is used to appraise nitrogen fertilizer projects by the World Bank and other financial agencies. However, the models are adapted to simplify sensitivity analysis of the main process parameters. Their main purpose is to assess the total cost of production or realization price for a range of energy prices, investment costs, plant sizes and plant operating rates. The "Realization Price" is the selling price that would have to be obtained to justify a certain rate of return on investment. In this case, an IRR is assumed to be based on total investment cost containing all infrastructure needed to operate the project, including all townships, ports, railways etc. that have to be provided specially for the project. It is assumed that natural gas is used to generate other forms of energy such as steam and electricity needed to operate the process and facilities are provided to provide these utilities for grassroot projects. It is further assumed that there is an economic advantage in establishing the largest plant possible commensurate with technical and market considerations. An ammonia plant with capacity of 1,500 metric tons per day is assumed with urea capacity of 2,500 tpd to match. If required, it is also possible to use the models to examine scenarios with ammonia and urea as joint products. Conceptually, the model considers four different scenarios:

(i) **Existing Site - Developed Location**

A plant on an existing site in a developed location, where all infrastructure exists. When an additional plant is built on an existing site, significant savings may be realized, not only in infrastructure, but also in offsites. In the model it is assumed that cost of a plant on an existing site would be about 20% lower than a plant on a new site in a developed location.

(ii) **New Site - Developed Location**

It is assumed that supporting facilities such as roads, a port, railroad etc. and social structure exist. People will be available to work in the plant. Equipment can often be provided from local sources and maintained using local facilities.

(iii) **New Site - Developing Location**

Some infrastructure is established, but not as much as for (ii). It is necessary to expand port or rail facilities to meet the needs of the project. Local specialized engineering facilities will not be available.

(iv) **Developing Site - Remote Location**

There is no supporting infrastructure available. All roads, ports, railroad etc. and social amenities have to be provided as part of the project cost. All equipment has to be imported. Most of the labor to build and operate the plant will have to be brought in from outside. There is no supporting technical infrastructure available before the project. Costs for establishing the required infrastructure will be very high.

Investment costs vary a great deal depending on the basis for estimation, often on the bidding location and on the relative strengths of international currencies. It will also depend on the market situation for the construction of chemical plants.

The investment cost data used in the model are summarized in Table 21 and represent typical figures based on the investment costs of numerous ammonia/urea projects surveyed. They have been used as typical scenarios in order to develop cost and realization price figures over a wide range of conditions that may be subsequently used for comparing specific project economics within a particular cost envelope.

Table 21:

INVESTMENT COSTS FOR AMMONIA AND UREA PROJECTS

(US$ Million)

	Existing Site Developed Location	New Site Developed Location	New site Developing Location	New Site Remote Location
Ammonia Project @ 1,500 tpd NH3				
Battery Limits Incl. Offsites	170	210	230	250
Infrastructure			50	100
Total Project cost	170	210	280	350
Urea Project @ 2,200 tpd Urea				
Battery Limits Incl. Offsites	230	285	315	340
Infrastructure			75	150
Total Project cost	230	285	390	490

ENERGY REQUIREMENTS FOR AMMONIA AND UREA PRODUCTION

The cost of energy, both in the form of fuel and feedstock, is the most important component in both ammonia and urea production. In the USA for example, energy costs average about 70% of production costs. Although total energy costs for ammonia and urea manufacture in the USA currently average about 37 MMBtu/ton and 32 MMBtu/ton, respectively, as many of the plants are old , but much lower averages would be obtained from new plants.

The new low-energy ammonia plants usually operate at a total specific energy consumption equivalent to about 7.0 Gcal "High Heating Value" (HHV), i.e. about 28 million Btu per ton of ammonia. These figures would apply to battery limit consumptions under steady state conditions. In practice, average consumption would be a little higher to allow for miscellaneous energy costs outside battery limits and also for periods of non-optimal operation. In some cases where gas is very cheap, say less than $1.0/MMBtu, the use of very low-energy technologies may not be justified, as the additional energy savings may not warrant excessive investment costs.

Besides using natural gas as feedstock, some ammonia plants import several other types of energy as a fuel or for power. In a fully integrated low-energy ammonia/urea plant, gas is used to generate all requirements for additional steam and electricity and all required facilities are accounted for in the capital cost estimates.

In order to calculate total energy equivalents, the following conversions can be used:

1 US gal. residual fuel oil	=	149,690 Btu
1 lb steam	=	1,000 Btu
1 kWh	=	10,000 Btu

In the model, an average total energy consumption of 30 MMBtu per ton of ammonia has been assumed.

About 0.58 tons of ammonia are required to produce one ton of urea. Although in theory about four million Btu are required to produce one ton of urea from ammonia; in practice the figure is much higher and the TFI surveys indicate an average of around 7 million Btu/t of prilled urea: about 3.7 MMBtu is required to produce the solution and about 3.3 MMBtu for the prilling process.

Sometimes, more energy is consumed because of the need for operating scrubbing processes to comply with environmental regulations. Allowance must also may made for the handling and storage of urea. In many locations, particularly in humid climates, bulk urea must be stored in air-conditioned silos. A total energy consumption of 24 MMBtu per ton of urea (incl. ammonia production) has been used in the model.

OTHER VARIABLE COSTS

Variable costs other than feedstock and fuel, are relatively low in ammonia and urea production. Catalyst costs are usually treated as part of the raw material cost and average about US$1.0/t ammonia. Other variable costs include miscellaneous chemicals, cooling and boiler feed water and for ammonia these are assumed to average US$4.0/ton and for urea US$4.4/ton.

FIXED COSTS

The estimates for labor and supervision costs are based on information available on large ammonia and urea plants in the USA and Western Europe. In developing countries, labor rates are lower, but more people are employed so that normally labor and supervision rates do not vary widely. Annual maintenance materials are assumed to be 2% of battery limit investment costs and 1% of infrastructure costs. Management and administration costs are based on experience in the USA and West Europe.

THE IRR MODEL

The basic assumptions made in the model are as follows:

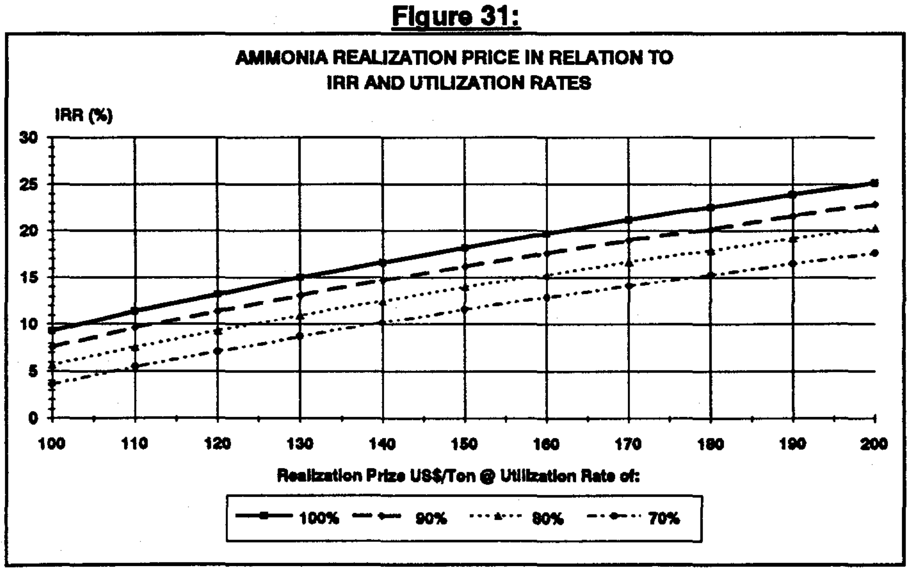
(i) Plant construction and investment will take place over 3 years.

(ii) Working capital will be built-up over 3 years. Working capital is assumed to be one month's production cost plus one month's accounts receivable.

(iii) The economic life of the plant will be 17 years (although the variation of IRR with different assumed lives is examined).

(iv) In the final year of the plant's life, a salvage value of 100% of working capital and 10% of investment cost is assumed.

Figure 31:



Typical IRR models for ammonia and urea are given in Annexes 12 and 14, respectively. Tables showing the variation of realization prices with gas costs, investment costs, plant size and utilization rates are given in Annexes 13 and 15. Summary data on realization prices are given for ammonia in Figures 31 - 34 and for urea in Figures 35 - 36. The most important parameters affecting realization price and return on investment are discussed below.

GAS PRICE

The cost of natural gas normally accounts for about 50% - 75% of total cash production costs and is an important consideration for export-based plants. The export price of ammonia and urea tends to fluctuate considerably and may occasionally reach very low levels. Under such conditions, only those with low cash costs and low energy prices can stay in business. In some cases, however, such as in Eastern Europe, plants have continued to operate despite prices lower than cash costs as part of state policies to obtain foreign exchange. In order to compete successfully in the export business, gas prices would normally have to be below US$1.0/MMBtu.

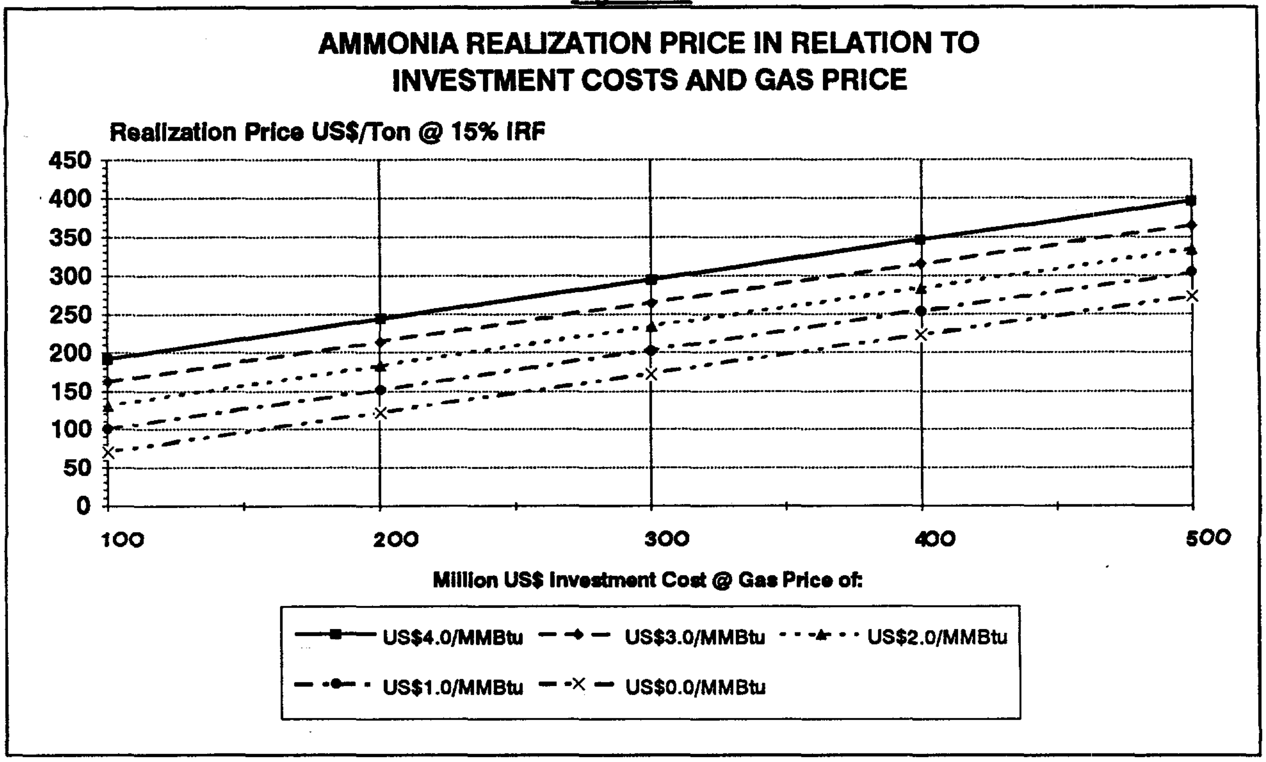
INVESTMENT COSTS

For ammonia and urea plants, the most expensive component of total cost is usually the capital charge i.e. the cost of recovering capital. If a project needs a high investment cost, particularly in those cases where considerable infrastructure is needed, the additional capital charge will far outweigh any benefits of cheap gas. For example, an increase in investment cost of US$10 million, may increase the total production cost of ammonia by US$5/ton. Considerable benefit can be gained by building an ammonia plant on an existing site, where for a large plant, such as 1,500 tpd, the benefits could be equivalent to about US$20/ton. On the other hand, a project in a remote location that requires an additional US$50 million to provide essential infrastructure would incur a penalty of about US$25/ton. The results of the analyses indicate that projects on new sites, particularly those with high infrastructure costs, are unlikely to compete successfully in the future nitrogen market.

UTILIZATION

Capacity utilization rate affects the capital charge component of total production cost and is therefore much more important in those cases where investment costs are high. For example, in a new plant in a developing location, a drop in utilization from 90% to 80% would increase the cost of capital recovery by about US$20/ton of ammonia. In a developed location, where the investment cost would be lower, the increase in cost would be correspondingly lower. Although projects are normally evaluated on the basis of operating at 90% of nominal capacity or sometimes even higher, in practice operating rates are often lower.

Figure 32

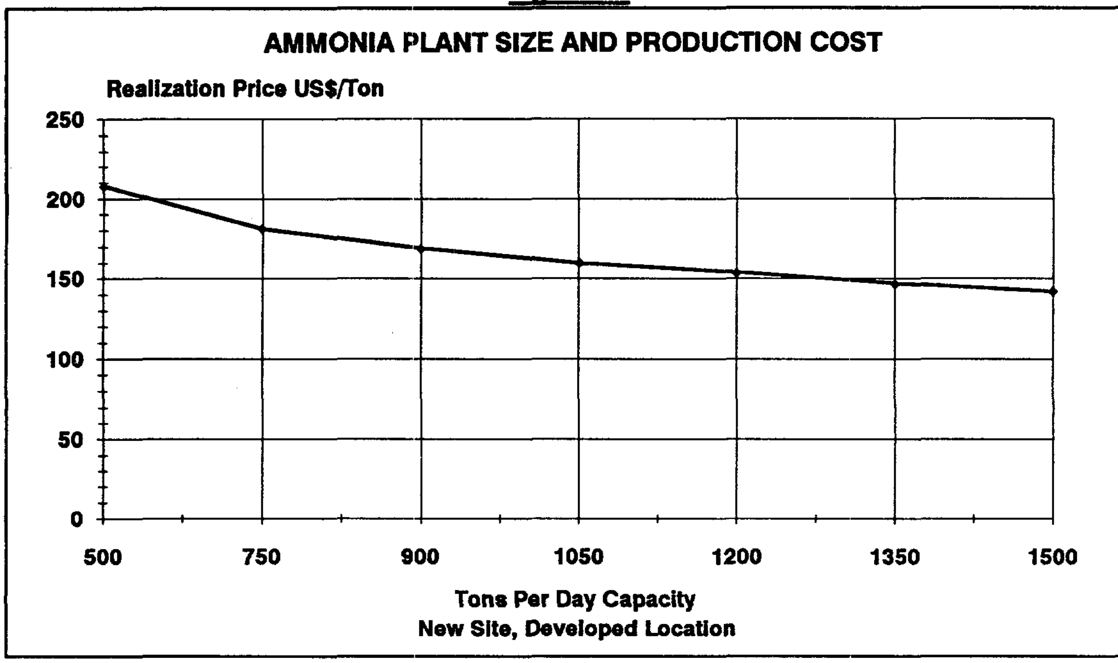


PLANT SIZE

The relationship between investment cost and plant size is not linear and there is almost always an economic advantage in larger scale plants, assuming that there is a market for the product. The disadvantage is even greater in developing locations as investment cost increases. A new ammonia plant producing at 1,500 tpd in a developing location will have a cost advantage of about US$15-20/ton compared with a plant operating at 1,000 tpd. In a developing location, the benefit should be considerably higher.

The penalties of reduced size apply mainly to a situation of a single plant on one site. Two smaller plants sharing the same offsites and management would not incur the same penalty and there may be some benefit in increased flexibility. There may be some situations in which smaller plants may have an advantage, where e.g. a market is developing slowly and production has to be phased-in gradually. However, such situations are likely to occur only rarely and it seems that the trend to large plants to achieve economies of scale will continue.

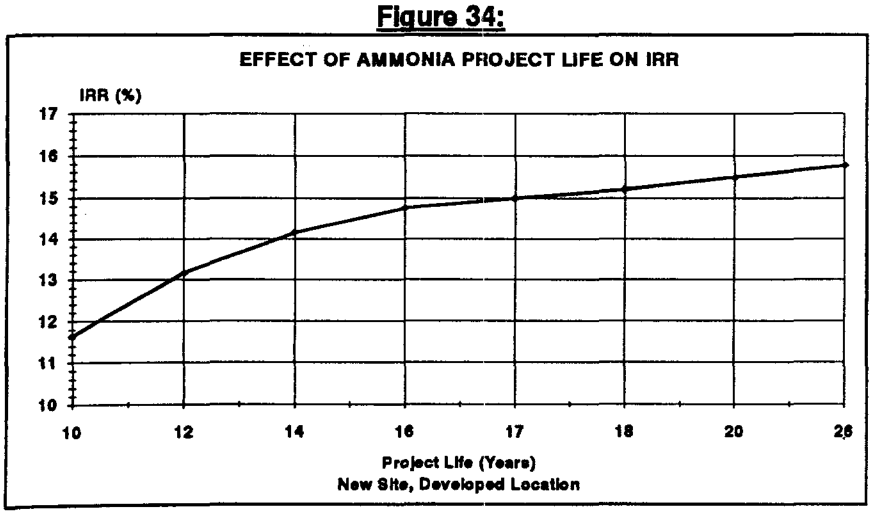
Figure 33



PROJECT LIFE

As discussed earlier, ammonia plants should operate for 20 years or more, provided they are properly operated and maintained. However, many of the older plants have been assessed on the basis of a much shorter life. Figure 34 shows how IRR varies with assumed project life. A project life of 17 years was assumed in the model. Generally, assumptions of a project life above about 15 years do not significantly affect the IRR.

Figure 34:



One important aspect of project life is the project implementation time. A delay of one year in the commissioning of a plant can have a major impact on the viability of the project. In the model, it is assumed that a well engineered project can be brought on-stream within 3 years. For a new plant on an existing site, a delay of one year may increase the total production cost by more than US$10/ton and of two years by more than US$20/ton.

On a developing site, the penalty would be correspondingly higher. Therefore, it is usually very important to avoid situations that may lead to implementation delays, such as design changes at an advanced project stage.

F. Production Costs for Ammonia with Different Feedstocks

Although natural gas is currently the most commonly used feedstock for ammonia production and is expected to remain so, there may be occasions when other feedstocks may be competitive, depending on relative energy pricing. The most important factors in determining the production costs are the relative investment and energy needs; they are shown in Table 22 and refer to a developed site.

Table 22:

RELATIVE INVESTMENT COSTS AND ENERGY CONSUMPTION FOR DIFFERENT FEEDSTOCKS IN AMMONIA PRODUCTION

PLANT FEEDSTOCK	Ratio of Investment Costs	Ratio of Energy Consumption
Natural Gas	1.00	1.00
Naphtha	1.15	1.08
Fuel Oil	1.60	1.15
Coal	2.00	1.40

Although there is much information available on the investment and production costs of gas-based processes, information on comparable up-to-date processes for different feedstocks is not so readily available, because very few other types of processes have been built in recent years. It has been assumed that certain improvements in energy conservation have taken place relative to what has been achieved in gas-based plants. Equivalent energy prices which have been used in the comparison are given in Table 23.

Table 23:

EQUIVALENT ENERGY PRICES FOR DIFFERENT FUELS

Natural Gas US$/MMBtu	Naphtha US$/Ton	Fuel Oil No. 6 US$/Ton	Coal US$/Ton	Crude Oil US$/BBL
1.0	44.8	41.9	25.1	7.1
2.0	89.6	83.8	50.2	14.2
3.0	134.4	125.7	75.3	21.4
4.0	179.2	167.6	100.4	28.5
5.0	224.0	209.5	125.5	35.6
6.0	268.8	251.4	150.6	42.6

The advantage of natural gas as a feedstock is apparent from Tables 23 and 26, which indicate the comparatively low energy and investment costs.

Figure 35

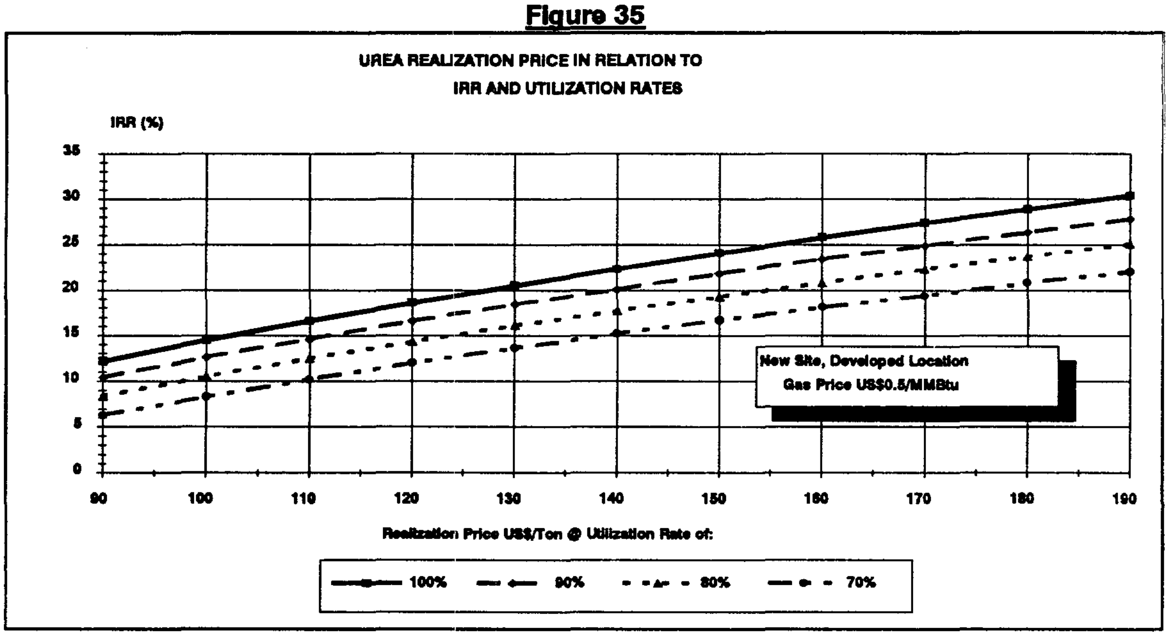
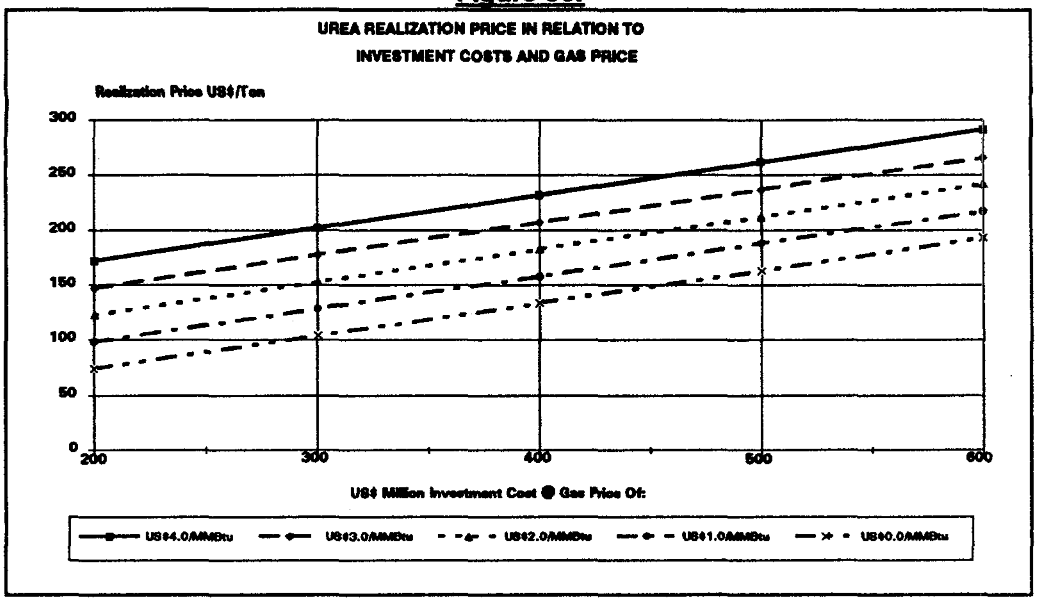


Figure 36:



IX. ECONOMICS OF INTERNATIONAL FERTILIZER TRADE

A. Natural Gas Prices

Besides being dependent on nitrogen fertilizer demand, the international fertilizer trade also relies on the relative economics of producing fertilizers in different regions and this in turn depends to a large extent on the cost of natural gas. Natural gas reserves are widespread throughout the world but, with the main deposits in the USSR, West Asia and North America. There are probably more than fifty countries that have potential reserves to develop an ammonia industry and about half of these are already producing ammonia.

One of the most important factors determining the feasibility of ammonia production in any country is the economic (opportunity) value of natural gas. This can vary significantly from location to location depending on the size of the resource and the opportunity for alternative uses. If gas can be used as a substitute for oil, its economic value should be linked to fuel oil. However, in many cases, particularly energy-rich developing countries, oil substitution is not available and the value of gas, particularly gas that is being flared, is often very low. The price of natural gas for the major producing companies in the world is reviewed below.

AFRICA

The ammonia producers from natural gas in Africa are Egypt, Algeria, Nigeria and Libya. Only limited information is available on gas prices in these countries, but prices are believed to be low. Ammonia production in South Africa is based mainly on coal and so the equivalent energy cost is relatively high. There are several countries with reserves of natural gas that have considered ammonia production. Although gas for these projects has been offered at very low prices, i.e. below US$0.5/MMBtu, the very high investment costs required to finance the projects have so far prevented further developments in countries including Tanzania, Mozambique, Cameroon and Angola.

NORTH AMERICA

Ammonia is produced mainly in two regions in North America, both based on the availability of relatively cheap natural gas. In the USA, ammonia is produced in large quantities in Louisiana, Oklahoma and Texas. In Canada, a major nitrogen industry has developed that is based on cheap natural gas in the Western Provinces.

The natural gas market in the USA operates more or less independently of the oil market and, over the last ten years, has been able to offer its customers a cheaper source of energy than fuel oil. This is due to an ample supply (often referred to as the "gas bubble"), aggressive competition between gas suppliers and a large interregional pipeline network. Average natural gas prices based on the TFI Annual Survey are shown in Table 24.

Table 24:

NATURAL GAS PRICES FOR USA AMMONIA PRODUCTION (US$/MMBtu)

Year	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Gas Price	1.14	1.34	1.62	1.96	2.33	2.4	2.34	2.68	2.65	1.83	1.65	1.85	1.87	1.81

During the Middle East crisis and the resulting rise in oil prices, natural gas prices in the USA remained below the levels of the preceding year and it looks as if the average price for 1991 will be even lower than 1990 as prices in February-May 1991 were in the range US$1.25-1.30/MMBtu. USA ammonia producers buy gas on a spot price basis or contracts tied to spot prices. Delivered prices include distribution costs that have to be added to spot prices. Gas is distributed to other regions in the USA from the Gulf Coast, Texas and Oklahoma. Distribution costs can add up to US$0.5/MMBtu. The USA also receives some gas for ammonia production from Canada.

In Western Canada, natural gas is available in Alberta, British Columbia and Saskatchewan. The largest resources are in Alberta, where gas prices are lowest and most ammonia capacity is situated. Eastern Canada receives gas from the western parts by the Trans-Canada pipeline and prices are therefore higher, as indicated in Table 25.

Table 25:

NATURAL GAS PRICES FOR CANADIAN AMMONIA PRODUCTION

(US$/MMBtu)

Year	1987	1988	1989	1990
Gas Price				
Western Canada	1.16	1.21	1.35	1.32
Eastern Canada	2.08	2.06	2.17	2.13

Natural gas prices have remained low during 1991 and average prices are likely to be lower than those in the preceding year.

CENTRAL AMERICA

Mexico is the largest producer of ammonia and urea in the region, although plans to add new capacity were shelved due to the country's economic problems. Ammonia is made by PEMEX, the national oil company and sold to FERTIMEX, the national fertilizer company that converts it into urea. In some cases, ammonia and carbon dioxide required for urea production have to be pumped over several miles and this makes integration of plants difficult and expensive. There is some doubt in Mexico about the future availability of both associated and non-associated gas and prices of natural gas are reported to have moved up to more than US$2.0/MMBtu. However, the cost of gas to PEMEX's ammonia plant is only about US$0.5/MMBtu and this is reflected in the transfer price of ammonia to FERTIMEX. With assistance from the World Bank, the Mexican Government is planning to restructure and privatize the domestic fertilizer industry and as part of this program, the price of gas for ammonia manufacture is expected to increase to a level commensurate with market prices of gas elsewhere in the country.

The second largest producer and the largest exporter of ammonia in the area is Trinidad, where ample supplies of gas are available for ammonia production following the commissioning of the Pelican Field. Several companies are examining the possibility of new plants, but most are deterred by rising gas costs and tough contractual terms set by the government. Natural gas for Trinidad's ammonia plants is purchased from the natural gas producers by the National Gas Company (GASCO) and re-sold to ammonia producers on a negotiated delivered price. Prices in 1991 are reported to be in the range US$1.1-1.4/MMBtu. At this level and after taking into account ammonia transport costs, producers in Trinidad feel they have little or no advantage over producers in the USA. Discussions on easing the pricing formulae are in progress, but no indication on their likely outcome could be obtained.

SOUTH AMERICA

Significant reserves of natural gas are known in several countries of Latin America, such as Argentina, Bolivia, Brazil, and others. Several export-based projects have been examined in these countries, but the large investment and transport costs for the products have halted project developments, even though in some cases gas prices below US$0.5/MMBtu were indicated. The only country that is developing a nitrogen export business is Venezuela. In 1991, the Venezuelan company Nitroriente and the Norwegian company Norsk Hydro were examining a joint venture for an export-based 1,500 tpd ammonia plant with a gas price in the order of US$0.5/MMBtu. Recent information indicates, however, that this project is unlikely to proceed.

WEST ASIA

All export-based plants in the Arab Gulf area are believed to be paying US$0.5/MMBtu or less. With ample supplies of gas in the region and few alternative opportunities for use, the various governments in the region have set attractive prices to encourage investors. In the past, prices have generally been fixed at low levels without escalation.

SOUTH ASIA

India is the largest producer of ammonia in this region and about half of the feedstock used is natural gas. It is difficult to assess the true cost of producing ammonia and the price of gas, as a result of the pricing and production cost structure applied under the "Retention Price Scheme". Under this scheme, producers have to pay a high cost for gas, around US$3-4/MMBtu at December 1991 exchange rates, while receiving several cost benefits from the government. The benefit of the high gas cost is realized by the gas producers. For this reason, the use of fuel oil or naphtha for ammonia production may sometimes appear more favorable in India than elsewhere. Ammonia producers in Bangladesh and Pakistan are believed to be paying about US$1.0/MMBtu for gas.

EAST ASIA

Although half of China's ammonia production is based on coal, the portion based on natural gas is increasing and will continue to do so in the future. There are no standard prices for natural gas as they tend to vary by province and allocation criteria, but are normally in the range US$1.5 - 2.0/MMBtu.

The second largest producer in the region is Indonesia, where ample supply and favorable gas pricing have helped develop a major industry supplying both domestic and export markets. The existing plants were based mainly on a gas price of about US$0.6/MMBtu, but the Indonesian Government has indicated that prices for new plants will be higher, probably in the order of US$1.5 - 2.0/MMBtu.

Malaysia operates a major plant at Bintulu, which, in line with other ASEAN plants, pays a gas price of US$0.6/MMBtu. Japan has no natural gas reserves and depends on naphtha, LPG and coal for feedstocks which are obtained at prevailing world market prices.

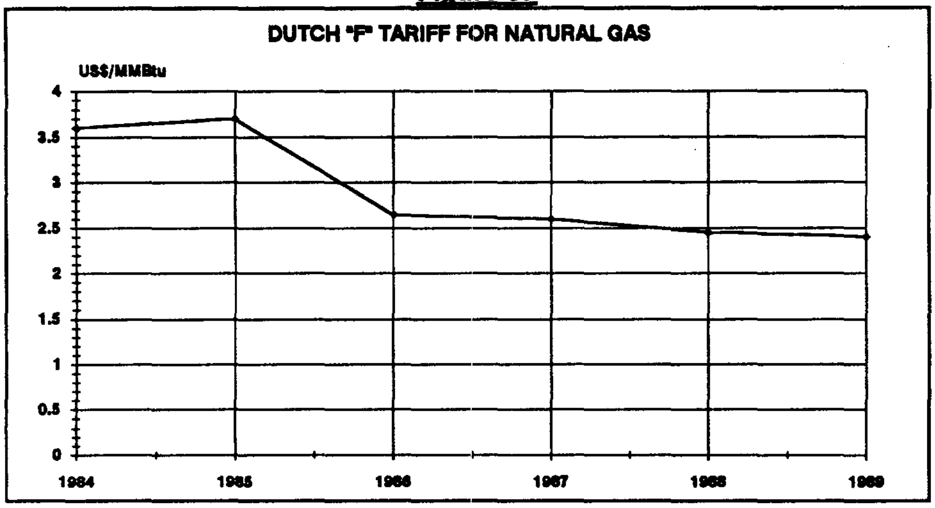
WESTERN EUROPE

Gas pricing for ammonia production is determined mainly by the Dutch "F" tariff, which refers to the price charged by Nederlands Gasunie, the Dutch state monopoly, to large industrial customers in Holland, who use it mainly for ammonia and methanol production. Since 1983, the Gasunie has used a system in which gas prices are determined quarterly and are related by a formula to the average price of fuel oil in Rotterdam. Figure 37 shows the Dutch "F" tariff since 1984.

Other European countries are closely aligned with the Dutch "F" tariff for natural gas. French and Belgium pay Dutch "F" tariff prices plus the cost of transport from the border to the factory.

In Germany, there is no state gas monopoly and the main gas supplier is Ruhrgas. The largest customer is BASF, Ludwigshafen, and in order to improve its position, BASF, through its subsidiary Wintershall, will build a pipeline to bring gas from Emden at the North Sea to Ludwigshafen. This has

Figure 37



strengthened the position of BASF and allowed it to negotiate contract prices closer to the Dutch "F" tariff.

The situation of natural gas supply to former East Germany has been changing since the reunification. In 1989, about half of the natural gas supply came from the Soviet Union. Currently, supply sources are being augmented to include gas from the new Wintershall pipeline.

Ammonia producers in the UK are supplied by British Gas and although this is no longer a state monopoly, it still retains its dominant position as British ammonia producers have no other source of feedstock. Gas prices are not so closely tied to oil prices as in continental Europe and, on average, prices tend to be a little higher than the Dutch "F" tariff.

Until recently, natural gas prices in Ireland were the lowest in Europe and determined by a basic price related to inflation, but have been adjusted and are now in line with prices elsewhere in Europe.

In Italy, gas prices are also related to fuel prices although by a rather different formulae based on lower grade oil and much shorter lag between oil and gas prices.

None of the four Scandinavian countries uses natural gas for the production of ammonia. Although Norway has the largest reserves of natural gas in Europe, all gas produced in the North Sea is piped to the UK and mainland Europe.

Gas prices prevailing at the beginning of 1991 in West Europe are given on the next page.

COUNTRY	US$/MMBtu
Netherlands	3.30
Belgium	3.40
France	3.50
Germany	3.60
UK	3.40
Italy	3.85

Lower gas prices were reported for the second and third quarter of 1991 due to a fall in oil prices.

EAST EUROPE

In recent years, the countries of East Europe have depended heavily on imports of natural gas from the USSR. The eight countries formally comprising East Europe, imported more than 50 billion m^3, comprising more than half their consumption, from the USSR. The political and economic changes in the region have had a major impact on gas trade as gas prices have increased in all these countries. Since January 1991, the USSR has required payment in hard currency for gas exports although reported settlements in the various countries vary somewhat.

Hungary appears to be the hardest hit, with producers facing a 75% price increase from US$2.2 up to US$3.9/MMBtu. Arrangements in other countries are lower. Bulgarian producers are paying as little as US$2.0/MMBtu and prices in Romania are believed to be at levels between US$2.0 - 2.5/MMBtu. Producers in Yugoslavia and Poland have been paying around US$3.5/MMBtu since the beginning of 1991.

USSR

No firm data are available on gas prices in the USSR. It is known, however, that gas prices were increased in both 1990 and 1991. Analysts have generally assumed a national cost of gas in the USSR of around US$0.5/MMBtu. In late December 1991, the Russian government announced that under its price liberalization policy, gas price increases would be limited to 500%. A gas price of US$2.0/MMBtu might now seem more appropriate.

Generally, the most serious problem for the USSR, and hence for East Europe, will be to maintain an adequate gas supply despite serious labor problems in Siberia and elsewhere in the country. GasProm, the Soviet state gas producer, expects that, compared with 1990, gas supply will fall by about 12-15% in 1991. Soviet as well as East European gas users have been advised that deliveries at previous levels cannot be guaranteed any longer.

B. Outlook for Fertilizer Freight Rates

FREIGHT RATES FOR UREA

The freight rates used in this report are based on prices prevailing in late 1991. Generally, as freight costs for urea fall under the dry bulk heading, they are expected to follow that market. However, other factors will also have an influence, such as the demand for ships for grain and coal transport, fuel oil prices and the addition of new capacity. In estimating the freight costs for urea, consideration has to be given to the specific markets, their ability to handle different size ships and whether or not ships can have multiple destinations or carry multi-cargoes. Although freight rates will fluctuate over the next decade or so, in real terms they are expected to average those assumed in Annex 17.

FREIGHT RATES FOR AMMONIA

The evaluation and projection of ammonia freight rates is much more complicated than for urea as it depends on a very specific part of the shipping fleet - the gas carriers, which are a relatively small portion of shipping, specifically designed to carry chemical gases, such as LPG and ammonia. In total, the ammonia/LPG fleet comprises about 150 semi- and fully refrigerated vessels, but there are only about 75 vessels dedicated to the deep sea transportation of ammonia. As ammonia world trade reached more than 11.5 million tons in 1990 with only 75 vessels available, the market may become very volatile, particularly as there is also competition from the LPG market for these vessels. As demand for vessels increased, freight rates on a typical run from the USSR to the USA Gulf in a 35,000 ton vessel have increased from US$25/ton in 1986 to US$73/ton in early 1989 and dropped to about US$60/ton by mid-1991.

As the LPG fleet is relatively old and in need of some replacements, there is currently a significant increase in the construction of new gas carriers. The most important question for the future outlook on freight is whether the new capacity will be balanced with the increase in trade of ammonia and LPG. Recent studies by the shipping analysts Purvis and Getz aimed primarily at the LPG market, suggest that the current shortage of shipping capacity is impeding trade and will continue to do so in the 1990s, but probably at a lower rate. Drewry Shipping Consultants also share this view and feel that although the peak for LPG rates has passed, the freight market is unlikely to exhibit a strong down-turn. On the other hand, according to "World Trade in Liquefied Petroleum Gases 1980-2000" - a study published recently by Poten & Partners, over-tonnaging could adversely affect the charter market for medium and large LPG carriers in the first half of the 1990s. Ship owners may have been over-optimistic in their assessment of demand, resulting in excessive addition of new vessels.

Growth in ammonia trade is expected to decline slightly over the next few years and then increase again after 1995. The decline in nitrogen demand in Europe could mean less exports into that region. This assumes that oil prices remain stable and European capacity can compete with imports. It is likely that the USSR, the worlds largest exporter, may have to limit ammonia exports because of problems with the supply of natural gas.

Freights rates are not expected to rise until the second half of the decade as demand expands and older vessels are scrapped. Taking these various views into account, it is assumed that freight rates overall will decline slowly in real terms over the next few years and then recover to current levels during the second half the 1990s. This projection been taken into account in the figures for ammonia freight shown in the "delivered cost matrix" in Annex 16.

C. Trade Practices for Nitrogen Fertilizers

As the international nitrogen fertilizer market has expanded, there has been tremendous growth in the number of traders. For most of the existing or former centrally planned countries, nitrogen fertilizers are bought or sold through central agencies such as shown on the next page.

Bulgaria		Chimimport
Czechoslovakia		Petrimex Foreign Trade Co.
Hungary		Chemolimpex
Poland		CIECH Import and Export
USSR		SOYUZ
China		SINOCHEM

It seems likely that with the economic reforms taking place in Eastern Europe and China and the break-up of the Soviet Union, the arrangements for importing and exporting will be widened.

As part of "perestroika", those ammonia factories in the USSR that had fulfilled their quotas were allowed to sell their surplus production independently of SOYUZ. In 1989, considerable exports through this route, often in the form of counter trade through western traders, contributed to a major decline in prices and an attempt by SOYUZ to limit these sales. In September 1991, Soyuzagrochimexport was transformed into a joint stock company under the name Agrochimexport representing 40 fertilizer companies with export potential, mainly in the Russian Republic and the Ukraine. At the end of 1991, these two countries announced the setting up of two additional agencies, called Russagrochim and Ukrainagrochim, to handle fertilizer exports from the two republics. Their relationship with Agrochimexport is not yet clear, but it is believed that Agrochimexport will be mainly concerned with government to government contracts.

A growing tendency in China for its provinces to purchase independently has led to some overlapping of urea purchases.

Elsewhere, there are two major trade associations in the nitrogen field. In West Europe, most offshore sales of nitrogen are made by NITREX representing West European producers. In India, purchases of ammonia and urea are made through the Minerals and Metals Trading Corporation of India Ltd (MMTC). Although there are several trade associations selling phosphates, potash and sulfur in North America, there are none for nitrogen.

There are certain import tariffs on fertilizer intermediates and products into the EEC:

Product	Percent ad Valorem on CIF
Ammonia	11
Urea	11
AN/CAN	8

However, certain key suppliers of imports to Europe have tariff exemptions under the Lome Convention, notably Trinidad in nitrogen. In addition, following claims of dumping of nitrogen products a few years ago, import quotas were imposed on East European exporters. The EEC commission has recently agreed to suspend quantitative restrictions on fertilizer imports from Bulgaria, Czechoslovakia and Romania through 1991. The earlier suspension of quota restrictions for Poland and Hungary has also been extended to the end of 1991.

D. Comparison of Delivered Costs for Nitrogen Fertilizer Projects

In order to assess the competitiveness of new ammonia and urea projects in the future, some matrixes have been set-up that estimate the delivered cost of product from new plants into the major markets word urea markets. These are East Asia (mainly China), South Asia (mainly India), West Europe and the USA. Several locations, where natural gas is available, have been assumed as potential locations for new ammonia and urea projects. Where plants are already operating, costs are estimated on the basis of an existing site.

The total cost of producing ammonia and urea has been estimated from the models given in Annexes 12 and 14 and includes a capital charge equivalent to 10% IRR in one case and in the other case 15% IRR, based on the total investment cost. Freight and handling costs are added to obtain the delivered cost in each market place. The detailed matrixes for urea and ammonia are given in Annexes 16 and 17 and are summarized in Tables 26 and 27.

Table 26:

DELIVERED COST COMPARISON OF POTENTIAL EXPORT-BASED AMMONIA PROJECTS

(US$/Ton Ammonia)

New Plant Built on Existing Site

Location	USA	Netherlands	USSR	Venezuela	Saudi Arabia	Indonesia
Total Delivered Cost @ 15% IRR						
USA Gulf Port	167	235	208	157	204	235
N.W. Europe	194	208	183	164	194	225
India	232	268	223	202	184	195
China	237	288	238	207	214	195

New Plant Built on New Site

Location	USA	Netherlands	USSR	Venezuela	Saudi Arabia	Indonesia
Total Delivered Cost @ 15% IRR						
USA Gulf Port	186	255	247	197	246	275
N.W. Europe	213	228	222	204	236	265
India	251	288	262	242	226	235
China	256	308	277	247	256	235

Table 27:

DELIVERED COST COMPARISON OF POTENTIAL EXPORT-BASED UREA PROJECTS

(US$/Ton Urea)

New Plant Built on Existing Site

Location	USA	Netherlands	USSR	Venezuela	Saudi Arabia	Indonesia
Total Delivered Cost @ 15% IRR						
USA Gulf Port	132	180	155	124	153	175
N.W. Europe	148	164	140	130	137	177
India	174	200	156	156	135	147
China	166	210	166	148	143	145

New Plant Built on New Site

Location	USA	Netherlands	USSR	Venezuela	Saudi Arabia	Indonesia
Total Delivered Cost @ 15% IRR						
USA Gulf Port	149	199	190	160	194	215
N.W. Europe	165	183	175	166	178	217
India	191	219	191	192	176	187
China	183	229	201	184	184	185

Updated estimates of delivered costs show in this survey that in real terms the total costs have declined, when compared with the estimates presented in World Bank Technical Paper No. 59. The main reasons for the decline are:

(i) There has been a significant reduction in energy needs for new ammonia and urea plants.
(ii) World energy costs in real terms are lower than five years ago.
(iii) Much larger plants are now available that show considerable economies of scale.
(iv) Plant construction times have been reduced.
(v) Longer plant life is expected.
(vi) In real terms, engineering costs for plants have declined.

The total production costs listed in Annexes 16 and 17 and integrated into the data shown in Tables 26 and 27, are for new projects built and operated under optimal conditions. Nevertheless, these conditions must be achieved if plants are to compete successfully in the future.

The comparisons show that a plant in the Caribbean area with cheap gas would be in a very good position to compete in various regions of America and also in Europe. The USSR is also well placed to compete in these markets on the basis of a gas price of US$1.0/MMBtu. Although Arab Gulf countries, such as Saudi Arabia, would be relatively low cost producers on an FOB basis, the relatively high cost of shipping ammonia over long distances would put them at some disadvantage in the USA and European markets.

With natural gas in the USA at its current relatively low level of less than US$2.0/MMBtu, the USA is competitive with most imports other than those based on low-cost gas in Central America. Although not included in the detailed comparisons, it is appreciated that Canada is also in a good position to compete in certain parts of the USA market, particularly from plants in Alberta and Saskatchewan based on low-cost gas. Although the relatively high cost of transportation would make Canadian products expensive in the USA Gulf area, they can compete successfully in many northern USA states.

In the South Asian market, the Arab Gulf producers are the most competitive due to comparatively low freights, although Indonesia is also well placed. It should be noted that new Indonesian projects are based on a relatively high cost gas of US$1.5/MMBtu or more as proposed by the Indonesian Government for new projects. Although Indonesia should still be able to compete well in countries like China and India at this gas price, a lower price would make Indonesia the most competitive ammonia supplier to the whole East Asian region.

In the case of urea, freight costs are not as important as for ammonia as the market is much wider, because of the lower requirement for special terminals. The Arab Gulf producers become relatively more competitive in Western Europe and the USA and are among the most competitive suppliers to China.

X. NITROGEN FERTILIZER PRICES

A. General

Ammonia and urea prices have fluctuated widely over the last several decades. Many analysts have tried to relate these fluctuations to several factors, such as supply and demand balances, grain prices, energy prices etc. in the hope of understanding the structure of the market and developing analytical tools that allow the prediction of future prices. However, no one single parameter has shown any significant correlation over an extended period of time, although more promising results have been obtained using econometric models involving a large variety of factors. One example of such an econometric approach is the World Bank's "Integrated Agricultural Fertilizer Model".

In a perfect market, prices will be determined by the forces of supply and demand. However, the international fertilizer market is far from a perfect market and, in general, the major factors distorting the market are:

(i) The limited number of buyers and sellers.
(ii) Limited entry or exit of producers to and from the industry.
(iii) Long term lags in adjustment to equilibrium.
(iv) Imperfect knowledge of market conditions.
(v) Effect of counter trade and barter deals.

The world fertilizer markets have always been dominated by a small number of buyers and sellers, although the various players have changed over time. At the present time, nitrogen exports are dominated by the USSR and imports by China.

As it may be excessively expensive for a new investor to enter the nitrogen fertilizer industry and in view of the high capital charges on new production capacity, there is always a wish to operate existing plants at high rates. Furthermore, since it is also very costly to close plants or maintain them in an idle condition, there is a reluctance to do this.

There is always a long time lag in adjusting to a market equilibrium in the fertilizer industry. The lead time to plan and implement a new fertilizer plant in a developing country can take five to seven years, so that indigenous supply can only reply to market signals after a considerable delay. The industry is characterized by a major price cycle of about 6-8 years, which, to some extent, follows the investment cycle.

Imperfect knowledge at the trading level can have a major impact on fertilizer prices. With a market that has become increasingly competitive among fertilizer traders, it is the perception of market conditions rather than actual conditions which determine the buying and selling patterns of fertilizers. If buyers perceive a shortage in the market and react in a panic manner to cover themselves, prices will increase much more rapidly than economic conditions would dictate. Likewise, if suppliers also react in a hasty manner to unload stocks, because they perceive a weakening of the market, this can also bring prices down quickly. It was mainly the psychological reaction to a perceived food and fertilizer shortage that made fertilizer prices double in price in 1974. There would have been no major shortage of fertilizers at that time, if off-take had been in a reasonable and regular manner.

Fertilizer prices are also exposed to other factors including counter-trade and bartering arrangements, tariffs and quotas maintained on particular products in some markets, and exchange rate variations. As international fertilizer prices are quoted in USA dollars and the dollar has been fluctuating widely in recent years against many currencies, the abilities of countries and farmers to buy fertilizers or raw materials have also varied, leading to further price instability in the market.

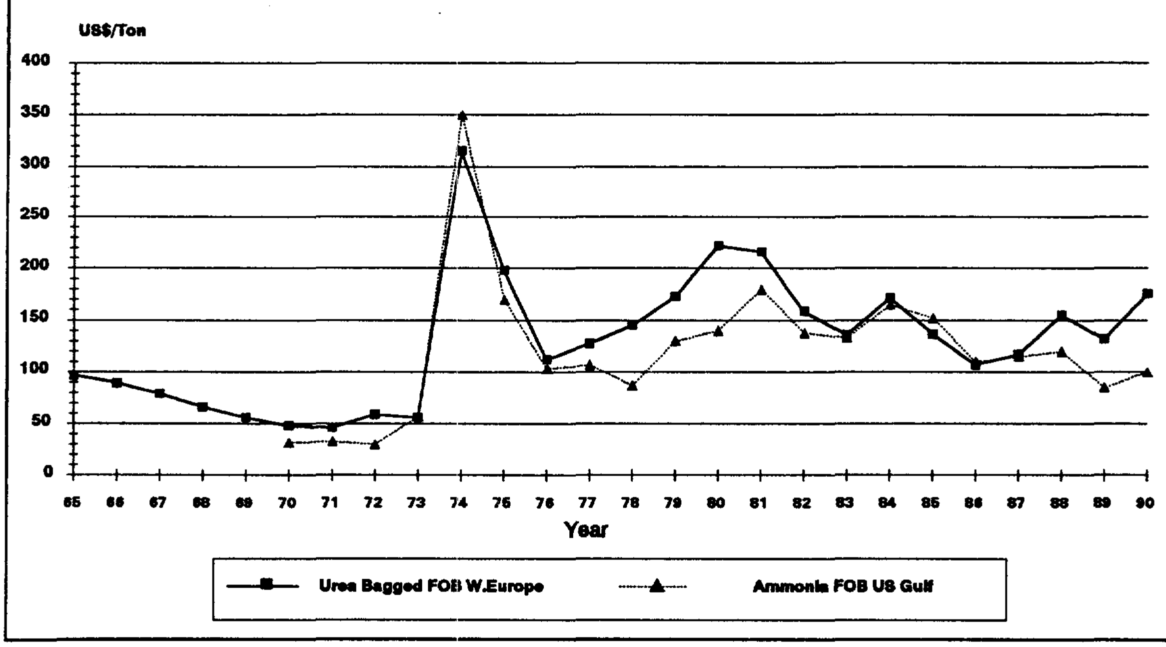
B. Historical Ammonia and Urea Prices

The prices of ammonia and urea, the two main nitrogen products traded internationally, have varied widely both in absolute and also in relative terms over the last two decades. Following the major investments in the late 1970s, there has been a large surplus supply situation that has depressed prices. Large exports of both ammonia and urea from Eastern Europe, at very low prices to gain hard currency and increase market share, resulted in a steady decline in fertilizer prices through the early years of the 1980s.

In 1984, it appeared that the bottom of the price cycle had been reached and prices started to rise again after a revival of demand in 1984/85, but prices declined again in 1987 with urea reaching a new low in real terms. A significant improvement in nitrogen prices followed during 1988 and expectations for 1989 also looked good with prospects of a major increase in USA demand due to increased plantings. However, poor weather constrained fertilizer use and prices tumbled as traders and producers unloaded high stocks. A new record low in constant dollar terms for urea was reached in August 1989, when Arab Gulf prices fell to less than US$60/ton. Ammonia prices also fell to a similar level. Subsequently, ammonia and urea prices increased steadily through the first half of 1990 as a strong demand developed for both urea and DAP in China and for urea also in other Asian countries. By mid 1990, urea FOB prices in the Near East had increased to US$135/ton and ammonia prices to about US$98/ton. At the end of 1990, following the crisis in the Arab Gulf, urea prices from East Europe had increased to about US$145/ton and ammonia to US$120/ton FOB US Gulf. However, there were indications that some of the tightness in the ammonia market was slackening. Long-term historical price patterns for urea and ammonia are shown in Figure 38.

Figure 38

HISTORICAL AMMONIA AND UREA PRICES
1965 - 1990



As 1991 progressed, ammonia prices softened initially, as producers in the Arab Gulf unloaded stocks, but then increased again as buyers looked for other sources to meet their needs. In other regions, the impact on ammonia prices was not so great. In the USA, relatively low gas prices favored ammonia production and in Western Europe, a return to stable oil prices made ammonia production more attractive .

Following the cease fire in the Gulf War, both urea and ammonia prices fell, but in the second half of 1990, with increased purchases from China and India, prices increased steadily. During the second half of 1991, as Chinese purchases slowed down, urea prices declined. Ammonia prices also fell, but stabilized towards the end of the year.

C. Future Ammonia and Urea Prices

In order to examine the longer term demand for fertilizers in a more systematic way, the International Commodity Markets Division of the World Bank has developed an integrated agricultural/fertilizer model that derives fertilizer demand explicitly from that of grain production. Long term prices are projected on the basis of a long term supply/demand equilibrium assumption in the fertilizer model. The price projections take into account the industry's investment and production behavior in response to fertilizer prices, the crop prices and production projections and expected movements in exchange rates and interest rates. Using the model, price projections have been made for the main fertilizer materials through the year 2000.

World Bank projections are only prepared for urea and expressed in 1985 constant US$, which makes comparison with other forecasts difficult. Historically, the Bank's projections have been based on bagged urea FOB West Europe, whereas the real yardstick today for prices is bulk urea East Europe.

Table 28:

UREA FERTILIZER PRICE FORECASTS

Year	1991	1992	1993	1994	1995	2000	2005
Urea (1)	170	180	190	200	210	243	273
Urea (2)	121	125	126	127	127	120	112
Urea (3)	140	154	163	177	186	201	240
Urea (4)	140	151	157	164	165	145	163

(1) Source: World Bank, current US$, bagged FOB West Europe
(2) Source: World Bank, constant 1985 US$, bagged FOB West Europe.
(3) Source: World Bank, current US$, adjusted bulk FOB East Europe.
(4) Source: World Bank, constant 1991 US$, adjusted bulk FOB East Europe.

Some new price projections have been made in this report with adjusted World Bank forecasts on a

1991 constant US$ basis and are given in Table 28.

Some other price forecasts have been developed, based on the assessment of the nitrogen outlook outlined in this report. Three scenarios are investigated and it is assumed in all scenarios that nitrogen fertilizer prices will depend mainly on developments in the USSR, the world's largest exporter of ammonia and urea. Generally, the view is taken that the relative impact of both fertilizer supply and domestic demand will not result in any constraint on export supply, although the break-up of the Soviet Union will result in many problems for the region in terms of gas supply and distribution. The scenarios chosen refer to the impact of oil prices on prices of nitrogen fertilizers.

OIL PRICE SCENARIOS

The major cost component of ammonia production is the cost of energy, both as a fuel and a feedstock. Generally, analysts expect that stable oil prices will prevail and the stabilization of oil prices after the recent Gulf War supports this view. Nevertheless, the prospect of an increase in oil prices could occur and it is important to assess what impact this would have on the nitrogen fertilizer industry.

An escalation of oil prices may not affect ammonia feedstock prices in the same way. In some cases, where the feedstock costs are directly related to oil prices, the impact would be proportional. The main case, where feedstock costs would be directly related to oil prices would be for oil-based and naphtha-based plants. This would affect about 10% of world ammonia production. Additionally, it would also involve those plants, where gas prices are directly related to oil prices, such as Western Europe, India, etc. and , to an increasing extent, Eastern Europe. It is estimated that, in total, about 30% of world ammonia production would be affected.

In some cases, such as the USA, where gas is the main feedstock, the natural gas and oil markets operate more or less independently and this relationship is expected to continue for some time.

About 45% of world ammonia capacity, mainly that in West Asia and South Asia, the former USSR and Latin America, is based on gas with an opportunity cost basically equal to the cost of collection, sweetening and distribution. In these cases, the cost of gas is cheap and will remain cheap. Most of the world nitrogen export market is based on this type of gas. World reserves of natural are very large and in particular there are many developing countries throughout the world that are in a position to provide cheap natural gas. Many new large plants will be built on existing sites to benefit from cheap gas and economies of scale and will be able to produce nitrogen fertilizers cheaply. Therefore, long term nitrogen fertilizer prices are not expected to rise significantly.

Effect of High Oil Prices on Nitrogen Fertilizer Prices

To a large extent, nitrogen fertilizer prices depend on the cash costs of the high cost producers. The most important region to be affected by high oil prices would be Europe, where feedstock costs are almost always related to oil prices. With Brent crude oil prices of US$20/BBL, the average cash cost of ammonia produced in Europe is about US$130/ton. If current oil prices doubled based on recent gas pricing policies, the cash cost of ammonia would increase to about US$230/ton. If oil prices did rise significantly, the European industry would no longer be competitive and plants would be forced to close; ammonia prices would further increase with reduced ammonia availability.

In the USA, a major increase in oil prices would force gas prices upwards, but not to the same extent. If it is assumed that gas prices double as a result of a doubling of oil prices, the total cash cost of ammonia production would increase from about US$90/ton to about US$160/ton.

Low Oil Price Scenario

Some analysts believe that, with large oil stocks and increased capacity in Saudi Arabia, oil prices may fall in the future even perhaps to a level of US$10/ton. Although such a scenario may not be very likely, it is interesting to examine its implications. The impact of such a low oil price would be felt mainly in Europe, where the equivalent gas price would drop to US$1.5/MMBTU and the average cash cost of ammonia production would fall to about US$80/ton On such a basis, existing ammonia capacity in Europe would be able to compete in the domestic market with any new or existing ammonia plants overseas. As a result, the closure rate of ammonia plants in Europe would slow down. Overall on an international basis, there would be a stabilization of both ammonia and nitrogen fertilizer prices.

However, with the development of a much tighter nitrogen supply and demand balance, international ammonia and urea prices are becoming more dependent on availability of supplies rather than cash costs. Although lower oil prices will delay price increases, the market has now approached a balanced situation, in which prices are likely to rise - even with low oil prices, until new capacity can be justified. In 1991 an FOB urea price of about US$ 150/ton would be sufficient to entice new production in certain favorable locations. A forecast of nitrogen fertilizer prices in relation to various oil price scenarios is shown in Table 29.

Table 29:

NITROGEN FERTILIZER PRICE FORECASTS FOR DIFFERENT OIL PRICE SCENARIOS

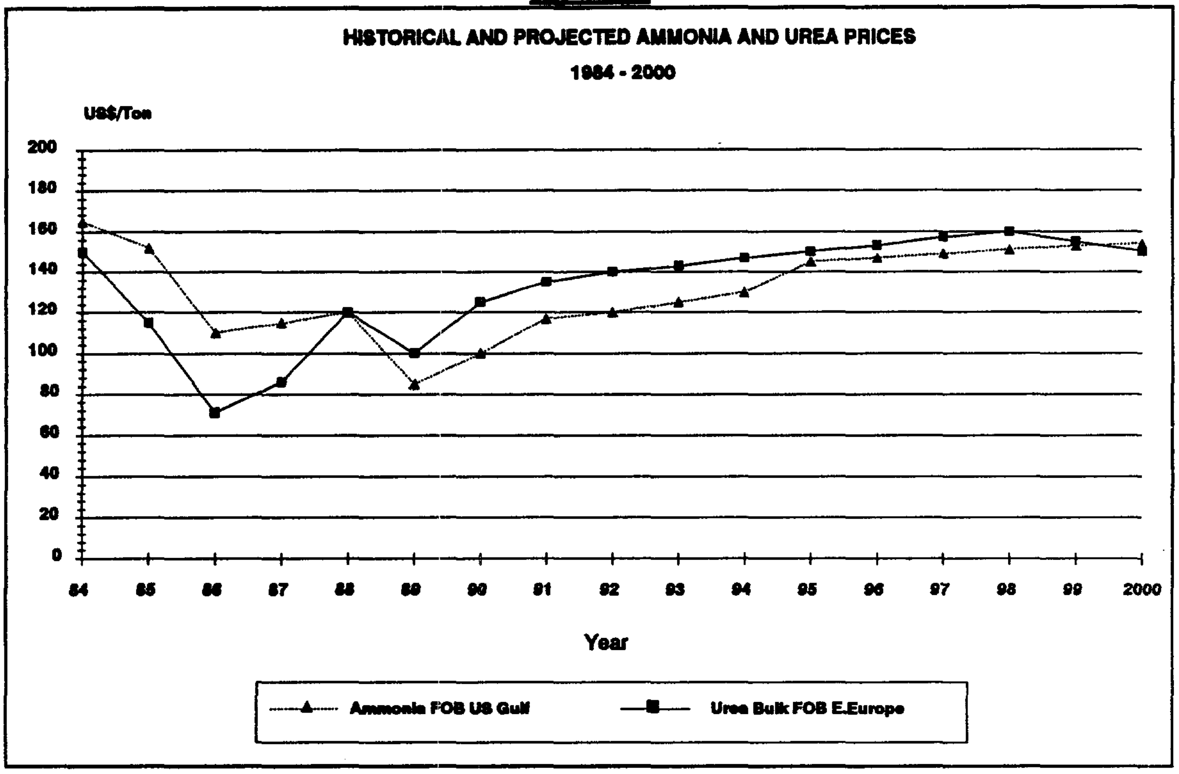
Year	1991	1992	1993	1994	1995	2000
Low Oil Price						
Urea (1)	135	136	137	138	140	145
Ammonia (2)	117	120	123	127	130	140
Stable Oil Price						
Urea (1)	135	140	143	147	150	150
Ammonia (2)	117	120	125	130	145	155
High Oil Price						
Urea (1)	135	150	160	165	170	170
Ammonia (2)	117	130	140	150	160	175

Low Oil Price: Oil price declining to US$10/BBL through 1995 - 2000
Stable Oil Price: Oil price at US$20/BBL through 2000
High Oil Price: Oil price increases to US$40/ton through 1995 - 2000

(1) Source: This Report, current US$, bulk FOB East Europe
(2) Source: This Report, current US$, FOB US Gulf.

Basically, these forecasts assume that, in the next year or two, the shortage caused by the Arab Gulf crisis will be moderated by additional exports from the USSR, which will be available because of a fall in domestic demand. The shortage will further be alleviated by new capacity coming on stream after 1991. By 1995, the supply demand balance will tighten again as new demand takes up the new capacity, but further investments should ease the situation again by 2000. Ammonia and urea prices will probably peak between 1995 and 2000. Historical prices and price projections covering the period 1984 to 2000 and assuming stable oil prices are shown in Figure 39.

Figure 39



The Relationship Between Ammonia and Urea Prices

Based on total production costs, the price of ammonia should theoretically be a little higher than urea. However, in practice the ratio of the two prices has varied considerably over the past two decades, as the relative demand in the markets for the two products has changed. Over the last two years, urea prices have been considerably higher than ammonia prices due to the stronger urea market. This situation is expected to remain through the next few years, but as more urea capacity comes on stream in the second half of the 1990s, the relative price of ammonia is expected to increase.

XI. WORLD CEREAL PRODUCTION AND NITROGEN FERTILIZER CONSUMPTION

A. Current Food Situation

Under its Global Information and Early Warning System on Food and Agriculture, the Food and Agriculture Organization of the United Nations (FAO) regularly issues its publication "Food Outlook". In the first half of the 1980s, the global food outlook was in general satisfactory, with good harvests and an adequate stocks. Recently, however, the "Food Outlook" has been warning about a serious decline in food stocks as food consumption has been outstripping food production for several years. Fortunately, the situation improved in 1990 as a result of a world record cereal harvest. Global cereal stocks recovered somewhat after having been drawn down for three successive years. In late 1991, the "Food Outlook" reported on a deterioration of global cereal harvests and FAO forecast a reduction in cereal output for 1991 to about 1,880 million tons, i.e. around 4% lower than in the preceding year. For the same period, in the USA, the harvest of wheat is expected to drop by 26% and of coarse cereals by 7%, and in the USSR, overall cereal production may decline by about 25% compared with the bumper crop of 1990, due to a reduction in the total area planted by around 2% compared with the previous year and damage to large amounts of both wheat and coarse grain crops.

The cereal supply and demand situation is likely to tighten in 1991/92 and world cereal inventory to diminish sharply, probably resulting in the lowest stock levels in the major grain exporting countries over the last 16 years. Some regional food supply problems are becoming particularly distressing. In Africa, food emergencies are expected to worsen in Ethiopia, Sudan, and Angola and remain serious in Mozambique and Liberia. In South America, cereal output has fallen for three consecutive years and per capita consumption is declining despite increasing imports.

B. Future Food and Fertilizer Needs

The world population is expected to increase from about 5,290 millions in 1990 to 6,260 millions in the year 2000 at an annual average growth rate between 1.65% and 1.70%. More than 90% of this growth and henceforth the greatest need for increased food production will occur in the developing countries and according to FAO's report "Agriculture Through The Year 2000" (AT2000), demand for agricultural products, both for food and non-food uses, will have to increase at an annual rate in excess of 3%.

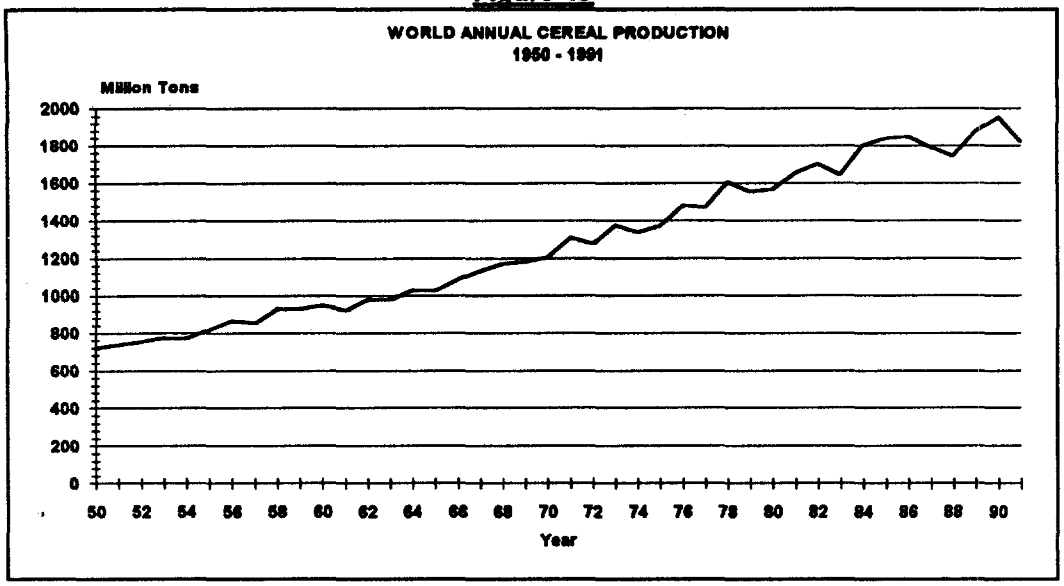
Assuming an unchanged pattern of agricultural development, increased production must come from improved farming practices and augmented inputs. It seems highly unlikely that there will be any major breakthrough in genetic engineering that could significantly affect food production through the year 2000. Few countries have significant quantities of good quality land left to bring into cultivation. Hence the bulk of future incremental production will have to come from increased cropping intensity and higher yields. According to the views of the FAO Fertilizer Commission which met in Rome April 1990, nearly two thirds of the increased crop production will have to come from raising average yields. The Fertilizer Commission debated at that meeting whether or not the projected increase in fertilizer consumption would be sufficient to provide the nutrient levels necessary for the required agricultural production and concluded that, following current trends, it would not, as forecasts of effective fertilizer demand were falling short of the projections made of fertilizer needs in the revised version of "AT2000".

In the developing countries, fertilizer growth through the year 2000 is expected to average about 3.5 % as compared with the "AT2000" forecast of 4.7% necessary to meet food production needs. Apart from a significant decline in projections of fertilizer use in developing countries, forecasts of fertilizer demand in developed countries have also been declining, mainly as a result of environmental considerations and major policy shifts to limit agricultural surpluses. Nitrogen fertilizer consumption is forecast to grow from 78 million tons N in 1990/91 to 91 million tons in 2000/01, i.e. at a growth rate of only 1.5%. Thus the projected increase in world fertilizer consumption falls below the expected growth in world population.

C. Cereal Production and Nitrogen Fertilizer Consumption

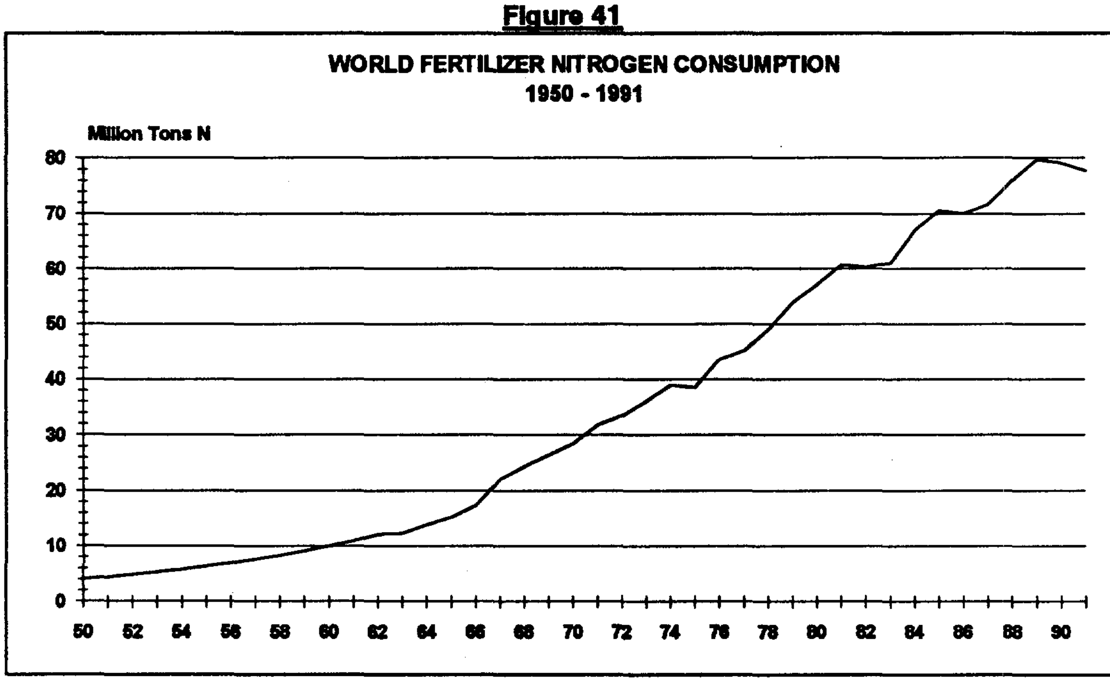
Based on the above mentioned trend, some doubts have been raised as to whether future nitrogen fertilizer consumption will be adequate to meet food needs; according to the FAO "AT2000" model, they will not. The World Bank Technical Paper No. 59 (World Nitrogen Survey, 1987), attempted to establish some relationships between nitrogen fertilizer consumption and food production using FAO statistical data for cereal production and nitrogen fertilizer consumption. The data have now been updated and are summarized in Annex-18, including information on population growth, cereal production and nitrogen consumption. Figures 40 and 41 illustrate the historical development of world total cereal production and world fertilizer nitrogen consumption.

Figure 40



Cereal production and world food production show a high degree of correlation, as cereals are by far the most important component of the world's food supply chain, receiving more than half of all fertilizers applied.

Figure 41

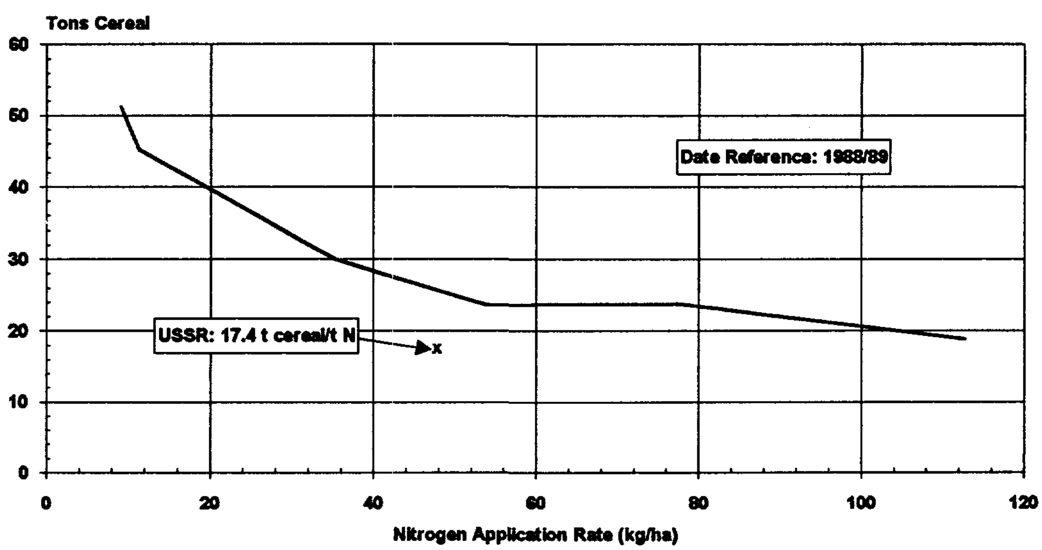


CEREAL PRODUCTION PER UNIT OF NITROGEN (G/N) AGAINST TIME (T)

The time series developed for cereal production and nitrogen fertilizer use have been combined to give a correlated time series of cereal production per unit of nitrogen fertilizer used and are shown in Figure 42. In Annex 18, the G/N was calculated both for the same year and for two years, based on the lagging of fertilizer consumption by one year. This seems appropriate as there is often a different phasing between crop production and fertilizer consumption, which is frequently recorded in terms of fertilizer deliveries. As the concept of production phasing gives usually a better correlation, this method has been used in Figure 42. Although future grain production will to a large extent depend on increased fertilizer use, it will also relate to many other factors, such as farm management practices, land area under cultivation, high yielding and hybrid varieties, other fertilizer use etc., that should directly or indirectly boost nitrogen fertilizer demand. Nevertheless, the G/N trend is downward, as fertilizer use increases and overall average global application rates move to the less responsive, flatter part of the nutrient application/yield-curve. The decline of G/N is projected to continue slowly unless some major breakthroughs can be achieved in biological and genetic engineering.

<u>Figure 42</u>

CEREAL PRODUCTION AND NITROGEN APPLICATION RATE



Information on nutrient application rates and agricultural production are summarized in Figure 42 and can be extrapolated to predict future cereal yields in terms of nitrogen fertilizer consumption, which has been attempted in Table 30.

Table 30:

CEREAL PRODUCTION AND FERTILIZER APPLICATION RATES

REGION	1989 Cereal Production (G) (Million Tons)	1988 Fertilizer Nitrogen Consumption (N) (Million Tons)	1989 Grain Production (G/N) (Tons Per Ton N)	1988 Nitrogen Application Rate (kg/ha)
WORLD	1,879.90	79.66	23.60	53.90
Africa	94.40	2.09	45.10	11.30
America	435.80	14.57	29.90	35.20
Asia	833.60	35.02	23.80	77.30
Europe	290.70	15.94	18.20	112.70
USSR	201.30	11.59	17.40	49.90
Oceania	23.10	0.45	51.20	9.10

CEREAL PRODUCTION PER UNIT OF NITROGEN (G/N) AGAINST TIME (T) AND NITROGEN FERTILIZER APPLICATION RATE (R)

In order to check the relationship between G/N and nitrogen fertilizer application rates, the G/N prevailing in different regions of the world where application rates vary widely against application rates, was analyzed and the data are shown in Table 31 and in Figure 43. The most recent and consistent data available for 1988/89 were derived from the FAO Fertilizer and Food Handbooks.

Generally, the data show a good correlation between cereal production and nitrogen fertilizer application rates. An exception is the USSR, where cereal production per unit of nitrogen is well below the general norms due to a variety of reasons, such as climate, inefficient farming practices and very large losses of both fertilizers and crops.

The overall trend indicates that cereal production per unit of nitrogen decreases, as application rates increase to high levels. At high application rates, such as prevailing in Europe, the ratio falls below 20.

Assuming an increase in fertilizer consumption of about 15% over the next decade with unavailability of additional land for cultivation, the world average fertilizer application rate will grow correspondingly. Based on the relationships illustrated in Figures 42 and 43, the global G/N value for the year 2000 is estimated to decline to about 20. Regression analyses were applied to estimate the values of G/N between 1990 and the year 2000, which have been used to calculate cereal production through the year 2000, assuming that yearly cereal production per capita remains constant. As indicated in Annex 18, yearly per capita cereal production over the last decade has remained reasonably stable at around 0.36 tons. Table 31 compares these estimated values of nitrogen fertilizer consumption and cereal production needs with current nitrogen projections of the Fertilizer Working Group.

Figure 43

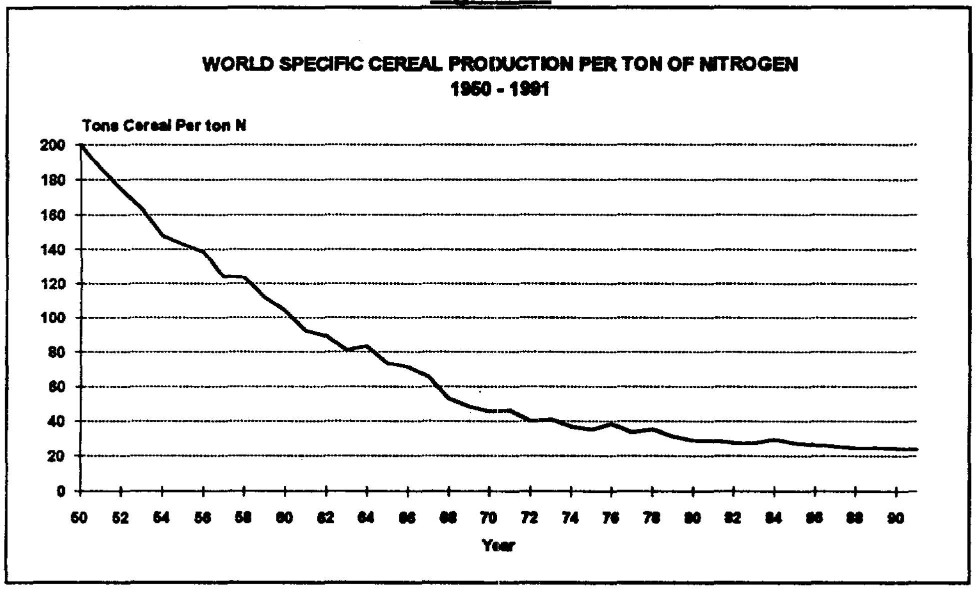


Table 31:

PROJECTIONS OF FERTILIZER NITROGEN CONSUMPTION

Year	Projected World Population (Millions)	Cereal Harvest Required To Maintain 1990 Food Per Capita Production (Million Tons)	Nitrogen Application Required To Maintain 1990 Food Per Capita Production (Million Tons N)	Nitrogen Demand Forecasts By The Working Group (Million Tons N)	Grain Production Based On N-Forecasts By the Working Group (Million Tons)
1991	5,381	1,937	81.39	77.76	1,850
1992	5,472	1,970	83.47	78.27	1,863
1993	5,565	2,003	85.61	80.12	1,828
1994	5,659	2,037	87.81	81.69	1,895
1995	5,757	2,073	90.11	83.56	1,922
1996	5,854	2,107	92.43	85.37	1,946
1997	5,953	2,143	94.82	87.23	1,971
1998	6,054	2,179	97.30	89.09	1,996
1999	6,157	2,217	99.84	90.95	2,019
2000	6,261	2,254	102.45	92.80	2,042

The comparison suggests that based on recent forecasts of future effective nitrogen consumption, food production will not be sufficient to maintain current levels of subsistence. It should be noted that current expectations of nitrogen fertilizer use are rather pessimistic and predominantly influenced by the on-going changes in Eastern Europe and the USSR and also by increasing environmental constraints on fertilizer use.

In the event however that the food situation does deteriorate in the next decade as projected, both the world agricultural industry and the world fertilizer industry have the ability to respond to ensure adequate supplies, although probably not without some sharp price fluctuations in the process.

XII. FERTILIZER USE AND THE ENVIRONMENT

A. General

An increasing number of nations, in particular from the developed regions, are becoming very concerned about the social and economic aspects of environmental degradation. In particular, the use of agrochemicals inputs and mineral fertilizers in agriculture has become a subject of much debate.

Although the manufacture, transportation and use of fertilizers involves many operations, it is mainly on the application side where controversies arise on very complex environmental and agricultural issues. Besides some emotional and unfounded criticism concerning the use of mineral fertilizers, there are nevertheless several issues that do require further investigation and many agencies, institutions and enterprises, including governmental organizations and the fertilizer industry, are getting more involved in assessing the impact of fertilizers on the environment as well as sustainable agriculture and investigate better and more efficient ways of producing and using fertilizers.

At the same time as the debate continues, it is essential for all involved to accept the need for applying mineral fertilizers as replenishment for the nutrients removed from the soil by growing crops, as organic manure alone would be inadequate to meet current let alone and future agricultural needs. For the foreseeable future, there is therefore no alternative to an efficient and responsible use of mineral fertilizers for achieving a food production commensurate with the needs of growing world population.

Environmental issues regarding the manufacture and transportation of fertilizer materials are usually better understood and dealt with than issues concerning actual fertilizer use. Legislation is available in most countries to ensure that producers remove toxic or harmful materials from their gaseous, solid or liquid effluent, even if economic considerations do not justify such treatment. Often laws also regulate the storage and transportation of potentially dangerous materials. In the nitrogen fertilizer industry, all facilities involved with the storage, processing and handling of materials such as ammonia, nitric acid, ammonium nitrate, urea, and related compounds are usually subject to stringent inspection and control by the legislators.

Environmental problems associated with the use of fertilizers are more difficult to assess and resolve and tend to be longer term in nature. Generally, they relate to large scale continued application , willingly or unwillingly, of unbalanced and excessive quantities of mineral fertilizers, occasionally of an inappropriate type, and the resulting potential harm to environment, ecology and human health.

Although current debates regarding the use of fertilizers cover several environmental issues, the most serious one relates to the leaching of nutrients into the ground water, in particular of highly soluble nitrogen compounds. However, the problem of nutrient leaching is not confined to mineral fertilizers, but also applies, often to a much larger extent, to organic materials, such as "green fertilizers" and manure. Several reports and studies on these topics have recently been published by local and international agencies, independent institutions and members of the industry that cover the agronomical, environmental and industrial aspects of agriculture and fertilizers.

B. Nitrogen Fertilizers

The two main environmental issues relating to nitrogen fertilizer use in agriculture concern the loss of nitrogen to the atmosphere (denitrification) and to ground water (nitrification and leaching). When a nitrogen fertilizer is applied to the soil, the proportion of nitrogen taken up by the plant will vary according to crop type, climate, soil condition and availability of other nutrients, and will normally be in the range 40 - 60%. Loss by denitrification and volatilization can be up to 30% and the loss by leaching up to 10%. Denitrification is the reduction of nitrate-salts - also occurring in the soil, to gaseous compounds such as nitrous oxides and nitrogen that are volatile and escape into the atmosphere. Nitrous oxides belong to the group of "green house gases" and are also considered to contribute toward the breaking down of the ozone layer. Highly cultivated land in temperate and tropical regions, tropical forests and grasslands are regarded as the major source of nitrous oxides. Although a large part of the denitrification processes occurring in the soil originates from natural organic sources, it is known that denitrification of mineral nitrogen fertilizers also may take place, to a varying extend dependent on soil and climatic conditions as well as nutrient application rates and techniques.

Ammonia emissions into the atmosphere come mainly from animal husbandry and from maturing cereal crops. However, under certain conditions, the application of nitrogenous mineral fertilizers may also contribute to ammonia loss to the atmosphere; for example, after application of fertilizers in the form of top dressing with ammonia or urea, particularly on the surface of calcareous soils. There is probably also a significant ammonia loss from the use of large quantities of ammonium bicarbonate fertilizer almost exclusively manufactured and applied in China.

The most important environmental issue concerning the use of nitrogen fertilizers relates to the leaching of nitrates into ground water and particularly into drinking water. Concern about nitrate-intake is related mainly to a fear of infant methemoglobinemia ("blue babies") and the fact that nitrite formed from nitrate in the stomach may react with food components to form carcinogenic compounds, e.g. nitrosamines and others. Considerable controversy exists regarding safe levels of nitrate in drinking water. The US Public Health Service suggests 45 mg nitrate per liter, a level which is also supported by the World Health Organization (WHO). Although the EEC regulates the limit at 50 mg per liter, several European countries, where both application of mineral fertilizers and farmyard manure is high, have nitrate levels, which at times exceed these limits. Currently, recommendations for reduced fertilizer use together with improved farming practices are being implemented in several countries to reduce or minimize nitrate leaching.

C. Low Input Sustainable Agriculture (LISA)

The concern about environmental issues has brought with it a host of ideas on alternative agricultural practices and systems, that generally aim, with some variations, at limiting or even eliminating the use of pesticides and mineral fertilizers. One of the most prevalent of these is the "Low Input Sustainable Agriculture", known better by the acronym LISA, which is backed by the US Department of Agriculture (USDA) and supported in its recent publication "Alternative Agriculture" by the US National Research Council (NCR). This report recommends a return to natural farming practices and a reduction in the use of pesticides and chemical fertilizers. It recommends that Congress and USDA should change farm policies to encourage farmers to use less mineral fertilizers and that research on natural farm methods should be increased significantly. The researchers conclude that, if farm subsidies were reduced, farmers would no longer produce surpluses marketable to the government and would be encouraged to adopt natural farming techniques. This would bring supply in line with demand thus raising prices and making up for the subsidies.

This idea has found support but also criticism, in particular from the fertilizer industry, the Fertilizer Institute and the Potash and Phosphate Institute, who have queried the findings and expressed their concern about the impact that a LISA program would have on USA agricultural production.

On the other side, however, the concept of LISA appeals to a wide range of organizations, partially with strong political support , who are concerned with environmental matters and programs that may greatly increase spending on LISA that have been authorized by both the House and Senate Agricultural Committees. The Senate Agricultural Committee has approved a large increase in both research and extension service work. The controversy over LISA and what it will mean to farmers and the general public is likely to continue for some time, but barring legislation to limit fertilizer use, farmers will develop their own levels of use to ensure maximum economic yields. While there are obviously many attractive features in practices of alternative agriculture that might lead to better economies or higher efficiencies in the use of mineral fertilizers, any major trend in this direction should be correlated with world food production prospects over the next decade, a critical period with major population growth. As the world relies heavily on USA exports of agricultural products, any major change in USA agricultural policy with adverse impacts on USA production and exports could have serious consequences on an already finely balanced world food situation.

D. Environmental Legislation

Legislation regarding the use of nitrogen fertilizers is complex and varies significantly from country to country, although in some areas, like the EEC, legislation is now being introduced on a regional basis. In the USA, environmental laws vary widely from state to state. A report on environmental legislation affecting the fertilizer industry was published by the International Fertilizer Industry Association (IFA) at the end of 1989.

The European community is probably the leader in the consideration of environmental issues involving fertilizers, as fertilizer use in the region is high and environmental concern is a major political issue with a strong "Green Party" in the European Parliament. Many individual countries have already adopted policies to control the effect of run-off from manure and mineral fertilizers, but there is public pressure for stronger EEC legislation. Serious discussions began in 1987, when the European Commission started on a directive on the control of nitrates in water. Initially it was proposed that nitrogen fertilizer use should be limited according to crop type. The proposal failed, because of opposition from farming lobbies that feared a cutback in incomes with reduced nitrogen fertilizer use.

One of the major problems in introducing new legislation in Europe is the difficulty in assessing the levels of fertilizer application that may pose a problem and also the relative contribution of organic manure as compared with mineral fertilizers. Some reports suggest that the levels of nitrate permissible in drinking water will necessitate reduced nitrogen fertilizer application rates below that required for maximum economic crop production.

In June 1991, after two years of debate, the EC environment ministers agreed on a draft directive to reduce the nitrate levels in water to a maximum of 50 mg per liter by amending current agricultural practices. Under the new draft directive, member states will have to establish "nitrate vulnerable areas", where nitrate levels in water exceed 50 mg per liter or where there is a risk of eutrification. No mandatory levels of nitrogen use will be set by the EEC and it will be left to each state to set its national levels by 1999. However, a mandatory level of organic manure application will be set by the EEC. About 10 million hectares in EEC countries are expected to be affected by this new legislation.

In North America, the problems of nitrate in drinking water is not as great as it is in Europe. A recent geological survey showed that in 91 of the principal aquifers in 46 states, nitrate levels were below 3 mg per liter. The levels in the remaining aquifers ranged between 3 and 10 mg per liter. The "maximum contaminant level" (MCL) is 10 mg per liter. In 1990, a study by the Environmental Protection Agency (EPA) indicated that about 2.4% of private drinking water wells are contaminated above the MCL level. Most studies of well water contamination suggest organic pollution sources. With nitrogen fertilizer use static in the USA for the last decade, the problem of water contamination by nitrates gives no cause for alarm, although there are individual situations that need attention.

Although several individual states in the USA have introduced legislation, which either limits or taxes nitrogen fertilizer use in certain situations, legislation is not wide-spread. The US congress has yet to debate a proposal on the introduction of a national sales tax on agricultural chemicals, including pesticides and fertilizers. Some form of regulation of fertilizer use seems likely in the pending "Clean Water Re-Authorization Bill" now being debated. Among others, the Bill requires the industry to develop fertilizer management programs in cases where customers buy more than 1,000 lbs of fertilizers over a 90 day period in a major water resource area. EPA will have the responsibility to define such areas. The fertilizer industry maintains that further legislation is not required as the agriculture sector is well on its way to solving the problem of non-point pollution and points out that fertilizers are not the prime source of water pollution by nitrates, which is caused mainly by animal wastes and legumes.

NUTRIENT DEPLETION IN THE SOIL

In some cases, particularly in the poor developing countries, there is a threat to the environment, not because of too much fertilizer use, but because of too little.

One of the major issues discussed at Fertilizer Commission Meeting in April 1990, was the problem of nutrient removal or "nutrient mining" from soils. Plants require an essential supply of the major plant nutrients nitrogen, phosphorus and potassium, as well as other macro nutrients such as sulfur, calcium, magnesium and several micro-nutrients (such as for example Zn, B, Mo, Mn and others). An average grain harvest will remove 100 - 150 kg/ha of major plant nutrients by a normal yielding crop and in order to ensure sustained productivity of the soil, it is imperative that an adequate level of these nutrients be maintained in the soil.

Although average world plant nutrient consumption is of the order of 90 kg per hectare and, in some regions, an equilibrium between nutrient removal and addition has been established, taking into account also the application of organic fertilizers, nutrient-mining is very serious in many areas. For example, Africa's annual maize harvest removes more than 3 million tons of plant nutrients from the soil each year, but mineral fertilizer application is only 1.7 million tons and therefore inadequate to sustain soil fertility. The situation is aggravated by increasing demands of a fast growing population that have caused a widespread breakdown of the previously balanced system of natural replenishment.

For the 93 developing countries covered by the "AT 2000" study, mineral fertilizer use will need to rise from around 40 kg/ha to about 80 kg/ha, an overall growth rate of some 5% per year. Because of the serious nature of this problem, the FAO is seeking support for launching an expanded "Program for Sustainable Soil Development" to overcome the problem of nutrient depletion in the soil.

XIII. THE FUTURE OUTLOOK FOR THE WORLD NITROGEN INDUSTRY

A. World Nitrogen Needs

World nitrogen demand for both fertilizers and industrial use is forecast to increase by more than 15 million tons through the year 2000. Taking into account nitrogen processing and distribution losses of about 8%, and a plant utilization of 85% (equivalent to the current world average), nearly two million tons N of new ammonia capacity will be required each year to meet new nitrogen demand. In addition, new plants will be required to replace worn-out or obsolete units. It is difficult to estimate replacement needs, but as world capacity increases this need is likely to follow. It is estimated that 25% of existing ammonia capacity is now older than 20 years and 40% is older than 15 years. The closure rate of ammonia plants is about 1.5 million tons per year and this will increase to two million tons per year or more by the end of the decade. Very roughly, capacity requirements for meeting increased demand and replacing old plants suggest a need for about 10 large new plants each year.

It should be noted, however, that these projections are still based on rather conservative projections of new nitrogen demand that may be insufficient to meet future food needs. In the event that current nitrogen demand forecasts are increased in the future, new capacity needs would have to be revised correspondingly.

B. Future Projects to Meet World Nitrogen Needs

In order to compare and assess the various potential nitrogen fertilizer projects, matrixes have been developed for both ammonia and urea projects and these are presented in Annex 13 and 14. The information on realization prices contained in Section VIII has been used as a basis for the specific projects compared in the matrixes. Because the locations chosen do not always fit exactly the conceptual scenarios examined in Section VII, interpolation and judgment have been used to assess investment costs for the specific projects. In some cases, the variable costs have been adjusted to take into account local conditions.

Projects are compared on the basis of total delivered costs to various major markets. Assessments have been made on the basis of a plant built on an existing site and a plant built on a new site. Freight rates are based on estimated rates prevailing through the 1990s. Here again, judgment has to be used on the size of vessel that can be used on certain routes and whether cost reductions can be obtained in the case of solid fertilizers joint cargoes. At this stage, no allowance is made for tariffs or quotas, but these should be taken into account, particularly in trade to Western Europe.

There are three clear conclusions that may be derived from the comparisons:

1. Plants on new green-field sites in remote locations, even with very cheap gas, will not be competitive. The product selling price necessary to justify these projects will be much higher than projected prices for ammonia and urea.

2. There is a major financial advantage in building plants on existing sites.

3. Freight costs are an important consideration in evaluating a project and can be as important as gas prices.

The comparisons indicate that the two most competitive locations to build a nitrogen fertilizer would be in the Arab Gulf area (such as Saudi Arabia), and in Southeast Asia (such as Indonesia) to serve the main market in Asia. Central America (e.g. Venezuela) would also be a favorable location to serve the markets of Latin America, the USA and Western Europe.

Based on current price projections, it should be possible to justify a plant on certain existing sites to produce urea and/or ammonia and get an acceptable return on investment. On a new site where the investment cost would be much higher, it would be more difficult to justify a new project.

Theoretically, the price of ammonia to justify a new project should be a little higher than that of urea. However, there are two different markets for urea and ammonia. This has occurred because these are currently not in balance as there is a higher demand for urea than for ammonia, since the main urea market is in the Far East and China, whereas the ammonia markets are those of the USA and Western Europe, which are currently growing at a much slower rate. However, as more new urea capacity comes on stream, the markets will become more balanced and ammonia prices should strengthen relative to urea, thus reducing the current price-gap between ammonia and urea.

WORLD BANK/FAO/UNIDO/INDUSTRY NITROGEN SUPPLY AND DEMAND BALANCES 1989/90 - 1995/96

ANNEX-1

COUNTRY AMMONIA CAPACITY (000 TONS N)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
WORLD	114,646	113,682	114,695	116,849	120,057	122,345	123,646
AFRICA	3,351	3,416	3,416	3,688	3,803	4,075	4,075
Algeria	816	816	816	816	816	816	816
Egypt	966	977	977	1,249	1,249	1,249	1,249
Libyan Arab Rep.	544	598	598	598	598	598	598
Malagasy Republic	0	0	0	0	0	0	0
Nigeria	272	272	272	272	272	544	544
Somalia	0	0	0	0	0	0	0
South Africa	608	608	608	608	723	723	723
Zambia	82	82	82	82	82	82	82
Zimbabwe	63	63	63	63	63	63	63
AMERICA	21,787	21,734	21,888	22,362	22,490	22,490	22,978
North America	15,653	15,514	15,562	15,969	16,023	16,023	16,023
Canada	3,116	2,930	2,956	3,363	3,417	3,417	3,417
U.S.A.	12,537	12,584	12,606	12,606	12,606	12,606	12,606
Central America	4,134	4,134	4,240	4,240	4,240	4,240	4,240
Cuba	321	321	321	321	321	321	321
Mexico	2,419	2,419	2,419	2,419	2,419	2,419	2,419
Trinidad	1,394	1,394	1,500	1,500	1,500	1,500	1,500
South America	2,000	2,086	2,086	2,153	2,227	2,227	2,715
Argentina	59	80	80	80	154	154	154
Brazil	1,024	1,074	1,074	1,141	1,141	1,141	1,141
Colombia	150	165	165	165	165	165	165
Peru	116	116	116	116	116	116	116
Venezuela	651	651	651	651	651	651	1,139

COUNTRY AMMONIA CAPACITY
(000 TONS N)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
ASIA	41,831	41,304	42,020	43,324	45,925	47,664	48,301
West Asia	5,687	4,872	5,144	5,551	5,551	5,551	5,551
Abu Dhabi	272	272	272	272	272	272	272
Bahrain	326	326	326	326	326	326	326
Iran	908	908	908	908	908	908	908
Iraq	857	857	857	857	857	857	857
Israel	68	68	68	68	68	68	68
Kuwait	815	0	0	0	0	0	0
Qatar	488	488	488	895	895	895	895
Saudi Arabia	1,256	1,256	1,256	1,256	1,256	1,256	1,256
Syria Arab Rep.	272	272	272	272	272	272	272
Turkey	425	425	697	697	697	697	697
South Asia	10,723	10,723	10,967	11,498	13,075	13,824	14,191
Afghanistan	58	58	58	58	58	58	58
Bangladesh	826	826	826	1,098	1,098	1,370	1,370
Myanmar	213	213	213	213	213	213	213
India	8,416	8,416	8,660	8,660	9,924	10,401	10,768
Pakistan	1,210	1,210	1,210	1,469	1,782	1,782	1,782
East Asia	25,421	25,709	25,909	26,275	27,299	28,289	28,559
China	18,769	19,244	19,444	19,444	19,984	20,974	21,244
Indonesia	2,772	2,777	2,777	3,143	3,627	3,627	3,627
Japan	1,636	1,636	1,636	1,636	1,636	1,636	1,636
Malaysia	272	322	322	322	322	322	322
Korea, D.P.R.	879	879	879	879	879	879	879
Korea Rep. of	734	492	492	492	492	492	492
Taiwan	305	305	305	305	305	305	305
Vietnam, Dem. Rep.	54	54	54	54	54	54	54

COUNTRY AMMONIA CAPACITY
(000 TONS N)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
EUROPE	**24,000**	**23,775**	**23,838**	**23,757**	**23,878**	**23,934**	**23,934**
Eastern Europe	**10,160**	**10,147**	**10,210**	**10,210**	**10,426**	**10,426**	**10,426**
Albania	82	137	137	137	137	137	137
Bulgaria	1,721	1,721	1,721	1,721	1,721	1,721	1,721
Czechoslovakia	874	982	982	982	982	982	982
Hungary	777	777	777	777	777	777	777
Poland	2,208	2,208	2,271	2,271	2,271	2,271	2,271
Romania	3,505	3,505	3,505	3,505	3,721	3,721	3,721
Yugoslavia	993	817	817	817	817	817	817
Western Europe	**13,840**	**13,628**	**13,628**	**13,547**	**13,452**	**13,508**	**13,508**
Austria	410	410	410	410	410	410	410
Belgium-Lux.	309	803	803	803	803	803	803
Finland	65	65	65	65	65	65	65
France	1,812	1,812	1,812	1,812	1,812	1,812	1,812
Germany (United)	3,325	2,830	2,830	2,830	2,830	2,830	2,830
Greece	331	331	331	331	331	387	387
Iceland	12	12	12	12	12	12	12
Ireland	365	365	365	365	365	365	365
Italy	1,408	1,452	1,452	1,371	1,371	1,371	1,371
Netherlands	3,053	3,053	3,053	3,053	3,053	3,053	3,053
Norway	440	440	440	440	345	345	345
Portugal	244	244	244	244	244	244	244
Spain	688	688	688	688	688	688	688
Switzerland	37	37	37	37	37	37	37
United Kingdom	1,341	1,086	1,086	1,086	1,086	1,086	1,086
U.S.S.R.	**23,067**	**22,843**	**22,923**	**23,108**	**23,351**	**23,572**	**23,748**
OCEANIA	**610**	**610**	**610**	**610**	**610**	**610**	**610**
Australia	534	534	534	534	534	534	534
New Zealand	76	76	76	76	76	76	76

COUNTRY AMMONIA SUPPLY CAPABILITY
(000 TONS N)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
WORLD	97,112	94,460	95,280	97,401	99,545	101,839	103,733
AFRICA	2,144	2,339	2,355	2,456	2,597	2,769	2,920
Algeria	281	286	286	286	286	286	286
Egypt	821	817	817	918	1,027	1,050	1,062
Libyan Arab Rep.	163	343	359	359	359	359	359
Malagasy Republic	0	0	0	0	0	0	0
Nigeria	258	272	272	272	272	381	503
Somalia	0	0	0	0	0	0	0
South Africa	517	517	517	517	549	589	606
Zambia	41	41	41	41	41	41	41
Zimbabwe	63	63	63	63	63	63	63
AMERICA	20,302	20,712	20,812	21,159	21,426	21,529	21,710
North America	14,977	15,317	15,326	15,599	15,824	15,901	15,920
Canada	2,844	2,756	2,731	2,993	3,218	3,295	3,314
U.S.A.	12,133	12,561	12,595	12,606	12,606	12,606	12,606
Central America	3,677	3,697	3,752	3,808	3,808	3,808	3,808
Cuba	177	177	177	177	177	177	177
Mexico	2,056	2,056	2,056	2,056	2,056	2,056	2,056
Trinidad	1,444	1,464	1,519	1,575	1,575	1,575	1,575
South America	1,648	1,698	1,734	1,752	1,794	1,820	1,982
Argentina	47	56	64	64	88	114	120
Brazil	908	944	967	985	1,003	1,003	1,003
Colombia	102	107	112	112	112	112	112
Peru	70	70	70	70	70	70	70
Venezuela	521	521	521	521	521	521	677

COUNTRY AMMONIA SUPPLY CAPABILITY (000 TONS N)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
ASIA	**34,970**	**34,437**	**34,796**	**36,194**	**37,762**	**39,591**	**40,825**
West Asia	**4,563**	**3,703**	**3,860**	**4,608**	**4,935**	**5,079**	**5,190**
Abu Dhabi	305	305	305	305	305	305	305
Bahrain	314	342	342	342	342	342	342
Iran	528	640	671	681	681	681	681
Iraq	533	0	0	428	514	599	686
Israel	61	61	61	61	61	61	61
Kuwait	693	0	0	0	0	0	0
Qatar	586	586	586	781	1,001	1,050	1,074
Saudi Arabia	1,088	1,314	1,359	1,382	1,382	1,382	1,382
Syria Arab Rep.	136	136	136	136	136	136	136
Turkey	319	319	400	492	513	523	523
South Asia	**8,739**	**8,865**	**8,863**	**9,273**	**10,009**	**10,935**	**11,477**
Afghanistan	58	58	58	58	58	58	58
Bangladesh	691	702	578	795	899	1,014	1,130
Myanmar	170	170	170	170	170	170	170
India	6,599	6,689	6,811	6,899	7,323	7,920	8,300
Pakistan	1,221	1,246	1,246	1,351	1,559	1,773	1,819
East Asia	**21,668**	**21,869**	**22,073**	**22,313**	**22,818**	**23,577**	**24,158**
China	15,995	16,269	16,553	16,676	16,899	17,457	17,980
Indonesia	2,169	2,209	2,222	2,339	2,621	2,822	2,880
Japan	1,491	1,472	1,472	1,472	1,472	1,472	1,472
Malaysia	237	258	280	280	280	280	280
Korea, D.P.R.	782	782	782	782	782	782	782
Korea Rep. of	697	582	467	467	467	467	467
Taiwan	275	275	275	275	275	275	275
Vietnam, Dem. Rep.	22	22	22	22	22	22	22

COUNTRY AMMONIA SUPPLY CAPABILITY
(000 TONS N)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
EUROPE	**19,911**	**18,147**	**18,530**	**18,711**	**18,713**	**18,731**	**18,943**
Eastern Europe	**7,075**	**6,095**	**6,249**	**6,414**	**6,470**	**6,518**	**6,714**
Albania	71	89	111	115	118	118	118
Bulgaria	1,155	1,166	1,195	1,204	1,204	1,204	1,204
Czechoslovakia	699	630	659	677	687	687	687
Hungary	506	544	544	544	544	544	544
Poland	1,656	1,325	1,456	1,590	1,590	1,590	1,590
Romania	2,278	1,753	1,753	1,753	1,796	1,844	2,040
Yugoslavia	710	588	531	531	531	531	531
Western Europe	**12,836**	**12,052**	**12,281**	**12,297**	**12,243**	**12,213**	**12,229**
Austria	410	410	410	410	410	410	410
Belgium-Lux.	308	456	656	700	723	723	723
Finland	55	55	55	55	55	55	55
France	1,685	1,685	1,685	1,685	1,685	1,685	1,685
Germany (United)	2,895	2,444	2,282	2,282	2,282	2,282	2,282
Greece	265	265	265	265	265	274	290
Iceland	10	10	10	10	10	10	10
Ireland	336	336	336	336	336	336	336
Italy	1,389	1,062	1,365	1,327	1,289	1,289	1,289
Netherlands	3,010	3,058	3,053	3,053	3,053	3,053	3,053
Norway	361	361	361	361	322	283	283
Portugal	178	146	146	146	146	146	146
Spain	550	550	550	550	550	550	550
Switzerland	38	31	31	31	31	31	31
United Kingdom	1,346	1,183	1,076	1,086	1,086	1,086	1,086
U.S.S.R.	**19,232**	**18,272**	**18,234**	**18,328**	**18,494**	**18,666**	**18,782**
OCEANIA	**553**	**553**	**553**	**553**	**553**	**553**	**553**
Australia	481	481	481	481	481	481	481
New Zealand	72	72	72	72	72	72	72

REGIONAL AMMONIA CAPACITY
(000 TONS N)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
WORLD	114.646	113.682	114.695	116.849	120.057	122.345	123.646
AFRICA	3.351	3.416	3.416	3.688	3.803	4.075	4.075
AMERICA	21.787	21.734	21.888	22.362	22.490	22.490	22.978
North America	15,653	15,514	15,562	15,969	16,023	16,023	16,023
Central America	4,134	4,134	4,240	4,240	4,240	4,240	4,240
South America	2,000	2,086	2,086	2,153	2,227	2,227	2,715
ASIA	41.831	41.304	42.020	43.324	45.925	47.664	48.301
West Asia	5,687	4,872	5,144	5,551	5,551	5,551	5,551
South Asia	10,723	10,723	10,967	11,498	13,075	13,824	14,191
East Asia	25,421	25,709	25,909	26,275	27,299	28,289	28,559
EUROPE	24.000	23.775	23.838	23.757	23.878	23.934	23.934
Eastern Europe	10,160	10,147	10,210	10,210	10,426	10,426	10,426
Western Europe	13,840	13,628	13,628	13,547	13,452	13,508	13,508
U.S.S.R.	23.067	22.843	22.923	23.108	23.351	23.572	23.748
OCEANIA	610	610	610	610	610	610	610

REGIONAL AMMONIA SUPPLY CAPABILITY
(000 TONS N)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
WORLD	97.112	94.460	95.280	97.401	99.545	101.839	103.733
AFRICA	2.144	2.339	2.355	2.456	2.597	2.769	2.920
AMERICA	20.302	20.712	20.812	21.159	21.426	21.529	21.710
North America	14,977	15,317	15,326	15,599	15,824	15,901	15,920
Central America	3,677	3,697	3,752	3,808	3,808	3,808	3,808
South America	1,648	1,698	1,734	1,752	1,794	1,820	1,982
ASIA	34.970	34.437	34.796	36.194	37.762	39.591	40.825
West Asia	4,563	3,703	3,860	4,608	4,935	5,079	5,190
South Asia	8,739	8,865	8,863	9,273	10,009	10,935	11,477
East Asia	21,668	21,869	22,073	22,313	22,818	23,577	24,158
EUROPE	19.911	18.147	18.530	18.711	18.713	18.731	18.943
Eastern Europe	7,075	6,095	6,249	6,414	6,470	6,518	6,714
Western Europe	12,836	12,052	12,281	12,297	12,243	12,213	12,229
U.S.S.R.	19.232	18.272	18.234	18.328	18.494	18.666	18.782
OCEANIA	553	553	553	553	553	553	553

REGIONAL NON-AMMONIA NITROGEN SUPPLY
(000 TONS N)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
WORLD	599	599	599	599	599	599	599
AFRICA	21	21	21	21	21	21	21
AMERICA	131	131	131	131	131	131	131
North America	128	128	128	128	128	128	128
Central America	0	0	0	0	0	0	0
South America	3	3	3	3	3	3	3
ASIA	144	144	144	144	144	144	144
West Asia	0	0	0	0	0	0	0
South Asia	24	24	24	24	24	24	24
East Asia	120	120	120	120	120	120	120
EUROPE	144	144	144	144	144	144	144
Eastern Europe	48	48	48	48	48	48	48
Western Europe	96	96	96	96	96	96	96
U.S.S.R.	150	150	150	150	150	150	150
OCEANIA	9	9	9	9	9	9	9

REGIONAL NITROGEN FERTILIZER DEMAND
(000 TONS N)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	2000/01
WORLD	**79,078**	**77,760**	**78,272**	**80,124**	**81,692**	**83,556**	**85,369**	**92,800**
AFRICA	**2,146**	**2,274**	**2,335**	**2,431**	**2,414**	**2,550**	**2,610**	**3,000**
AMERICA	**15,124**	**15,196**	**15,377**	**15,518**	**15,668**	**15,816**	**15,969**	**16,800**
North America	11,244	11,127	11,152	11,177	11,202	11,227	11,252	11,500
Central America	2,083	2,150	2,238	2,287	2,344	2,400	2,460	2,700
South America	1,797	1,919	1,987	2,054	2,122	2,189	2,257	2,600
ASIA	**35,929**	**37,290**	**38,530**	**39,855**	**41,010**	**42,300**	**43,610**	**49,300**
West Asia	2,529	2,680	2,800	2,970	2,950	3,000	3,050	3,300
South Asia	9,596	10,120	10,530	10,950	11,380	11,840	12,310	14,000
East Asia	23,804	24,490	25,200	25,935	26,680	27,460	28,250	32,000
EUROPE	**15,366**	**13,900**	**13,300**	**13,350**	**13,400**	**13,450**	**13,500**	**13,500**
Eastern Europe	4,393	3,500	3,000	3,250	3,500	3,750	4,000	4,500
Western Europe	10,973	10,400	10,300	10,100	9,900	9,700	9,500	9,000
U.S.S.R.	**10,045**	**8,600**	**8,200**	**8,400**	**8,600**	**8,800**	**9,000**	**9,500**
OCEANIA	**468**	**500**	**530**	**570**	**600**	**640**	**680**	**700**

REGIONAL INDUSTRIAL AND FEED NITROGEN DEMAND
(000 TONS N)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
WORLD	**10,370**	**10,340**	**10,310**	**10,270**	**10,350**	**10,370**	**10,420**
AFRICA	**280**	**280**	**280**	**280**	**280**	**280**	**280**
AMERICA	**3,750**	**3,770**	**3,780**	**3,790**	**3,800**	**3,800**	**3,830**
	3,500	3,510	3,520	3,530	3,540	3,530	3,560
Central America	100	110	110	110	110	120	120
South America	150	150	150	150	150	150	150
ASIA	**1,980**	**1,990**	**2,010**	**2,020**	**2,030**	**2,040**	**2,050**
West Asia	120	120	130	130	130	130	130
South Asia	150	150	150	150	150	150	150
East Asia	1,710	1,720	1,730	1,740	1,750	1,760	1,770
EUROPE	**3,080**	**3,070**	**3,060**	**3,050**	**3,060**	**3,070**	**3,080**
Eastern Europe	580	570	560	550	560	570	580
Western Europe	2,500	2,500	2,500	2,500	2,500	2,500	2,500
U.S.S.R.	**1,150**	**1,100**	**1,050**	**1,000**	**1,050**	**1,050**	**1,050**
OCEANIA	**130**	**130**	**130**	**130**	**130**	**130**	**130**

WORLD AND REGIONAL SUPPLY AND DEMAND BALANCES
(000 TONS N)

WORLD TOTAL	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
NH3 Nominal Capacity	114,646	113,682	114,695	116,849	120,057	122,345	123,646
NH3 Supply Capability	97,112	94,460	95,280	97,401	99,545	101,839	103,733
NH3 Industrial Use	10,370	10,340	10,310	10,270	10,350	10,370	10,420
Losses	6,939	6,730	6,798	6,970	7,136	7,318	7,465
NH3 Available for Ferts.	79,803	77,390	78,172	80,161	82,059	84,151	85,848
Non-NH3 Nitrogen	599	599	599	599	599	599	599
N Ferts.Supply Potential	80,402	77,989	78,771	80,760	82,658	84,750	86,447
N Ferts. Consumption	79,078	77,760	78,272	80,124	81,692	83,556	85,369
Surplus (-Deficit)	**1,324**	**229**	**499**	**636**	**966**	**1,194**	**1,078**

AFRICA	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1994/95
NH3 Nominal Capacity	3,351	3,416	3,416	3,688	3,803	4,075	4,075
NH3 Supply Capability	2,144	2,339	2,355	2,456	2,597	2,769	2,920
NH3 Industrial Use	280	280	280	280	280	280	280
Losses	149	165	166	174	185	199	211
NH3 Available for Ferts.	1,715	1,894	1,909	2,002	2,132	2,290	2,429
Non-NH3 Nitrogen	21	21	21	21	21	21	21
N Ferts.Supply Potential	1,736	1,915	1,930	2,023	2,153	2,311	2,450
N Ferts. Consumption	2,146	2,274	2,335	2,431	2,414	2,550	2,610
Surplus (-Deficit)	**(410)**	**(359)**	**(405)**	**(408)**	**(261)**	**(239)**	**(160)**

AMERICA	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
NH3 Nominal Capacity	21,787	21,734	21,888	22,362	22,490	22,490	22,978
NH3 Supply Capability	20,302	20,712	20,812	21,159	21,426	21,529	21,710
NH3 Industrial Use	3,750	3,770	3,780	3,790	3,800	3,800	3,830
Losses	1,324	1,355	1,363	1,390	1,410	1,418	1,430
NH3 Available for Ferts.	15,228	15,587	15,669	15,979	16,216	16,311	16,450
Non-NH3 Nitrogen	131	131	131	131	131	131	131
N Ferts.Supply Potential	15,359	15,718	15,800	16,110	16,347	16,442	16,581
N Ferts. Consumption	15,124	15,196	15,377	15,518	15,668	15,816	15,969
Surplus (-Deficit)	**235**	**522**	**423**	**592**	**679**	**626**	**612**

WORLD AND REGIONAL SUPPLY AND DEMAND BALANCES
(000 TONS N)

North America	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
NH3 Nominal Capacity	15,653	15,514	15,562	15,969	16,023	16,023	16,023
NH3 Supply Capability	14,977	15,317	15,326	15,599	15,824	15,901	15,920
NH3 Industrial Use	3,500	3,510	3,520	3,530	3,540	3,530	3,560
Losses	918	945	944	966	983	990	989
NH3 Available for Ferts.	10,559	10,862	10,862	11,103	11,301	11,381	11,371
Non-NH3 Nitrogen	128	128	128	128	128	128	128
N Ferts.Supply Potential	10,687	10,990	10,990	11,231	11,429	11,509	11,499
N Ferts. Consumption	11,244	11,127	11,152	11,177	11,202	11,227	11,252
Surplus (-Deficit)	**(557)**	**(137)**	**(162)**	**54**	**227**	**282**	**247**

Central America	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
NH3 Nominal Capacity	4,134	4,134	4,240	4,240	4,240	4,240	4,240
NH3 Supply Capability	3,677	3,697	3,752	3,808	3,808	3,808	3,808
NH3 Industrial Use	100	110	110	110	110	120	120
Losses	286	287	291	296	296	295	295
NH3 Available for Ferts.	3,291	3,300	3,351	3,402	3,402	3,393	3,393
Non-NH3 Nitrogen	0	0	0	0	0	0	0
N Ferts.Supply Potential	3,291	3,300	3,351	3,402	3,402	3,393	3,393
N Ferts. Consumption	2,083	2,150	2,238	2,287	2,344	2,400	2,460
Surplus (-Deficit)	**1,208**	**1,150**	**1,113**	**1,115**	**1,058**	**993**	**933**

South America	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
NH3 Nominal Capacity	2,000	2,086	2,086	2,153	2,227	2,227	2,715
NH3 Supply Capability	1,648	1,698	1,734	1,752	1,794	1,820	1,982
NH3 Industrial Use	150	150	150	150	150	150	150
Losses	120	124	127	128	132	134	147
NH3 Available for Ferts.	1,378	1,424	1,457	1,474	1,512	1,536	1,685
Non-NH3 Nitrogen	3	3	3	3	3	3	3
N Ferts.Supply Potential	1,381	1,427	1,460	1,477	1,515	1,539	1,688
N Ferts. Consumption	1,797	1,919	1,987	2,054	2,122	2,189	2,257
Surplus (-Deficit)	**(416)**	**(492)**	**(527)**	**(577)**	**(607)**	**(650)**	**(569)**

WORLD AND REGIONAL SUPPLY AND DEMAND BALANCES
(000 TONS N)

ASIA	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
NH3 Nominal Capacity	41,831	41,304	42,020	43,324	45,925	47,664	48,301
NH3 Supply Capability	34,970	34,437	34,796	36,194	37,762	39,591	40,825
NH3 Industrial Use	1,980	1,990	2,010	2,020	2,030	2,040	2,050
Losses	2,639	2,596	2,623	2,734	2,859	3,004	3,102
NH3 Available for Ferts.	30,351	29,851	30,163	31,440	32,873	34,547	35,673
Non-NH3 Nitrogen	144	144	144	144	144	144	144
N Ferts.Supply Potential	30,495	29,995	30,307	31,584	33,017	34,691	35,817
N Ferts. Consumption	35,929	37,290	38,530	39,855	41,010	42,300	43,610
Surplus (-Deficit)	(5,434)	(7,295)	(8,223)	(8,271)	(7,993)	(7,609)	(7,793)

West Asia	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
NH3 Nominal Capacity	5,687	4,872	5,144	5,551	5,551	5,551	5,551
NH3 Supply Capability	4,563	3,703	3,860	4,608	4,935	5,079	5,190
NH3 Industrial Use	120	120	130	130	130	130	130
Losses	355	287	298	358	384	396	405
NH3 Available for Ferts.	4,088	3,296	3,432	4,120	4,421	4,553	4,655
Non-NH3 Nitrogen	0	0	0	0	0	0	0
N Ferts.Supply Potential	4,088	3,296	3,432	4,120	4,421	4,553	4,655
N Ferts. Consumption	2,529	2,680	2,800	2,970	2,950	3,000	3,050
Surplus (-Deficit)	**1,559**	**616**	**632**	**1,150**	**1,471**	**1,553**	**1,605**

South Asia	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
NH3 Nominal Capacity	10,723	10,723	10,967	11,498	13,075	13,824	14,191
NH3 Supply Capability	8,739	8,865	8,863	9,273	10,009	10,935	11,477
NH3 Industrial Use	150	150	150	150	150	150	150
Losses	687	697	697	730	789	863	906
NH3 Available for Ferts.	7,902	8,018	8,016	8,393	9,070	9,922	10,421
Non-NH3 Nitrogen	24	24	24	24	24	24	24
N Ferts.Supply Potential	7,926	8,042	8,040	8,417	9,094	9,946	10,445
N Ferts. Consumption	9,596	10,120	10,530	10,950	11,380	11,840	12,310
Surplus (-Deficit)	**(1,670)**	**(2,078)**	**(2,490)**	**(2,533)**	**(2,286)**	**(1,894)**	**(1,865)**

WORLD AND REGIONAL SUPPLY AND DEMAND BALANCES
(000 TONS N)

East Asia	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
NH3 Nominal Capacity	25,421	25,709	25,909	26,275	27,299	28,289	28,559
NH3 Supply Capability	21,668	21,869	22,073	22,313	22,818	23,577	24,158
NH3 Industrial Use	1,710	1,720	1,730	1,740	1,750	1,760	1,770
Losses	1,597	1,612	1,627	1,646	1,685	1,745	1,791
NH3 Available for Ferts.	18,361	18,537	18,716	18,927	19,383	20,072	20,597
Non-NH3 Nitrogen	120	120	120	120	120	120	120
N Ferts.Supply Potential	18,481	18,657	18,836	19,047	19,503	20,192	20,717
N Ferts. Consumption	23,804	24,490	25,200	25,935	26,680	27,460	28,250
Surplus (-Deficit)	(5,323)	(5,833)	(6,364)	(6,888)	(7,177)	(7,268)	(7,533)

EUROPE	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
NH3 Nominal Capacity	24,000	23,775	23,838	23,757	23,878	23,934	23,934
NH3 Supply Capability	19,911	18,147	18,530	18,711	18,713	18,731	18,943
NH3 Industrial Use	3,080	3,070	3,060	3,050	3,060	3,070	3,080
Losses	1,346	1,206	1,238	1,253	1,252	1,253	1,269
NH3 Available for Ferts.	15,485	13,871	14,232	14,408	14,401	14,408	14,594
Non-NH3 Nitrogen	144	144	144	144	144	144	144
N Ferts.Supply Potential	15,629	14,015	14,376	14,552	14,545	14,552	14,738
N Ferts. Consumption	15,366	13,900	13,300	13,350	13,400	13,450	13,500
Surplus (-Deficit)	263	115	1,076	1,202	1,145	1,102	1,238

East Europe	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
NH3 Nominal Capacity	10,160	10,147	10,210	10,210	10,426	10,426	10,426
NH3 Supply Capability	7,075	6,095	6,249	6,414	6,470	6,518	6,714
NH3 Industrial Use	580	570	560	550	560	570	580
Losses	520	442	455	469	473	476	491
NH3 Available for Ferts.	5,975	5,083	5,234	5,395	5,437	5,472	5,643
Non-NH3 Nitrogen	48	48	48	48	48	48	48
N Ferts.Supply Potential	6,023	5,131	5,282	5,443	5,485	5,520	5,691
N Ferts. Consumption	4,393	3,500	3,000	3,250	3,500	3,750	4,000
Surplus (-Deficit)	1,630	1,631	2,282	2,193	1,985	1,770	1,691

WORLD AND REGIONAL SUPPLY AND DEMAND BALANCES
(000 TONS N)

West Europe	**1989/90**	**1990/91**	**1991/92**	**1992/93**	**1993/94**	**1994/95**	**1995/96**
NH3 Nominal Capacity	13,840	13,628	13,628	13,547	13,452	13,508	13,508
NH3 Supply Capability	12,836	12,052	12,281	12,297	12,243	12,213	12,229
NH3 Industrial Use	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Losses	827	764	782	784	779	777	778
NH3 Available for Ferts.	9,509	8,788	8,999	9,013	8,964	8,936	8,951
Non-NH3 Nitrogen	96	96	96	96	96	96	96
N Ferts.Supply Potential	9,605	8,884	9,095	9,109	9,060	9,032	9,047
N Ferts. Consumption	10,973	10,400	10,300	10,100	9,900	9,700	9,500
Surplus (-Deficit)	**(1,368)**	**(1,516)**	**(1,205)**	**(991)**	**(840)**	**(668)**	**(453)**

USSR	**1989/90**	**1990/91**	**1991/92**	**1992/93**	**1993/94**	**1994/95**	**1995/96**
NH3 Nominal Capacity	23,067	22,843	22,923	23,108	23,351	23,572	23,748
NH3 Supply Capability	19,232	18,272	18,234	18,328	18,494	18,666	18,782
NH3 Industrial Use	1,150	1,100	1,050	1,000	1,050	1,050	1,050
Losses	1,447	1,374	1,375	1,386	1,396	1,409	1,419
NH3 Available for Ferts.	16,635	15,798	15,809	15,942	16,048	16,207	16,313
Non-NH3 Nitrogen	150	150	150	150	150	150	150
N Ferts.Supply Potential	16,785	15,948	15,959	16,092	16,198	16,357	16,463
N Ferts. Consumption	10,045	8,600	8,200	8,400	8,600	8,800	9,000
Surplus (-Deficit)	**6,740**	**7,348**	**7,759**	**7,692**	**7,598**	**7,557**	**7,463**

OCEANIA	**1989/90**	**1990/91**	**1991/92**	**1992/93**	**1993/94**	**1994/95**	**1995/96**
NH3 Nominal Capacity	610	610	610	610	610	610	610
NH3 Supply Capability	553	553	553	553	553	553	553
NH3 Industrial Use	130	130	130	130	130	130	130
Losses	34	34	34	34	34	34	34
NH3 Available for Ferts.	389	389	389	389	389	389	389
Non-NH3 Nitrogen	9	9	9	9	9	9	9
N Ferts.Supply Potential	398	398	398	398	398	398	398
N Ferts. Consumption	468	500	530	570	600	640	680
Surplus (-Deficit)	**(70)**	**(102)**	**(132)**	**(172)**	**(202)**	**(242)**	**(282)**

NITROGEN FERTILIZER CONSUMPTION 1979/80 - 1989/90
(000 TONS N)

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
WORLD	57.166	60.725	60.305	61.019	67.117	70.513	69.969	71.602	76.037	79.658	79.078
AFRICA	1.495.6	1.811.0	1.889.3	1.865.0	1.830.9	1.845.1	1.970.0	1.960.3	1.884.4	2.095.3	2.146.3
Algeria	60.3	84.0	71.0	48.7	59.3	87.7	98.1	112.7	97.4	76.0	82.0
Angola	9.4	9.2	4.6	2.8	3.8	3.7	12.8	5.0	4.0	5.2	9.2
Benin	0.9	0.4	0.5	1.1	3.0	3.6	3.8	4.4	3.4	2.1	1.1
Botswana	0.5	0.6	0.6	0.6	0.5	0.4	0.1	0.2	0.3	0.3	0.3
Burkina Faso	2.0	1.2	3.1	3.7	4.1	4.2	4.7	6.4	7.4	8.0	8.2
Burundi	0.5	0.9	0.3	0.5	1.2	0.6	1.6	1.1	1.0	1.0	2.0
Cameroon	14.2	18.1	22.7	24.2	22.0	26.0	26.9	20.7	24.6	22.0	18.2
Centr. African Rep.	0.1	1.4	1.2	0.7	0.3	1.1	2.5	0.6	0.8	0.6	0.7
Chad	0.0	0.5	1.6	1.7	2.5	3.0	3.2	2.6	2.0	2.2	2.0
Congo	0.1	0.2	0.2	0.9	0.8	0.9	1.3		0.1	0.5	0.2
Cote d'Ivoire	16.6	19.7	11.3	7.4	10.0	11.0	8.2	8.0	4.5	8.2	10.0
Egypt	500.0	554.0	585.0	667.8	722.2	649.2	640.3	655.4	677.0	799.1	800.0
Ethiopia	16.0	16.0	16.0	15.0	18.0	13.0	25.8	32.6	22.4	30.2	38.0
Gabon	0.1	0.1	0.8	0.2	0.6	0.5	0.5	0.6	1.0	0.3	0.4
Gambia	1.5	0.6	0.3	0.8	1.1	1.0	3.0	3.0	0.8	1.4	2.0
Ghana	8.4	5.0	13.0	12.5	11.0	5.0	5.0	4.1	5.1	7.0	5.8
Guinea	1.1	0.1	0.5	0.7		0.1	0.2	0.3	0.3	0.3	0.4
Guinea Bissau	0.1	0.1	1.2	0.2	0.3				0.3		0.3
Kenya	20.1	26.7	37.0	34.2	31.0	36.0	57.5	63.7	43.4	67.2	45.0
Lesotha	0.4	0.5	0.5	0.5	0.5	0.6	0.1	0.1	0.4	0.4	0.5
Liberia	4.2	2.1	2.0	0.7	0.9	0.4	1.0	0.8	1.6	1.6	1.4
Libya	22.5	29.5	30.5	35.2	33.9	56.4	20.9	24.8	25.1	32.5	30.0
Madagascar	3.4	4.0	3.5	6.6	7.4	2.0	5.6	4.7	8.4	3.8	4.0
Malawi	14.4	22.8	25.7	24.2	23.1	23.6	15.9	17.5	29.8	27.2	30.3
Mali	4.0	7.8	5.7	2.4	8.6	15.0	13.0	16.5	23.0	9.0	8.7
Mauritania	1.2	0.4			0.4	0.4	1.9	0.9	0.9	2.0	1.7
Mauritius	9.8	10.2	9.5	9.9	10.7	10.6	11.0	9.9	12.6	11.0	11.5
Morocco	100.8	122.6	81.1	92.4	111.5	103.6	136.5	153.3	132.9	142.5	150.7
Mozambique	10.8	16.2	20.1	20.0	7.5	1.7	1.7	2.0	3.0	1.1	1.7
Niger	0.8	1.2	2.4	1.3	1.4	1.5	2.1	2.0	1.5	1.1	1.8
Nigeria	62.4	92.2	96.7	102.0	123.5	131.0	159.0	160.0	148.0	160.0	197.0
Reunion	5.1	1.8	5.3	3.5	6.3	4.7	5.1	5.4	4.2	5.2	5.7
Rwanda	0.1	0.1	0.1	0.4	0.5	1.0	1.0	0.8	1.3	0.3	0.6
Senegal	8.0	6.8	6.3	3.4	8.0	8.0	7.0	7.5	7.0	8.0	9.0
Sierra Leone	1.2	0.8	1.2	0.2	0.4	0.5	1.6	1.8	0.2	1.3	1.4
Somalia	0.1	1.2	1.3	0.8	1.8	2.6	3.2	0.9	3.0	1.3	1.4
South Africa	403.0	466.4	527.2	474.5	367.8	406.7	367.3	361.7	328.2	380.8	371.9
Sudan	33.8	80.4	74.5	54.0	36.8	41.4	92.0	46.0	30.0	45.6	46.9
Swaziland	3.7	7.5	8.5	8.5	10.0	4.5	5.1	5.5	3.1	4.0	4.0
Tanzania	23.0	22.8	17.5	16.4	15.5	23.5	24.7	29.5	30.9	27.0	28.7
Togo	1.6	0.9	0.8	1.0	1.2	2.6	3.7	4.0	4.9	5.2	6.5
Tunisia	27.0	23.8	30.5	39.9	32.8	41.5	44.9	47.1	50.6	46.4	51.0
Uganda		0.7	0.5			0.4	0.2	0.4	0.5	0.1	0.3
Zaire	5.1	3.7	2.5	2.1	4.1	4.5	3.6	0.1	1.8	1.9	4.0
Zambia	38.2	53.0	66.5	68.3	43.3	37.8	53.4	53.8	62.2	56.2	60.0
Zimbabwe	59.1	92.8	98.0	73.1	81.3	71.6	93.0	81.9	73.5	88.2	89.8

NITROGEN FERTILIZER CONSUMPTION 1979/80 - 1989/90
(000 TONS N)

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
AMERICA	13,835.7	14,595.0	13,798.1	12,247.5	13,897.9	14,883.4	14,139.5	14,302.3	14,683.7	14,569.2	15,123.7
North America	11,178.9	11,731.0	10,929.5	9,359.6	11,219.8	11,680.9	10,681.8	10,406.9	10,688.5	10,769.2	11,244.2
Canada	831.0	914.0	965.9	1,018.0	1,157.2	1,255.1	1,225.0	1,145.0	1,185.5	1,160.2	1,196.3
U.S.A.	10,347.9	10,817.0	9,963.6	8,341.6	10,062.6	10,425.8	9,456.8	9,261.9	9,503.0	9,609.0	10,047.9
Central America	1,355.8	1,425.2	1,713.1	1,779.6	1,626.2	1,767.7	1,862.0	1,997.0	2,021.9	1,944.4	2,082.5
Bahamas	0.4	0.5	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2
Barbados	1.7	1.8	2.0	2.0	1.6	1.6	1.3	1.4	1.5	1.5	1.5
Belize	0.7	0.8	0.5	0.5	0.7	0.8	1.1	2.0	1.5	1.8	1.9
Bermuda	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1
Costa Rica	39.4	40.5	45.2	49.0	54.0	50.6	49.0	52.0	55.0	59.0	63.0
Cuba	280.4	267.4	315.0	275.2	248.7	294.4	293.6	328.0	306.0	304.7	366.7
Dominica	0.5	0.9	1.0	1.0	0.8	0.8	0.9	1.0	1.0	1.0	2.0
Dominician Rep.	34.3	28.2	31.4	30.7	25.0	31.3	33.0	37.0	44.0	25.1	32.8
El Salvador	50.6	47.7	66.5	44.2	59.4	39.8	61.1	49.1	64.5	67.8	56.2
Guadeloupe	2.2	2.1	1.3	2.3	3.1	2.9	3.5	3.6	2.3	4.1	3.9
Guatemala	58.2	51.9	47.0	58.7	41.7	55.5	60.0	80.0	85.0	82.2	90.5
Haiti	2.3	0.2	3.0	2.6	1.6	2.0	1.6	1.0	1.3	1.4	2.3
Honduras	10.4	16.0	14.1	12.8	19.0	23.0	14.1	20.3	23.4	21.5	20.3
Jamaica	6.4	8.7	10.2	6.0	6.7	8.8	5.9	6.6	12.0	16.0	16.0
Martinique	3.6	5.4	4.3	4.4	5.4	3.0	5.0	6.0	7.0	6.4	6.4
Mexico	826.1	904.3	1,111.7	1,254.6	1,087.8	1,193.1	1,262.6	1,324.9	1,345.0	1,269.6	1,335.0
Nicaragua	17.8	30.0	39.0	14.2	51.4	38.0	44.9	55.1	44.1	55.0	60.0
Panama	11.9	11.4	13.9	13.9	11.0	12.2	14.0	20.6	20.3	21.1	18.7
St. Chris Etc.	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5
Saint Lucia	1.4	0.7	0.8	0.8	1.2	1.5	1.7	1.5	1.5	1.5	1.5
St. Vincent	2.4	2.4	2.4	2.4	2.4	2.5	2.5	2.6	2.6	2.6	1.5
Trinidad Etc.	4.7	3.9	2.8	3.4	3.9	5.0	5.5	3.5	3.1	1.3	1.5
South America	1,301.0	1,438.8	1,155.5	1,108.3	1,051.9	1,434.8	1,595.7	1,898.4	1,973.3	1,855.6	1,797.0
Argentina	58.9	62.7	51.2	53.2	64.6	90.0	104.6	93.0	94.5	99.1	102.0
Bolivia	1.6	1.4	2.7	1.3	3.1	2.5	2.7	2.8	4.4	3.1	3.6
Brazil	778.7	905.5	657.8	642.3	553.1	813.8	852.3	981.1	957.8	815.0	823.3
Chile	50.7	51.4	48.2	48.3	64.9	86.3	106.1	136.0	150.0	160.0	187.0
Colombia	151.0	151.2	143.0	155.0	157.4	180.9	184.9	211.5	248.9	236.0	233.5
Ecuador	43.3	40.7	34.8	33.2	47.0	43.0	43.2	62.8	45.0	40.0	53.4
French Guyana	0.1	0.1	0.2	0.2	0.4	0.4	0.4	0.5	0.5	0.5	0.3
Guyana	6.5	4.3	9.3	7.2	9.6	9.7	7.3	12.4	8.0	10.6	12.0
Paraguay	1.1	1.4	2.3	2.0	1.7	1.3	3.5	3.8	1.9	2.2	3.5
Peru	86.4	84.8	100.6	71.2	52.9	53.8	50.6	121.5	159.5	156.1	113.9
Suriname	1.9	1.2	5.4	7.1	7.1	10.5	7.5	8.0	7.4	1.6	1.3
Uraguay	21.8	21.1	20.4	16.5	16.7	19.5	17.1	15.0	15.5	30.9	22.1
Venezuela	97.0	113.0	69.6	70.8	73.4	123.1	215.5	250.0	279.9	300.5	241.1

NITROGEN FERTILIZER CONSUMPTION 1979/80 - 1989/90
(000 TONS N)

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
ASIA	19.525.2	21.452.6	21.525.9	22.818.7	25.624.6	27.853.9	27.169.1	27.740.6	31.599.9	35.019.0	35.929.3
West Asia	1.208.4	1.372.4	1.480.8	1.696.9	2.043.2	1.946.8	2.021.8	2.194.2	2.269.1	2.349.7	2.528.7
Afghanistan	33.2	37.8	25.6	31.4	36.8	52.8	53.2	50.5	52.2	49.8	50.0
Bahrain			0.3		0.2	0.3	0.2	0.9	1.2	0.1	0.1
Cyprus	9.1	8.2	9.0	11.6	10.6	10.1	10.1	11.3	11.6	12.1	12.5
Iran	237.0	274.8	386.6	492.8	596.6	489.5	465.3	529.0	524.1	548.4	668.3
Iraq	74.2	64.5	63.6	62.1	61.3	73.0	120.0	131.5	148.5	146.5	138.4
Israel	35.7	39.5	35.8	39.2	47.1	55.5	52.8	49.8	52.0	54.0	56.0
Jordan	6.2	6.0	2.9	7.1	8.8	7.0	10.7	10.8	9.8	14.3	15.0
Kuwait	0.3	0.1	0.3	0.6	0.8	0.5	0.7	0.4	0.3	0.8	0.8
Lebanon	16.0	14.0	16.9	17.3	18.0	17.4	11.9	10.6	10.0	11.3	14.0
Oman	0.8	0.7	1.0	0.7	0.6	0.4	2.3	2.1	2.2	2.4	2.4
Qatar	0.6	0.8	0.8	0.7	0.6	0.6	0.5	0.7	0.7	0.6	1.1
Saudi Arabia	16.0	25.2	41.5	59.0	113.3	138.6	169.0	181.8	219.0	256.2	265.0
Syria Arab Rep.	78.9	79.8	83.1	95.9	109.5	126.7	137.0	143.6	116.6	160.6	153.6
Turkey	685.5	807.5	798.8	863.4	1,021.4	954.8	968.0	1,056.1	1,110.7	1,081.6	1,140.4
United Arab Emirates	2.1	2.3	2.3	2.9	2.5	3.0	2.8	1.0	2.0	2.0	2.0
Yemen	12.8	11.2	12.3	12.2	15.1	16.6	17.3	14.1	8.2	9.0	9.1
South Asia	4.572.9	4.741.4	5.061.7	5.410.0	6.009.1	6.786.4	7.379.3	7.662.4	7.732.9	9.243.7	9.596.2
Bangladesh	260.2	267.9	251.6	306.0	356.4	386.3	367.8	423.0	474.6	524.0	629.8
India	3,444.2	3,522.0	3,881.7	4,043.0	4,627.3	5,333.3	5,750.0	5,772.7	5,835.6	7,246.1	7,396.0
Nepal	15.5	16.3	17.3	23.0	28.1	31.7	31.7	35.0	37.4	39.8	50.0
Pakistan	775.8	843.6	832.6	958.6	914.3	934.8	1,128.1	1,332.4	1,281.4	1,324.8	1,422.4
Sri Lanka	77.2	91.6	78.5	79.4	83.0	100.3	101.7	99.3	103.9	109.0	98.0
East Asia	13.743.9	15.338.8	14.983.4	15.711.8	17.572.3	19.150.7	17.768.0	17.884.0	21.597.9	23.425.6	23.804.4
Cambodia		7.2	10.5	7.3	1.6	0.5					
China	10,641.0	12,112.1	11,528.3	12,210.0	13,678.9	15,075.0	13,650.0	13,470.0	16,994.0	18,514.0	18,855.3
Indonesia	620.4	850.9	997.0	981.0	1,049.1	1,285.4	1,299.0	1,359.0	1,460.3	1,585.4	1,559.4
Japan	777.0	614.0	643.0	687.0	701.0	697.0	680.0	687.0	669.0	640.0	641.0
Malaysia	137.7	139.3	127.9	138.0	235.0	216.0	243.0	247.0	262.0	273.0	267.0
Mongolia	4.6	5.7	9.5	9.7	11.7	11.8	13.1	12.8	14.3	11.3	10.0
Myanmar	69.7	66.8	92.9	114.7	115.0	127.4	134.0	142.0	97.5	86.6	70.0
Korea, D.P.R.	540.0	550.0	564.1	591.6	582.8	597.0	623.0	605.5	602.0	634.0	644.0
Korea Rep. of	443.9	447.2	431.8	308.6	367.3	401.8	414.0	418.0	450.9	439.0	446.0
Laos	0.1	4.0	4.0	0.5	0.5		1.4		0.3	0.1	0.1
Philippines	226.7	224.8	210.7	231.4	240.2	177.9	205.3	300.6	372.3	371.0	375.9
Singapore	1.8	1.8	2.0	2.0	2.0	2.0	2.2	2.2	2.5	2.6	2.6
Thailand	160.0	159.0	162.0	180.0	236.2	248.9	238.0	319.9	342.8	439.7	498.0
Vietnam, Dem. Rep.	121.0	156.0	199.7	250.0	351.0	310.0	265.0	320.0	330.0	428.9	435.1

NITROGEN FERTILIZER CONSUMPTION 1979/80 - 1989/90
(000 TONS N)

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
EUROPE	14.559.8	14.321.9	14.416.5	14.766.8	15.149.4	15.236.6	15.354.7	15.717.5	15.654.8	15.936.4	15.365.4
Eastern Europe	4.230.1	4.136.6	4.340.4	4.484.2	4.572.9	4.436.1	4.294.8	4.346.6	4.263.3	4.668.2	4.393.0
Albania	70.9	67.7	72.5	73.0	73.0	75.0	75.0	75.0	66.1	69.3	79.9
Bulgaria	420.6	450.0	518.0	536.0	550.0	479.0	474.0	440.0	418.0	548.0	495.0
Czechoslovakia	630.0	675.0	615.0	646.0	682.0	691.7	670.8	646.2	589.0	642.0	704.8
Hungary	570.1	536.8	562.9	647.0	625.4	625.9	558.4	593.4	613.8	646.3	617.2
Poland	1,312.5	1,343.8	1,213.0	1,239.2	1,321.5	1,238.5	1,336.6	1,370.0	1,335.4	1,520.6	1,273.9
Romania	786.0	646.3	882.0	880.0	878.0	857.0	703.0	716.0	720.0	739.0	778.2
Yugoslavia	440.0	417.0	477.0	463.0	443.0	469.0	477.0	506.0	521.0	503.0	444.0
Western Europe	10.329.7	10.185.3	10.076.1	10.282.6	10.576.5	10.800.5	11.059.9	11.370.9	11.391.5	11.268.2	10.972.4
Austria	158.0	159.7	161.5	146.3	152.5	161.1	165.1	136.7	131.5	140.9	135.6
Belgium-Lux.	197.8	194.3	195.3	197.0	198.8	199.0	195.0	199.0	199.0	196.0	195.0
Denmark	393.9	374.1	376.0	391.4	419.0	398.0	382.0	380.0	362.0	377.0	385.5
Finland	196.2	196.9	183.6	216.0	204.8	196.1	202.2	218.0	214.3	199.4	231.6
France	2,134.8	2,146.5	2,193.0	2,196.4	2,320.0	2,336.8	2,408.0	2,568.4	2,557.1	2,603.7	2,660.0
Germany D.R.	747.6	751.8	750.0	607.0	693.9	697.0	770.3	708.9	773.9	873.2	766.2
Germany F.R.	1,477.5	1,550.8	1,323.0	1,464.5	1,377.8	1,451.7	1,515.7	1,578.3	1,601.4	1,539.9	1,487.2
Greece	356.1	333.3	372.9	408.0	417.9	428.3	450.0	425.0	430.0	409.2	425.7
Iceland	15.7	14.9	15.2	14.0	14.8	13.5	12.9	12.6	11.4	11.5	11.0
Ireland	247.5	275.1	275.2	296.0	331.4	329.7	313.7	323.0	340.0	349.0	348.5
Italy	1,106.8	1,006.0	988.0	967.8	996.1	1,026.3	1,054.5	1,010.6	1,059.0	924.0	827.3
Malta	0.5	1.0	0.3	0.2	0.5	0.5	0.5	0.5	0.5	0.4	0.4
Netherlands	486.1	482.8	477.3	456.7	478.3	505.3	499.7	504.0	458.2	435.0	421.0
Norway	113.2	110.1	106.7	114.1	110.3	113.3	107.3	109.7	113.6	110.1	110.4
Portugal	155.0	136.6	142.8	138.8	125.7	123.2	137.2	149.8	153.0	156.5	145.4
Spain	908.2	901.9	818.3	796.9	808.5	916.8	960.0	1,063.5	1,147.8	1,168.4	1,109.4
Sweden	256.3	243.9	248.1	249.3	257.8	253.2	245.9	240.8	241.2	240.4	221.5
Switzerland	64.5	65.6	62.9	60.2	67.4	70.7	71.9	71.1	72.6	71.6	69.7
United Kingdom	1,314.0	1,240.0	1,386.0	1,560.0	1,601.0	1,580.0	1,568.0	1,671.0	1,525.0	1,462.0	1,421.0
U.S.S.R.	7.467.0	8.262.0	8.383.0	9.038.0	10.302.0	10.279.0	10.950.0	11.475.0	11.787.0	11.587.0	10.045.0
OCEANIA	283.0	282.9	292.6	283.4	312.5	384.6	385.8	406.3	427.6	451.0	467.8
Australia	245.0	248.0	250.0	248.0	269.0	330.0	340.0	360.0	372.1	393.9	409.0
New Zealand	22.3	20.3	21.7	21.0	31.4	40.0	32.0	27.0	36.8	40.0	38.5
Fiji	12.1	10.8	12.8	10.3	7.5	10.1	7.8	12.0	10.6	10.1	13.2
Papua N. Guinea etc	3.6	3.8	8.1	4.1	4.6	4.5	6.0	7.3	8.1	7.0	7.1

COUNTRY AMMONIA CAPACITY 1979/80 - 1990/91
(000 TONS N)

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
WORLD	94.294	95.023	97.526	100.651	104.765	106.518	109.256	109.845	112.264	114.246	114.646	113.682
AFRICA	1.702	2.109	2.381	2.710	2.617	2.617	2.617	2.914	3.232	3.397	3.351	3.416
Algeria	0	0	272	272	272	272	272	544	544	816	816	816
Egypt	641	966	966	966	966	966	966	966	966	966	966	977
Libyan Arab Rep.	272	272	272	544	544	544	544	544	544	544	544	598
Malagasy Republic	0	0	0	0	0	0	0		46	46	0	
Nigeria									272	272	272	272
Somalia	0	0	0	0	0	0	0	25	25			
South Africa	701	783	783	783	690	690	690	690	690	608	608	608
Zambia	25	25	25	82	82	82	82	82	82	82	82	82
Zimbabwe	63	63	63	63	63	63	63	63	63	63	63	63
AMERICA	22.055	21.781	21.727	21.793	22.264	22.136	22.393	22.132	22.423	21.911	21.787	21.734
North America	18.125	17.824	16.760	16.501	16.726	16.598	16.904	16.371	16.319	15.777	15.653	15.514
Canada	2,163	2,163	2,175	2,455	2,901	2,901	3,207	3448	3,369	3141	3116	2930
U.S.A.	15,962	15,661	14,585	14,046	13,825	13,697	13,697	12923	12,950	12636	12537	12584
Central America	2.531	2.531	3.541	3.541	3.541	3.541	3.492	3.764	4.134	4.134	4.134	4.134
Cuba	321	321	321	321	321	321	321	321	321	321	321	321
Mexico	1,730	1,730	2,468	2,468	2,468	2,468	2,419	2419	2,419	2419	2419	2419
Trinidad	480	480	752	752	752	752	752	1024	1,394	1394	1394	1394
South America	1.399	1.426	1.426	1.751	1.997	1.997	1.997	1.997	1.970	2.000	2.000	2.086
Argentina	59	59	59	59	59	59	59	59	59	59	59	80
Brazil	450	450	450	775	1,021	1,021	1,021	1021	994	1024	1024	1074
Colombia	123	150	150	150	150	150	150	150	150	150	150	165
Peru	116	116	116	116	116	116	116	116	116	116	116	116
Venezuela	651	651	651	651	651	651	651	651	651	651	651	651

COUNTRY AMMONIA CAPACITY 1979/80 - 1990/91
(000 TONS N)

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
ASIA	29.713	30.274	31.467	32.053	32.768	33.580	35.984	36.565	38.541	41.010	41.831	41.304
West Asia	3.098	1.738	2.010	2.323	2.595	2.895	3.167	3.493	4.408	4.950	5.687	4.872
Abu Dhabi	0	0	0	0	272	272	272	272	272	272	272	272
Bahrain	0	0	0	0	0	272	272	272	272	272	326	326
Iran	582	38	38	38	38	38	38	364	364	636	908	908
Iraq	816	0	0	41	41	41	41	41	585	857	857	857
Israel	68	68	68	68	68	68	68	68	68	68	68	68
Kuwait	543	543	543	543	543	543	815	815	815	815	815	0
Qatar	488	488	488	488	488	488	488	488	488	488	488	488
Saudi Arabia	163	163	163	435	435	435	435	435	845	845	1256	1256
Syria Arab Rep.	41	41	313	313	313	313	313	313	272	272	272	272
Turkey	397	397	397	397	397	425	425	425	425	425	425	425
South Asia	5.085	6.189	6.746	7.386	7.460	7.558	9.140	9.140	9.583	10.684	10.723	10.723
Afghanistan	58	58	58	58	58	58	58	58	58	58	58	58
Bangladesh	233	233	505	505	505	554	554	554	826	826	826	826
Myanmar	66	66	66	66	66	115	213	213	213	213	213	213
India	4,181	4,913	5,026	5,621	5,695	5,695	7,163	7163	7,326	8427	8416	8416
Pakistan	547	919	1,091	1,136	1,136	1,136	1,152	1152	1,160	1160	1210	1210
East Asia	21.530	22.347	22.711	22.344	22.713	23.127	23.677	23.932	24.552	25.376	25.421	25.709
China	15,376	15,985	16,394	16,394	16,394	16,394	17,210	17510	18,130	18764	18769	19244
Indonesia	1,104	1,104	1,104	1,104	1,782	2,460	2,460	2460	2,460	2732	2772	2777
Japan	2,773	2,773	2,728	2,685	2,376	2,260	1,722	1677	1,677	1636	1636	1636
Malaysia	41	41	41	41	41	41	313	313	313	272	272	322
Korea, D.P.R.	671	879	879	879	879	879	879	879	879	879	879	879
Korea Rep. of	1,058	1,058	1,058	734	734	734	734	734	734	734	734	492
Taiwan	453	453	453	453	453	305	305	305	305	305	305	305
Vietnam, Dem. Rep.	54	54	54	54	54	54	54	54	54	54	54	54

COUNTRY AMMONIA CAPACITY 1979/80 - 1990/91
(000 TONS N)

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
EUROPE	24.276	24.023	23.633	23.796	24.682	24.715	25.012	24.851	24.561	24.338	24.000	23.775
Eastern Europe	8.240	8.160	8.160	8.442	9.059	9.438	9.585	9.789	9.969	9.969	10.160	10.147
Albania	82	82	82	82	82	82	82	82	82	82	82	137
Bulgaria	957	957	957	1,066	1,066	1,111	1,111	1111	1,351	1351	1721	1721
Czechoslovakia	844	844	844	844	844	974	874	874	874	874	874	982
Hungary	817	817	817	817	817	817	817	817	777	777	777	777
Poland	1,800	1,800	1,800	1,800	1,800	2,004	2,004	2208	2,208	2208	2208	2208
Romania	3,165	3,085	3,085	3,258	3,505	3,505	3,505	3505	3,505	3505	3505	3505
Yugoslavia	575	575	575	575	945	945	1,192	1192	1,192	1192	993	817
Western Europe	16.036	15.863	15.473	15.354	15.623	15.277	15.427	15.062	14.572	14.349	13.840	13.628
Austria	380	380	380	380	380	380	410	410	410	410	410	410
Belgium-Lux.	573	573	573	573	573	573	376	376	376	376	309	803
Finland	65	65	65	65	65	65	65	65	65	65	65	65
France	2,765	2,765	2,765	2,765	2,684	2,467	2,541	2359	2,213	1812	1812	1812
Germany D.R.	1,319	1,319	1,319	1,319	1,319	1,319	1,319	1319	1319	1499	1499	1059
Germany F.R.	2,426	2,426	2,226	2,147	2,147	2,032	1,992	1992	1,992	1992	1826	1771
Greece	266	266	266	266	266	266	376	331	331	331	331	331
Iceland	12	12	12	12	12	12	12	12	12	12	12	12
Ireland	403	365	365	365	365	365	365	365	365	365	365	365
Italy	1,628	1,612	1,568	1,582	1,582	1,582	1,608	1608	1,608	1548	1408	1452
Netherlands	2,312	2,189	2,189	2,189	2,596	2,719	2,764	2764	2,959	3017	3053	3053
Norway	647	647	647	647	647	647	585	585	540	440	440	440
Portugal	263	263	263	263	206	150	394	350	350	350	244	244
Spain	1,079	1,038	892	892	892	811	704	704	633	688	688	688
Sweden	103	103	103	49	49	49	49	49	49			
Switzerland	53	53	53	53	53	53	53	53	53	53	37	37
United Kingdom	1,742	1,787	1,787	1,787	1,787	1,787	1,814	1720	1,297	1391	1341	1086
U.S.S.R.	16.099	16.387	17.869	19.774	21.909	22.945	22.725	22.858	22.903	22.980	23.067	22.843
OCEANIA	449	449	449	525	525	525	525	525	604	610	610	610
Australia	449	449	449	449	449	449	449	449	528	534	534	534
New Zealand	0	0	0	76	76	76	76	76	76	76	76	76

REGIONAL AMMONIA PLANT CLOSURES 1979/80 - 1990/91
(000 TONS N)

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
WORLD	871	942	1,623	1,633	984	1,518	1,185	1,631	2,128	1,767	1,673	2,567
AFRICA	0	0	0	0	175	0	0	0	107	46	0	98
Algeria												
Egypt												98
Libyan Arab Rep.												
Malagasy Republic										46		
Nigeria												
Somalia									25			
South Africa					175				82			
Zambia												
Zimbabwe												
AMERICA	56	398	1,188	539	256	167	309	870	404	692	150	241
North America	56	398	1,188	539	256	167	260	870	377	692	150	241
Canada			51						377	253	25	186
U.S.A.	56	398	1,137	539	256	167	260	870		439	125	55
Central America	0	0	0	0	0	0	49	0	0	0	0	0
Cuba												
Mexico							49					
Trinidad												
South America	0	0	0	0	0	0	0	0	27	0	0	0
Argentina												
Brazil									27			
Colombia												
Peru												
Venezuela												

COUNTRY UREA CAPACITIES 1976/77 - 1995/96
(000 TONS N)

	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
WORLD	20,930	23,468	25,851	28,211	31,250	32,523	34,041	35,658	37,399	39,141
AFRICA	270	270	270	446	638	819	896	924	1,151	1,189
Algeria	0	0	0	0	0	0	0	67	67	67
Egypt	0	0	0	176	368	474	474	474	474	474
Libyan Arab Rep.	0	0	0	0	0	75	152	152	418	418
Malagasy Republic	0	0	0	0	0	0	0	0	0	0
Nigeria	0	0	0	0	0	0	0	0	0	0
Somalia	0	0	0	0	0	0	0	0	0	0
South Africa	270	270	270	270	270	270	270	231	192	230
Zambia	0	0	0	0	0	0	0	0	0	0
Zimbabwe	0	0	0	0	0	0	0	0	0	0
AMERICA	4,170	4,319	4,808	4,954	5,265	5,586	5,918	6,386	6,763	6,675
North America	3,143	3,330	3,740	3,886	4,045	4,138	4,077	4,424	4,461	4,373
Canada	475	572	572	613	649	704	728	1,027	1,027	1,009
USA	2,668	2,758	3,168	3,273	3,396	3,434	3,349	3,397	3,434	3,364
Central America	318	318	318	318	470	584	697	799	1,139	1,139
Cuba	88	88	88	88	88	88	88	88	88	88
Mexico	199	199	199	199	351	465	578	578	805	805
Trinidad	31	31	31	31	31	31	31	133	246	246
South America	709	671	750	750	750	864	1,144	1,163	1,163	1,163
Argentina	29	29	29	29	29	29	29	48	48	48
Brazil	37	37	158	158	158	272	552	552	552	552
Colombia	88	50	8	8	8	8	8	8	8	8
Peru	77	77	77	77	77	77	77	77	77	77
Venezuela	478	478	478	478	478	478	478	478	478	478

COUNTRY UREA CAPACITIES 1976/77 - 1995/96
(000 TONS N)

	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
WORLD	41.092	40.763	42.318	43.916	44.382	45.554	46.977	49.758	51.487	51.870
AFRICA	1.189	1.226	1.339	1.339	1.339	1.339	1.339	1.381	1.609	1.542
Algeria	67	67	67	67	67	67	67	67	67	0
Egypt	474	474	474	474	474	474	474	474	474	474
Libyan Arab Rep.	418	418	418	418	418	418	418	418	418	418
Malagasy Republic	0	0	0	0	0	0	0	42	42	42
Nigeria	0	76	228	228	228	228	228	228	456	456
Somalia	0	0	0	0	0	0	0	0	0	0
South Africa	230	191	152	152	152	152	152	152	152	152
Zambia	0	0	0	0	0	0	0	0	0	0
Zimbabwe	0	0	0	0	0	0	0	0	0	0
AMERICA	6.674	6.653	6.603	6.649	6.718	6.745	7.151	7.220	7.220	7.220
North America	4.372	4.377	4.351	4.362	4.397	4.397	4.803	4.803	4.803	4.803
Canada	991	994	994	994	994	994	1,400	1,400	1,400	1,400
USA	3,381	3,383	3,357	3,368	3,403	3,403	3,403	3,403	3,403	3,403
Central America	1.139	1.113	1.089	1.089	1.089	1.089	1.089	1.089	1.089	1.089
Cuba	88	88	88	88	88	88	88	88	88	88
Mexico	805	779	755	755	755	755	755	755	755	755
Trinidad	246	246	246	246	246	246	246	246	246	246
South America	1.163	1.163	1.163	1.198	1.232	1.259	1.259	1.328	1.328	1.328
Argentina	48	48	48	58	69	69	69	138	138	138
Brazil	552	552	552	577	600	627	627	627	627	627
Colombia	8	8	8	8	8	8	8	8	8	8
Peru	77	77	77	77	77	77	77	77	77	77
Venezuela	478	478	478	478	478	478	478	478	478	478

COUNTRY UREA CAPACITIES 1976/77 - 1995/96
(000 TONS N)

	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
ASIA	7,869	10,038	11,477	12,582	14,774	15,067	15,725	16,139	17,047	18,327
West Asia	1,094	1,311	1,311	1,939	2,175	2,009	2,069	2,396	2,510	2,537
Abu Dhabi	0	0	0	0	0	0	0	114	228	228
Bahrain	0	0	0	0	0	0	0	0	0	0
Israel	46	46	46	46	46	46	46	46	46	60
Iran	121	121	121	235	349	24	24	24	24	24
Iraq	122	221	221	583	705	705	705	705	705	705
Kuwait	381	381	381	381	381	381	381	381	381	381
Qatar	152	152	152	304	304	304	304	304	304	304
Saudi Arabia	155	155	155	155	155	155	215	397	397	410
Syria Arab Rep.	0	0	0	0	0	159	159	159	159	159
Turkey	117	235	235	235	235	235	235	266	266	266
South Asia	2,548	2,803	2,915	3,517	4,402	4,785	5,472	5,551	5,954	6,925
Afghanistan	48	48	48	48	48	48	48	48	48	48
Bangladesh	221	221	221	221	221	342	463	463	463	509
India	1,952	2,207	2,288	2,890	3,511	3,773	4,014	4,093	4,435	5,277
Myanmar	62	62	62	62	62	62	62	62	123	192
Pakistan	265	265	296	296	560	560	885	885	885	899
East Asia	4,227	5,924	7,251	7,126	8,197	8,273	8,184	8,192	8,583	8,865
China	1,446	2,770	3,872	4,740	4,790	4,790	4,790	4,790	4,790	4,918
Indonesia	378	635	902	1,028	1,028	1,028	1,023	1,284	1,727	1,901
Japan	1,361	1,282	1,240	121	1,017	1,017	1,017	945	946	755
Malaysia	0	0	0	0	0	0	0	0	0	171
Korea, D.P.R.	420	420	420	420	526	526	526	526	526	526
Korea Rep. of	421	573	573	573	592	668	584	448	395	395
Taiwan	150	193	193	193	193	193	193	148	148	148
Vietnam, D.R.	51	51	51	51	51	51	51	51	51	51

COUNTRY UREA CAPACITIES 1976/77 - 1995/96
(000 TONS N)

	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
ASIA	19,062	19,584	21,071	22,157	22,167	23,263	24,192	26,802	28,243	28,643
West Asia	2,590	2,652	2,880	3,435	3,054	3,509	3,509	3,952	3,952	3,952
Abu Dhabi	228	256	256	256	256	256	256	256	256	256
Bahrain	0	0	0	0	0	0	0	0	0	0
Israel	60	60	60	60	60	60	60	60	60	60
Iran	24	24	252	577	577	577	577	577	577	577
Iraq	705	739	739	739	739	739	739	739	739	739
Kuwait	381	381	381	381	0	0	0	0	0	0
Qatar	357	357	357	357	357	357	357	800	800	800
Saudi Arabia	410	410	410	640	640	1,095	1,095	1,095	1,095	1,095
Syria Arab Rep.	159	159	159	159	159	159	159	159	159	159
Turkey	266	266	266	266	266	266	266	266	266	266
South Asia	7,168	7,728	8,544	8,545	8,545	8,992	9,399	11,030	11,671	11,971
Afghanistan	48	48	48	48	48	48	48	48	48	48
Bangladesh	509	638	767	767	767	767	1,090	1,090	1,331	1,331
India	5,504	5,935	6,603	6,603	6,603	7,050	7,050	8,300	8,700	9,000
Myanmar	192	192	192	192	192	192	192	192	192	192
Pakistan	915	915	934	935	935	935	1,019	1,400	1,400	1,400
East Asia	9,304	9,204	9,647	10,177	10,568	10,762	11,284	11,820	12,620	12,720
China	5,277	5,277	5,580	5,967	6,400	6,600	6,860	7,100	7,900	8,000
Indonesia	2,009	2,009	2,149	2,292	2,292	2,292	2,554	2,850	2,850	2,850
Japan	670	570	570	570	570	530	530	530	530	530
Malaysia	228	228	228	228	262	296	296	296	296	296
Korea, D.P.R.	526	526	526	526	450	450	450	450	450	450
Korea Rep. of	395	395	395	395	395	395	395	395	395	395
Taiwan	148	148	148	148	148	148	148	148	148	148
Vietnam, D.R.	51	51	51	51	51	51	51	51	51	51

COUNTRY UREA CAPACITIES 1976/77 - 1995/96
(000 TONS N)

	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
EUROPE	5,991	6,211	6,377	6,588	6,628	6,802	6,989	7,569	7,478	7,600
Eastern Europe	2,238	2,238	2,238	2,334	2,431	2,522	2,735	3,315	3,409	3,520
Albania	36	36	36	36	36	36	36	36	36	36
Bulgaria	322	322	322	322	322	413	626	687	687	687
Czechoslovakia	307	307	307	307	307	307	307	307	307	307
Hungary	189	189	189	189	189	189	189	189	189	189
Poland	456	456	456	456	456	456	456	456	456	567
Romania	840	840	840	936	1,033	1,033	1,033	1,419	1,419	1,419
Yugoslavia	88	88	88	88	88	88	88	221	315	315
Western Europe	3,753	3,973	4,139	4,254	4,197	4,280	4,254	4,254	4,069	4,080
Austria	136	182	152	152	152	152	152	152	152	152
Belgium-Lux.	105	105	105	105	105	105	105	105	105	105
Finland	45	45	45	45	60	60	60	60	60	60
France	331	331	313	313	313	381	359	359	359	359
Germany F.R.	1,141	1,141	1,225	1,204	1,188	1,188	1,184	1,184	1,000	1,000
Greece	0	0	0	0	0	0	0	0	0	0
Iceland	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	114	152	152	152	152	152	152
Italy	689	863	993	1,015	880	880	880	880	880	887
Netherlands	709	709	709	709	740	740	740	740	739	743
Norway	110	110	110	110	110	110	110	110	110	110
Portugal	23	23	23	23	23	38	38	38	38	38
Spain	282	282	282	282	292	292	292	292	292	292
Sweden	30	30	30	30	30	30	30	30	30	30
Switzerland	0	0	0	0	0	0	0	0	0	0
United Kingdom	152	152	152	152	152	152	152	152	152	152
U.S.S.R.	2,547	2,547	2,813	3,535	3,839	4,143	4,371	4,461	4,781	5,171
OCEANIA	83	83	106	106	106	106	142	179	179	179
Australia	83	83	106	106	106	106	106	106	106	106
New Zealand	0	0	0	0	0	0	36	73	73	73

COUNTRY UREA CAPACITIES 1976/77 - 1995/96
(000 TONS N)

	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
EUROPE	8,401	7,484	7,345	7,712	7,924	7,962	8,000	8,000	8,000	8,000
Eastern Europe	3,881	3,881	3,881	4,118	4,406	4,406	4,406	4,406	4,406	4,406
Albania	36	36	36	36	36	36	36	36	36	36
Bulgaria	687	687	687	884	884	884	884	884	884	884
Czechoslovakia	307	307	307	307	307	307	307	307	307	307
Hungary	236	236	236	236	236	236	236	236	236	236
Poland	677	677	677	677	677	677	677	677	677	677
Romania	1,623	1,623	1,623	1,663	1,784	1,784	1,784	1,784	1,784	1,784
Yugoslavia	315	315	315	315	482	482	482	482	482	482
Western Europe	4,520	3,603	3,464	3,594	3,518	3,556	3,594	3,594	3,594	3,594
Austria	152	152	152	152	152	152	152	152	152	152
Belgium-Lux.	95	93	70	55	55	55	55	55	55	55
Finland	60	60	60	60	60	60	60	60	60	60
France	359	319	319	319	319	319	319	319	319	319
Germany F.R.	1,000	919	818	975	975	975	975	975	975	975
Greece	0	0	0	0	0	38	76	76	76	76
Iceland	0	0	0	0	0	0	0	0	0	0
Ireland	167	167	167	167	167	167	167	167	167	167
Italy	811	733	733	733	733	733	733	733	733	733
Netherlands	709	709	709	709	709	709	709	709	709	709
Norway	55	0	0	0	0	0	0	0	0	0
Portugal	38	38	38	38	38	38	38	38	38	38
Spain	892	246	246	310	310	310	310	310	310	310
Sweden	30	15	0	0	0	0	0	0	0	0
Switzerland	0	0	0	0	0	0	0	0	0	0
United Kingdom	152	152	152	76	0	0	0	0	0	0
U.S.S.R.	5,587	5,637	5,781	5,857	6,009	6,020	6,070	6,130	6,190	6,240
OCEANIA	179	179	179	202	225	225	225	225	225	225
Australia	106	106	106	129	152	152	152	152	152	152
New Zealand	73	73	73	73	73	73	73	73	73	73

REGIONAL UREA FERTILIZER DEMAND 1989/90 - 2000/01
(000 TONS N)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	2000/01
WORLD	31,950	32,632	33,969	35,764	37,369	39,141	40,484	45,159
AFRICA	800	841	864	924	917	995	1,018	1,170
AMERICA	5,400	5,468	5,678	5,760	5,871	6,096	6,166	6,589
North America	3,700	3,672	3,792	3,800	3,809	3,929	3,938	4,025
Central America	800	817	873	892	938	984	1,009	1,134
South America	900	979	1,013	1,068	1,125	1,182	1,219	1,430
ASIA	19,850	21,050	22,307	23,713	25,019	26,151	27,283	31,034
West Asia	850	938	1,008	1,069	1,092	1,140	1,159	1,254
South Asia	8,200	8,602	8,951	9,417	9,787	10,182	10,587	12,180
East Asia	10,800	11,510	12,348	13,227	14,140	14,828	15,538	17,600
EUROPE	3,500	3,166	3,007	3,190	3,240	3,425	3,475	3,690
Eastern Europe	1,500	1,190	1,050	1,170	1,260	1,388	1,480	1,710
Western Europe	2,000	1,976	1,957	2,020	1,980	2,037	1,995	1,980
U.S.S.R.	2,200	1,892	1,886	1,932	2,064	2,200	2,250	2,375
OCEANIA	200	215	228	245	258	275	292	301

UREA SUPPLY CAPABILITY 1989/90 - 1995/96
(000 TONS N)

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
WORLD	36,585	36,538	37,590	39,142	41,511	42,781	43,834
AFRICA	857	911	924	897	939	1,094	1,110
AMERICA	6,139	6,309	6,334	6,707	6,811	6,824	6,837
North America	4,188	4,353	4,309	4,707	4,755	4,755	4,755
Central America	969	958	980	980	980	980	980
South America	982	998	1,045	1,020	1,076	1,089	1,102
ASIA	18,319	18,567	19,423	20,492	22,711	23,758	24,662
West Asia	2,748	2,321	2,632	2,912	3,517	3,596	3,675
South Asia	6,921	7,263	7,643	7,989	9,265	9,687	10,175
East Asia	8,650	8,983	9,148	9,591	9,929	10,475	10,812
EUROPE	6,225	5,739	5,888	6,046	6,002	6,010	6,090
Eastern Europe	2,883	2,644	2,688	2,776	2,732	2,776	2,820
Western Europe	3,342	3,096	3,200	3,271	3,271	3,235	3,271
U.S.S.R.	4,861	4,807	4,816	4,795	4,843	4,890	4,930
OCEANIA	184	205	205	205	205	205	205

AMMONIA TRADE 1990
(000 TONS N)

to: \ from:	Belgium	France	W.Germany	Ireland	Italy	Netherlands	Hungary	Poland	USSR	Canada	USA	Mexico	Trinidad	Venezuela
AFRICA	0	0	0	0	54	0	0	0	345	0	133	17	90	0
Algeria														
Cote d'Ivoire														
Liberia														
Mauritius											5			
Morocco					47				163			17	90	
Mozambique														
Senegal					7				6					
South Africa											127			
Tanzania									4					
Tunisia									173					
Zambia														
Zimbabwe														
Others														
AMERICA	0	0	0	0	0	0	0	0	851	916	1	470	829	98
North America	0	0	0	0	0	0	0	0	765	916	1	432	823	57
Canada											1			
U.S.A.									765	916		432	823	57
Central America	0	0	0	0	0	0	0	0	69	0	0	38	0	6
Costa Rica												28		6
Cuba									69			10		
Dominician Rep.														
El Salvador														
Guatemala												0		
Mexico														
Trinidad Etc.														
South America	0	0	0	0	0	0	0	0	16	0	0	0	6	35
Brazil									16					
Chile														23
Columbia													6	12
Venezuela														

AMMONIA TRADE 1990
(000 TONS N)

from:	Algeria	Libya	Abu Dhabi	Bahrain	Kuwait	Qatar	Saudi Arabia	Indonesia	Malaysia	Various Others	1990	1989	1988
to:													
AFRICA	23	0	0	14	0	3	0	0	0	56	733	774	583
Algeria											0	8	
Cote d'Ivoire											0		1
Liberia											0	1	2
Mauritius											5	15	7
Morocco	23			14		3				19	374	319	230
Mozambique											0	17	22
Senegal											12	12	6
South Africa											127	106	75
Tanzania											4	3	
Tunisia											173	251	220
Zambia										4	4		
Zimbabwe										23	23	23	20
Others										10	10	19	0
AMERICA	0	0	0	13	0	0	8	0	0	9	3,194	3,082	2,906
North America	0	0	0	0	0	0	8	0	0	4	3,006	2,973	2,767
Canada											13	2	7
U.S.A.							8			4	2,993	2,972	2,760
Central America	0	0	0	0	0	0	0	0	0	0	113	40	68
Costa Rica											34	25	37
Cuba											79	10	18
Dominician Rep.											0		0
El Salvador											0		12
Guatemala											0	1	
Mexico											0		
Trinidad Etc.											0	5	
South America	0	0	0	13	0	0	0	0	0	5	75	69	72
Brazil				13							29	31	16
Chile										5	28	20	22
Columbia											18	18	24
Venezuela													11

AMMONIA TRADE 1990
(000 TONS N)

to: \ from:	Belgium	France	W.Germany	Ireland	Italy	Netherlands	Hungary	Poland	USSR	Canada	USA	Mexico	Trinidad	Venezuela
ASIA	0	0	0	0	0	0	0	0	733	10	223	0	0	13
West Asia	0	0	0	0	0	0	0	0	614	0	0	0	0	0
Iran														
Iraq														
Israel														
Jordan									21					
Turkey									593					
South Asia	0	0	0	0	0	0	0	0	119	0	0	0	0	0
India									119					
East Asia	0	0	0	0	0	0	0	0	0	10	223	0	0	13
China														13
Korea Rep. of											222			
Malaysia														
Philippines														
Singapore											1			
Taiwan										10				
Thailand														

AMMONIA TRADE 1990
(000 TONS N)

to: / from:	Algeria	Libya	Abu Dhabi	Bahrain	Kuwait	Qatar	Saudi Arabia	Indonesia	Malaysia	Various Others	1990	1989	1988
ASIA	0	0	73	279	67	182	217	224	8	0	2,016	1,735	1,859
West Asia	0	0	2	89	36	21	0	0	0	0	762	567	631
Iran			2	17	7	21					46	5	
Iraq											0		2
Israel											0	14	28
Jordan				72	29						123	81	86
Turkey											593	466	515
South Asia	0	0	31	123	12	70	98	0	0	0	454	324	547
India			31	123	12	70	98				454	324	547
East Asia	0	0	40	67	19	90	119	224	8	0	801	845	681
China													
Korea Rep. of			11	54	8	47	29	65			435	474	380
Malaysia								30			30	24	2
Philippines			4	6		15	41	96	3		165	140	138
Singapore								0			1	1	1
Taiwan			25	7	10	28	50	24			155	196	150
Thailand								10	6		15	10	11

AMMONIA TRADE 1990
(000 TONS N)

from: / to:	Belgium	France	W.Germany	Ireland	Italy	Netherlands	Hungary	Poland	USSR	Canada	USA	Mexico	Trinidad	Venezuela
EUROPE	0	14	302	85	95	956	63	141	1,356	0	81	8	361	0
Eastern Europe	0	0	0	0	0	0	8	9	378	0	0	0	0	0
Czechoslovakia									74					
East Germany			0					9	255					
Hungary														
Poland									46					
Romania									3					
Yugoslavia							8							
Western Europe	0	14	302	85	95	956	56	132	978	0	81	8	361	0
Austria							3	2						
Belgium-Lux.		2	9			251			120		47	8	152	
Cyprus														
Denmark			35			168			50				15	
Finland						30			207					
France			59		7	79			67		7		136	
Germany F.R.		4				115	23	50						
Greece					22				56					
Iceland		2												
Ireland			9											
Italy							11		133				7	
Netherlands		1	8								12			
Norway			8						56		16		26	
Portugal														
Spain		2	32		66	47			186				19	
Sweden			48			11		69	92					
Switzerland		4	2					11						
United Kingdom		0	93	85		256	19		12				7	
OCEANIA														
Australia														
OTHERS			0								1		43	
WORLD	0	14	302	85	148	956	63	141	3,285	926	437	495	1,322	111

AMMONIA TRADE 1990
(000 TONS N)

from:	Algeria	Libya	Abu Dhabi	Bahrain	Kuwait	Qatar	Saudi Arabia	Indonesia	Malaysia	Various Others	1990	1989	1988
to:													
EUROPE	144	0	0	19	21	32	30	0	0	242	3.946	4.032	3.652
Eastern Europe	0	0	0	0	0	0	0	0	0	45	439	483	407
Czechoslovakia											74	100	
East Germany											264	300	324
Hungary										4	4		
Poland											46		
Romania											3		
Yugoslavia										41	48	83	83
Western Europe	144	0	0	19	21	32	30	0	0	197	3.507	3.549	3.245
Austria										18	23	19	35
Belgium-Lux.					14					16	620	570	594
Cyprus											0		2
Denmark											267	313	303
Finland										72	309	255	233
France	16				5	5	14				395	399	211
Germany F.R.							16			8	215	328	193
Greece	12					10				14	114	133	137
Iceland											2	1	3
Ireland											9	28	
Italy	35			3		5				25	219	135	189
Netherlands					1						22	37	8
Norway											106	262	239
Portugal											0	30	45
Spain	80			15		13				41	499	623	553
Sweden											220	42	184
Switzerland										3	19	9	14
United Kingdom											471	364	303
OCEANIA								2			2	10	0
Australia								2			2	10	
OTHERS			2				21	1		10	77	191	264
WORLD	167	0	75	325	87	216	276	227	8	317	9.968	9.823	9.264

Source: IFA Preliminary Data

UREA TRADE 1990
(000 TONS N)

from: / to:	France	W.Germany	Ireland	Italy	Netherlands	Bulgaria	E.Germany	Hungary	Romania	USSR	Canada	USA	Mexico	Trinidad	Venezuela
AFRICA	2	0	0	5	56	0	0	0	0	0	0	0	0	0	0
Algeria															
Burkina Faso					3										
Cameroon															
Ethiopia					12										
Cote d'Ivoire					2										
Kenya															
Madagascar	2														
Malawi					7										
Mali					9										
Mauritius															
Morocco															
Mozambique					1										
Nigeria															
Senegal					1										
Somalia															
South Africa					10										
Sudan					1										
Tanzania				5	1										
Togo															
Tunisia															
Zaire															
Zambia															
Zimbabwe															
Others					9										
AMERICA	7	0	0	37	108	0	0	0	0	156	570	131	146	165	100
North America	7	0	0	31	88	0	0	0	0	0	554	46	58	61	24
Canada					62							46			
U.S.A.	7			31	26						554		58	61	24
Central America	0	0	0	0	9	0	0	0	0	108	16	11	20	0	11
Costa Rica											7	7			
Cuba										83					
Dominician Rep.					2										
El Salvador					1										2
Guatemala					2					14		0	20		
Haiti															1
Honduras					3						7				8
Jamaica											3				
Mexico											0				
Nicaragua										11		4			
Panama															

UREA TRADE 1990
(000 TONS N)

from:	Nigeria	Abu Dhabi	Iraq	Kuwait	Qatar	Saudi Arabia	Bangladesh	Indonesia	Malaysia	Various Others	1990	1989	1988
to:													
AFRICA	11	35	0	0	16	9	0	1	0	25	160	239	218
Algeria											0	2	4
Burkin Faso											3		1
Cameroon	2										2	6	3
Ethiopia											12	18	
Cote d'Ivoire	8										10	2	1
Kenya								1			1	6	8
Madagascar											2	1	1
Malawi										1	5		
Mali											9	6	
Mauritius											0		2
Morocco										9	9	34	40
Mozambique										1	2	3	1
Nigeria											0	0	2
Senegal											1	2	3
Somalia						1					1	0	1
South Africa											10	23	30
Sudan		35				8		0		5	49	6	78
Tanzania	1										7	17	4
Togo										0	0		1
Tunisia											0	0	
Zaire											0	29	2
Zambia					9					9	18	9	32
Zimbabwe					7	0					8		4
Others										1	10	73	2
AMERICA	18	0	0	0	11	30	0	0	0	21	1.501	1.710	1.883
North America	18	0	0	0	11	30	0	0	0	6	933	859	1.122
Canada	6										114	80	126
U.S.A.	12				11	30				6	819	779	996
Central America	0	0	0	0	0	0	0	0	0	5	180	302	258
Costa Rica											13	25	19
Cuba											83	161	113
Dominician Rep.										1	3		20
El Salvador											4	5	1
Guatemala											36	49	35
Haiti											1	1	3
Honduras										4	22	16	11
Jamaica											3	4	2
Mexico											0	0	
Nicaragua											15	42	47
Panama											0	2	6

UREA TRADE 1990
(000 TONS N)

to: \ from:	France	W.Germany	Ireland	Italy	Netherlands	Bulgaria	E.Germany	Hungary	Romania	USSR	Canada	USA	Mexico	Trinidad	Venezuela
South America	0	0	0	6	11	0	0	0	0	48	0	74	68	105	66
Argentina													10		5
Bolivia															
Brazil				6	3					10					
Chile					8							50			
Colombia										32		5	25		39
Ecuador										7		1	9		10
Guyana															
Paraguay															
Peru												10	24		12
Uraguay												3			
Venezuela												5			
Others												1	0	105	1
ASIA	2	0	0	4	26	0	0	18	0	1,637	23	212	69	12	70
West Asia	0	0	0	3	3	0	0	1	0	112	0	0	0	0	0
Abu Dhabi															
Bahrain															
Iran															
Iraq															
Israel				3	3										
Jordan															
Syria								1							
Turkey										112					
Yemen															
Others															
South Asia	2	0	0	0	19	0	0	15	0	45	0	0	0	0	0
Afghanistan															
India					10										
Nepal	2														
Pakistan					10			15		45					
Sri Lanka															
East Asia	0	0	0	1	5	0	0	3	0	1,480	23	212	69	12	70
China				1						1,200	15	203	69		70
Hong Kong				0						17					
Japan					5					5	2	10			
Korea Rep. of								3		28					
Malaysia										11					
Philippines										31					
Singapore											6				
Taiwan															
Thailand										5					
Vietnam										180					
Others										4				12	

UREA TRADE 1990
(000 TONS N)

from:	Nigeria	Abu Dhabi	Iraq	Kuwait	Qatar	Saudi Arabia	Bangladesh	Indonesia	Malaysia	Various Others	1990	1989	1988
to:													
South America	0	0	0	0	0	0	0	0	0	10	389	549	504
Argentina											15	52	70
Bolivia										0	0	5	0
Brazil											19	4	29
Chile											58	115	111
Colombia											101	167	167
Ecuador											26	37	48
Guyana											0		10
Paraguay											0		65
Peru											46	53	4
Uraguay										10	13	10	
Venezuela											5		0
Others											106	106	1
ASIA	19	186	0	0	346	269	155	706	128	230	4,111	5,321	5,778
West Asia	0	7	0	0	0	9	0	0	0	11	145	499	459
Abu Dhabi											0		0
Bahrain						0					0	0	0
Iran											0	252	253
Iraq											0	14	17
Israel											6	5	0
Jordan						3					3	8	5
Syria										11	12	74	48
Turkey											112	144	117
Yemen		4				6					10	1	18
Others		3									3	3	0
South Asia	0	36	0	0	32	28	53	42	0	10	261	116	413
Afghanistan											0		2
India							7				17	6	196
Nepal							16				18	3	29
Pakistan		28			32	28		17		10	183	69	80
Sri Lanka		9					30	26			64	36	106
East Asia	19	145	0	0	314	232	102	664	128	209	3,665	4,706	4,907
China	12	129			127	150	57	225	10	202	2,468	3,398	3,723
Hong Kong						18	12	12			58	74	51
Japan		1			75	2		12	6		116	105	84
Korea Rep. of								28	0		59	64	16
Malaysia					21			96			127	111	134
Philippines	6				37	6	13	140	9	7	249	251	324
Singapore							4	19			26	30	3
Taiwan						32		24			55	88	16
Thailand					43	13	4	47	103		214	217	162
Vietnam		8				5	12	53			256	366	392
Others		7			12	6		10			82		2

UREA TRADE 1990
(000 TONS N)

to: \ from:	France	W.Germany	Ireland	Italy	Netherlands	Bulgaria	E.Germany	Hungary	Romania	USSR	Canada	USA	Mexico	Trinidad	Venezuela
EUROPE	45	0	103	55	238	0	0	135	0	328	19	33	0	26	0
Eastern Europe	0	0	0	0	0	0	0	16	0	230	0	0	0	0	0
Albania															
Bulgaria										7					
Czechoslovakia										63					
East Germany								1							
Hungary										161					
Poland															
Yugoslavia								16							
Western Europe	45	0	103	55	238	0	0	118	0	98	19	33	0	26	0
Austria				0				15							
Belgium-Lux.	3				8					35		7			
Cyprus															
Denmark					6										
Finland					12										
France			26	11	40							26			
Germany F.R.	2		8	0	16			3				1			
Greece				7											
Ireland	3				19										
Italy	3				24			0							
Netherlands	2							2		63	11				
Norway					13									26	
Portugal				4	17										
Spain	14		3	31	36										
Sweden			2		2			0							
Switzerland				2	7			12							
United Kingdom	18		63		37			86			8				
Others															
OCEANIA	0	0	0	0	0	0	0	0	0	0	61	17	0	13	0
Australia											61	17		13	
New Guinea															
OTHERS					32			17		190					19
WORLD	56	NA	103	101	461	NA	NA	169	NA	2,311	672	393	215	217	189

UREA TRADE 1990
(000 TONS N)

	Nigeria	Abu Dhabi	Iraq	Kuwait	Qatar	Saudi Arabia	Bangladesh	Indonesia	Malaysia	Various Others	1990	1989	1988
EUROPE	74	0	0	0	0	0	0	12	0	271	1,338	1,808	1,381
Eastern Europe	0	0	0	0	0	0	0	0	0	35	281	482	383
Albania											0		9
Bulgaria											7	2	
Czechoslovakia											63	115	82
East Germany										11	12	35	0
Hungary											161	210	235
Poland											0	35	
Yugoslavia										23	39	85	58
Western Europe	74	0	0	0	0	0	0	12	0	237	1,057	1,327	999
Austria										14	29	34	6
Belgium-Lux	1									15	69	60	49
Cyprus											0	3	0
Denmark										1	7	21	23
Finland										5	17	21	20
France	17									49	170	337	211
Germany F.R.	9									58	97	104	108
Greece										3	10	28	16
Ireland										4	25	16	33
Italy	2									36	66	98	111
Netherlands	13									12	102	5	56
Norway										0	39	16	17
Portugal										1	22	31	19
Spain	3									21	109	139	146
Sweden										1	5	14	37
Switzerland	1									0	22	14	20
United Kingdom	29									16	256	234	123
Others								12		1	13	154	5
OCEANIA	0	0	0	0	0	0	0	1	37	37	166	162	82
Australia									37	37	165	161	82
New Guinea								1			1	0	0
OTHERS										2	260	179	384
WORLD	122	223	NA	NA	373	308	155	720	165	586	7,536	9,419	9,708

Source: IFA Preliminary results

NITROGEN FERTILIZER TRADE 1980 - 1989
(000 TONS N)

AMMONIA

EXPORTING COUNTRIES	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
WORLD	5.615.563	5.678.486	5.679.842	6.639.925	7.638.477	8.330.538	7.414.868	8.859.814	9.475.823	9.498.242
AFRICA	64.609	72.008	243.230	376.687	221.446	207.752	194.170	181.039	162.137	117.221
Algeria		45,128	93,790	71,597	62,472	77,596	86,874	51,878	64,055	54,068
Libya	63,294	26,880	139,740	280,266	133,986	112,614	90,896	42,792	38,215	6,598
Nigeria								66,312	43,155	33,888
South Africa	1,315		9,700	24,824	24,988	17,542	16,400	20,057	16,712	22,667
AMERICA	2.105.755	2.063.170	2.534.165	2.557.917	2.673.893	3.116.056	2.438.263	3.173.638	3.247.475	3.103.569
North America	975,183	823,184	979,040	828,346	1,081,753	1,707,841	1,244,273	2,014,975	1,720,210	1,433,009
Canada	357,300	363,571	427,029	554,829	684,290	791,321	762,849	1,084,971	1,138,153	1,064,958
USA	617,883	459,613	552,011	273,517	397,463	916,520	481,424	930,004	582,057	368,051
Central America	1.005.331	1.056.632	1.342.144	1.606.929	1.415.435	1.108.374	1.019.382	1.012.991	1.457.033	1.561.073
Mexico	593,017	654,593	695,970	638,119	416,433	200,085	94,129	160,926	346,851	242,728
Trinidad	412,314	402,039	646,174	968,810	999,002	908,289	925,253	852,065	1,110,182	1,318,345
South America	125.241	183.354	212.981	122.642	176.705	299.841	174.608	145.672	70.232	109.487
Argentina									241	
Brazil						110,723	34,925	27,787		
Columbia	4,110	14,878	20,222	20,549	10,589	12,387	2,409	16,440	15,618	4,345
Venezuela	121,131	168,476	192,759	102,093	166,116	176,731	137,274	101,445	54,373	105,142

NITROGEN FERTILIZER TRADE 1980 - 1989
(000 TONS N)

AMMONIA

EXPORTING COUNTRIES	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
WORLD	5.615.563	5.678.486	5.679.842	6.639.925	7.638.477	8.330.538	7.414.868	8.859.814	9.475.823	9.498.242
AFRICA	64.609	72.008	243.230	376.687	221.446	207.752	194.170	181.039	162.137	117.221
Algeria		45,128	93,790	71,597	62,472	77,596	86,874	51,878	64,055	54,068
Libya	63,294	26,880	139,740	280,266	133,986	112,614	90,896	42,792	38,215	6,598
Nigeria								66,312	43,155	33,888
South Africa	1,315		9,700	24,824	24,988	17,542	16,400	20,057	16,712	22,667
AMERICA	2.105.755	2.063.170	2.534.165	2.557.917	2.673.893	3.116.056	2.438.263	3.173.638	3.247.475	3.103.569
North America	975,183	823,184	979,040	828,346	1,081,753	1,707,841	1,244,273	2,014,975	1,720,210	1,433,009
Canada	357,300	363,571	427,029	554,829	684,290	791,321	762,849	1,084,971	1,138,153	1,064,958
USA	617,883	459,613	552,011	273,517	397,463	916,520	481,424	930,004	582,057	368,051
Central America	1.005.331	1.056.632	1.342.144	1.606.929	1.415.435	1.108.374	1.019.382	1.012.991	1.457.033	1.561.073
Mexico	593,017	654,593	695,970	638,119	416,433	200,085	94,129	160,926	346,851	242,728
Trinidad	412,314	402,039	646,174	968,810	999,002	908,289	925,253	852,065	1,110,182	1,318,345
South America	125.241	183.354	212.981	122.642	176.705	299.841	174.608	145.672	70.232	109.487
Argentina									241	
Brazil						110,723	34,925	27,787		
Columbia	4,110	14,878	20,222	20,549	10,589	12,387	2,409	16,440	15,618	4,345
Venezuela	121,131	168,476	192,759	102,093	166,116	176,731	137,274	101,445	54,373	105,142
ASIA	299.222	237.022	213.936	249.479	384.816	596.058	896.025	1.081.661	1.480.825	1.478.658
West Asia	296.825	216.390	189.514	230.327	230.233	402.150	637.335	886.261	1.172.962	1.208.841
Bahrain						78,115	294,307	281,124	303,348	289,209
Iran	117,381								20,550	20,550
Kuwait	66,418	132,929	69,459	91,147		54,171	85,100	174,945	97,854	258,681
Qatar	113,026	83,461	120,055	139,180	165,303	163,907	182,716	240,350	223,584	201,739
Saudi Arabia								124,700	482,515	397,848
Turkey										2,452
United Arab Emirates					64,930	105,957	75,212	65,142	45,111	38,362
East Asia	2.397	20.632	24.422	19.152	154.583	193.908	258.690	195.400	307.863	269.817
Indonesia		18,166	6,280	18,988	145,082	187,004	212,900	185,435	249,485	259,094
Japan	2,397	2,466	18,142	164	9,501	575		23	38,733	202
Malaysia						6,329	39,200	9,942	19,645	10,521
Taiwan							6,590			

NITROGEN FERTILIZER TRADE 1980 - 1989
(000 TONS N)

AMMONIA

EXPORTING COUNTRIES	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
EUROPE	1.308.397	1.273.397	1.268.917	1.232.496	1.780.038	2.173.697	1.684.834	1.938.059	1.812.137	1.789.996
Eastern Europe	136.746	119.026	145.247	176.813	247.219	274.650	212.217	267.512	249.364	312.599
Bulgaria								1,355	38,232	10,773
Czechoslovakia	21,831	16,440	7,562	29,181	34,524	25,390	18,200	22,501	49,320	37,887
Germany DR	21,044	21,454	68,143	91,325	141,324	92,722	59,420	46,197	25,157	4,066
Hungary	71,184	57,787	46,937	56,307	53,041	35,818	49,322	45,307	47,326	77,293
Poland	9,864				10,768	58,020	43,058	101,290	83,285	176,416
Romania	12,823	23,345	22,605		6,740	9,453	6,200	4,720	284	
Yugoslavia					822	53,247	36,017	46,142	5,760	6,164
Western Europe	1.171.651	1.154.371	1.123.670	1.055.683	1.532.819	1.899.047	1.472.617	1.670.547	1.562.773	1.477.397
Austria	59,184	69,952	94,036	70,363	87,461	67,648	28,487	31,589	32,072	32,692
Belgium / Lux.	45,272	41,744	18,421	24,562	35,817	29,940	41,149	37,058	40,851	44,352
Denmark								4,686		
Finland								7		
France	130,943	200,524	85,157	149,999	204,774	117,379	158,795	213,041	75,443	32,948
Germany F.R.	195,145	203,011	181,866	134,444	291,898	259,547	157,776	351,647	360,298	248,122
Greece						13,316		10,522		
Ireland	55,723	28,296	97,304	79,479	71,103	97,313	88,287	85,297	35,257	112,800
Italy	36,267	29,196	28,417	38,331	74,736	128,042	152,813	67,695	64,777	116,424
Netherlands	497,783	331,847	329,273	324,891	538,666	893,059	755,558	819,690	917,962	819,545
Norway	21,865	50,306	42,189	36,005	65,783	32,464	4,086	250	9,651	82
Portugal	6,006						19,647	19,200	7,174	9,104
Spain								59		
Switzerland									1,374	
United Kingdom	123,463	199,495	247,027	197,609	162,581	260,339	66,019	29,806	17,914	61,328
USSR	1.837.580	2.032.889	1.407.264	2.149.284	2.534.307	2.168.749	2.148.576	2.424.099	2.745.732	2.995.646
OCEANIA			12.330	74.062	43.977	68.226	53.000	61.318	27.517	13.152
Australia			12,330	74,062	43,977	68,226	53,000	61,318	27,517	13,152

NITROGEN FERTILIZER TRADE 1980 - 1989
(000 TONS N)
UREA

EXPORTING COUNTRIES	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
WORLD	6.226.203	5.837.057	5.506.159	6.175.046	7.731.917	7.519.426	8.039.353	8.858.294	9.213.323	9.317.636
AFRICA	25.580	3.983	117.073	201.332	470.603	312.121	253.011	340.345	363.178	267.934
Egypt	920	1,058	417	55,200	123,424	9,200				13,664
Ivory Coast				460						
Kenya		198								
Libya			110,860	139,554	309,580	276,000	242,512	303,399	166,118	112,401
Mauritius					8					
Nigeria								22,400	189,229	134,049
Senegal				3,082						
South Africa	24,660	2,727	5,796	3,036	37,591	26,921	10,499	14,546	7,831	7,820
AMERICA	1.227.359	1.092.995	1.098.599	1.054.972	1.239.748	1.133.258	1.194.077	1.643.374	1.576.020	1.596.105
North America	1.134.776	966.340	965.365	764.564	1.000.924	898.450	799.613	1.176.746	1.081.815	1.009.349
Canada	323,997	298,087	267,212	305,918	471,146	416,921	570,672	685,178	632,385	478,891
USA	810,779	668,253	698,153	458,646	529,778	481,529	228,941	491,568	449,430	530,458
Central America	21.700	15.849	26.068	87.745	93.652	163.930	279.108	273.494	311.302	299.224
Cuba									17	
Dom. Repub.			1,333			313				
Martinique				54						
Mexico			2,752	69,874	37,674	2,760	36,319	59,548	73,580	67,044
Trinidad	21,700	15,849	21,983	17,817	55,978	160,857	226,997	213,946	237,705	232,180
West Indies							15,792			
South America	70.883	110.806	107.166	202.663	145.172	70.878	115.356	193.134	182.903	287.532
Argentina			920			2,300		124	28	
Brazil	419	269	584	53,669	7,384	3,257		877	18,203	63,042
Chile										118
Columbia										2
Venezuela	70,464	110,537	105,662	148,994	137,788	65,321	115,356	192,133	164,672	224,370
ASIA	1.676.966	1.100.016	969.042	1.154.889	1.659.124	1.818.025	2.170.542	2.171.137	2.533.115	2.750.263
West Asia	978.287	560.657	607.933	742.941	1.079.326	1.061.435	1.302.044	1.273.428	1.508.564	1.569.227
Iran										11
Iraq	302,816								142,600	343,161
Israel				92			6,132	6,470	27	23
Kuwait	223,193	175,508	195,757	241,002	270,664	265,281	329,076	395,157	400,006	385,729
Qatar	320,940	252,539	278,050	329,757	326,048	323,427	367,571	279,543	372,169	327,098
Saudi Arabia	131,338	132,610	134,126	166,708	325,636	314,487	373,766	250,821	243,215	237,234
Syria				5,382	11,658					
Turkey					1,285	460	922	86,461	104,447	33,854
United Arab Emirates					144,035	157,780	224,577	255,176	246,100	242,117
South Asia	47.724	29.514	55.517	121.035	271.278	306.587	52.519	153.239	224.373	120.832
Afghanistan	34,730	23,736	19,918	9,844	4,600	18,400	13,800	15,640	11,040	2,300
Bangladesh	12,994	5,778	12,827	26,283	12,098	9,430	9,200	102,599	136,857	93,324
India							10			
Myanmar						11,454	29,509	35,000	76,476	25,208
Pakistan				84,908	254,580	267,303				
Sri Lanka			22,772							
East Asia	650.955	509.845	305.592	290.913	308.520	450.003	815.979	744.470	800.178	1.060.204
Indonesia	74,724	17,894	43,792	145,464	91,540	338,032	695,820	483,204	477,600	782,965
Japan	387,918	350,212	211,839	70,883	117,747	71,461	35,844	27,268	83,296	30,276
Malaysia							81,474	161,177	161,500	222,153
North Korea	4,830	38,318	24,776	52,532	54,952	9,244		48,000	35,648	15,982
South Korea	183,483	103,421	25,185	22,034	44,281	29,678	2,841	4,821	42,134	8,828
Taiwan						1,588				

NITROGEN FERTILIZER TRADE 1980 - 1989
(000 TONS N)

UREA

EUROPE	2.533.185	2.632.618	2.062.168	2.430.914	2.817.365	2.608.789	2.469.417	2.505.018	2.610.405	2.295.566
Eastern Europe	1.123.873	1.265.341	1.242.808	1.370.553	1.529.099	1.480.715	1.603.223	1.542.433	1.469.995	1.301.073
Albania	5,278	506								
Bulgaria	192,250	143,708	139,541	178,900	245,442	234,133	250,796	223,373	238,848	256,495
Czechoslovakia	115,512	71,318	89,942	69,235	118,926	116,783	109,110	73,879	49,789	47,311
Germany DR	113,730	187,300	252,390	319,278	219,128	279,979	285,657	260,211	238,411	236,588
Hungary	68,486	122,700	157,480	154,560	163,374	180,050	170,649	160,394	95,507	131,282
Poland	48,479		3,700	18,242	42,336	20,516	28,011	30,286	27,619	63,995
Romania	576,450	734,980	594,019	622,518	695,808	611,217	696,172	684,169	725,354	500,062
Yugoslavia	3,688	4,829	5,736	7,820	44,085	38,037	62,828	110,121	94,467	65,340
Western Europe	1.409.312	1.367.277	819.360	1.060.361	1.288.266	1.128.074	866.194	962.585	1.140.410	994.493
Austria	99,249	55,914	66,807	156,835	78,149	103,190	57,103	55,992	38,665	40,703
Belgium / Lux.	65,855	71,278	34,186	25,365	19,801	51,026	51,432	78,638	80,072	58,973
Denmark	7							694		4,079
Finland	6,544	13,165	6,063	10,166	25,464	8,131		29	22	
France	80,274	93,906	55,968	64,120	64,873	48,199	19,356	7,921	74,953	47,809
Germany F.R.	166,771	167,849	122,876	75,947	178,894	145,862	78,741	128,923	175,696	136,229
Greece	4,600						3,680	102		
Ireland	21,400	68,770	90,528	34,658	107,197	58,331	69,199	72,917	84,168	83,837
Italy	314,953	258,903	49,956	126,158	153,900	184,026	175,679	127,012	195,304	139,108
Netherlands	563,776	517,356	331,996	454,875	512,440	468,172	393,136	458,994	464,185	452,368
Norway	53,086	63,782	39,682	69,735	87,620	33,083	10,035	13,776		
Portugal	2,401				55	690	288	73	46	
Spain	4,800	5,050		1,000	22,854	4,419		3,460	1,302	13,195
Sweden	4,600	1,702	53			25		1,934	1,494	
Switzerland								153	11	16
United Kingdom	20,996	49,602	21,245	41,502	37,019	22,920	7,545	11,967	24,492	18,176
USSR	752.413	999.945	1,254,277	1,310,675	1,511,284	1,602,253	1,907,116	2,148,224	2,095,670	2,375,906
OCEANIA	10,700	7,500	5,000	22,264	33,793	44,980	45,190	50,196	34,935	31,862
Australia	10,700	7,500	5,000					42	6	3,914
New Zealand				22,264	33,793	44,980	45,190	50,154	34,929	27,948

AMMONIA PRODUCTION FROM NATURAL GAS

General

The conventional industrial way of synthesizing ammonia is by reacting nitrogen with hydrogen at high pressure and temperature using a catalyst. The chemistry and thermodynamics of this reaction have been studied intensively and an advanced level has been achieved in energy efficiency of modern ammonia processes. The principles of the process for the production of ammonia have changed little over the last 50 years and more recent improvements in the process are often related to the integration of energy conservation features.

Basically the ammonia process comprises three main steps:

1. Synthesis gas preparation
2. Purification of the synthesis gas
3. Compression of the synthesis gas and ammonia synthesis

(1) The synthesis gas preparation involves the generation of hydrogen and the appropriate introduction of nitrogen. (2) Purification of the synthesis gas involves the removal of carbon monoxide (CO) and carbon dioxide (CO_2), the removal of catalyst poisons, such as sulfur, and the preparation of hydrogen and nitrogen in a stoichiometric ratio of $3H_2{:}1N_2$. (3) The ammonia synthesis involves the catalytic fixation of nitrogen and hydrogen at elevated temperature and high pressure and the separation of ammonia product from the gas mixture.

A wide range of feedstocks can be used for the production of hydrogen, such as electrolysis, refinery and coke oven gases, natural gas, light gasoline, crude and residual oil, and coal. As electrolytic hydrogen is usually rather expensive, nearly all synthesis gas is produced directly from gaseous fuels or by gasification of liquid or solid hydrocarbons. Synthesis gas containing carbon requires oxidation with oxygen or steam in one of the following ways:

$C + 1/2O_2$	=>	CO	(partial oxidation)
$C + H_20$	=>	$CO + H2$	(water-gas reaction)
$CH_{(2n+2)} + (n/2)O_2$	=>	$nCO + (n+1)H_2$	(partial oxidation)
$CH_{(2n+2)} + (n/2)H_2O$	=>	$nCO + (2n+1)H_2$	(steam reforming)
$CO + H_2O$	=>	$CO_2 + H_2$	(CO shift conversion)

Generally, as the molecular weight of the feedstock increases so does the complexity and cost of the process. The higher the H_2:C ratio of the fuel, the more economic the process. The partial oxidation process is used for the production of hydrogen from fuel oil and the steam reforming process is used for processing naphtha and gaseous hydrocarbons, such as methane. As there is a lot of excellent literature available that describes in detail the production of ammonia from different feedstocks, the main objective of this section is to only highlight some of the major process features and developments that have recently taken place, particularly in ammonia technology based on natural gas.

Basically, the production of ammonia comprises a succession of high temperature gaseous reactions, both exothermic and endothermic, into which heat is introduced as fuel and from which waste heat should be recovered in a usable form (i.e. steam, etc.). By careful process and plant design, taking into account the thermodynamics and kinetics of the reactions involved, the heat balance of the plant can be optimized. Progress along the last two decades following the major developments of large plants using centrifugal compressors has been largely along the lines of improving the design of the existing system, with the objective of reducing energy consumption and capital costs. The significant progress that has been made in reducing energy needs can be seen in Figure 12 in the main body of this report. Energy consumption has been almost halved since the end of 1963, when the first large single-stream ammonia plant with centrifugal compressors was commissioned.

The Technology of the Natural Gas Steam-Reforming Process.

Although ammonia plants offered by major suppliers may vary considerably in their detailed design and operating conditions, they basically contain the same operational process stages:

1. Desulfurization
2. Primary reforming
3. Secondary reforming
4. CO-shift conversion
5. Carbon dioxide removal
6. Methanation
7. Ammonia synthesis

(1) Desulfurization: Natural gas is compressed to reformer pressure and the residual sulfur removed to prevent catalyst poisoning later in the process. Removal of sulfur is usually achieved by adsorption on activated carbon or by treatment with zinc oxide.

(2) Primary Reformer: In the primary reformer, the bulk of the hydrocarbon gas, i.e. mainly methane, is converted into hydrogen and carbon monoxide by reaction with steam. The reaction is highly endothermic and heat has to be supplied to maintain the temperature at about 1,000 deg.C by burning fuel. The preheated feedstock and high pressure steam are mixed and passed through tubes containing a nickel-based catalyst in a primary reformer furnace at a pressure of 30 - 50 atm. The reformed gas leaving the tubes passes to the secondary reformer.

(3) Secondary Reformer: The purpose of the secondary reformer is to complete the conversion of unreacted methane coming from the primary reformer and to supply the nitrogen (from air) required for ammonia synthesis. Oxygen from the air reacts with part of the hydrogen, carbon monoxide and methane, thereby raising the temperature and assisting the completion of the reaction.

The process air compressor is a large energy consumer and conventionally has been driven by a steam turbine. A relatively recent development in ammonia plant design is the use of a gas turbine to drive the process air compressor and to use the turbine exhaust gas as combustion air in the primary reformer. The use of a gas turbine is appropriate, if steam can be exported from the process to replace steam that would otherwise need to be generated on site. A gas turbine is also normally used in those plants which use more than stoichiometric quantities of air in the secondary reformer and remove the excess nitrogen in a low temperature separation unit.

The use of high temperatures and pressures in the reforming section requires high grade materials of construction and careful design to obtain good heat transfer and optimum flow distribution to minimize equipment costs. The earlier development of ammonia plants concentrated on a high degree of conversion in the primary reformer and the recovery of heat in the flue gas. One improvement in this area is in the preheating of combustion air and the feedstock to the primary reformer to reduce fuel requirements. The more modern plants also operate at a much lower steam to carbon ratio than the traditional levels of 3.5 - 4.0. A reduction in process steam requirements results in considerable fuel savings, but sufficient steam has to be added to ensure that all the natural gas is reacted and that the correct hydrogen to nitrogen ratio is obtained in the synthesis gas. Sufficient steam should be added to prevent carbon deposition in the catalyst tubes of the primary reformer, which can lead to hot spots and reduce the life of catalyst and tubes. One area of development to achieve a lower steam to carbon ratio has been the use of more active reforming catalysts, which can operate with steam to carbon ratios of 2.5 - 3.0 : 1.0 without carbon formation.

Another method of energy conservation in the reforming section is to allow less extreme operating conditions in the primary reformer and increasing the proportion of the reaction that is carried out in the secondary reformer. In some new designs, the dry gas feed is divided so that only about half the conversion takes place in the primary reformer thereby halving the overall steam to carbon ratio. A large excess of air is used in the secondary reformer to complete the reaction.

(4) Shift Conversion: Carbon monoxide is a poison for ammonia synthesis catalysts and must therefore be removed from the synthesis gas coming from the reformer. This is done by converting it into the more easily removable carbon dioxide and at the time producing more hydrogen using the water-gas shift reaction. In the early plants, two stages of high temperature shift (HTS) were normally used together with some intercooling and perhaps interstage carbon dioxide removal, but it was still difficult to reduce the carbon dioxide concentration to an acceptably low level. The development of effective low temperature shift reaction (LTS) catalysts in the 1960s meant that carbon monoxide could be removed to a lower level and today almost all ammonia processes employ both HTS and LTS stages to reduce the carbon monoxide content of the synthesis gas. The iron/chromium catalysts in the HTS section are relatively insensitive to poisons although they have the major disadvantage that they must be operated at high temperature. The LTS catalyst is much more sensitive to poisoning and most developments in this section of the ammonia plant have been to increase the life and efficiency of the LTS catalyst. One significant improvement is the use of a guard converter - the LTS catalyst absorbs poisons in a concentrated layer at the top of the catalyst bed, so a separate guard bed is inserted to act as a poison trap and enable the operator to remove poisoned catalyst at any time so that the main bed can be used for longer periods without changing the catalyst.

(5) Carbon Dioxide Removal: After leaving the shift conversion, the carbon dioxide has to be removed from the synthesis gas after cooling. Most removal systems have been based on chemical absorption, using compounds such as monoethanolamine (MEA) solution or a solution of potassium carbonate, etc.. Carbon dioxide in the synthesis gas is removed in an absorption tower and the solution is regenerated by heating at a lower pressure to remove CO_2 before being recirculated to the system. This part of the process requires energy to regenerate the scrubbing solution that can be provided as low pressure steam or more recently by recovering heat from the process gas leaving the LT shift section. In order to improve energy efficiency, systems have been developed to improve the absorption capacity of the circulating solution by operating at higher concentrations. Unfortunately in the case of MEA, higher concentrations means increased corrosion and this is being overcome by addition of corrosion inhibitors. Other developments include the use of non-corrosive methyldiethanolamine (MDEA) that can be regenerated more cheaply than MEA.

Hot potassium carbonate solutions also have a high capacity for removing CO_2, but absorption rates are lower than ethanol amine solutions. However, the properties for dissolving carbon dioxide have been improved by the addition of diethanol amine and corrosion inhibitors. Two of the best known potassium carbonate systems are the Benfield and the Giammarco-Vetrocoke processes. A recent advance in the Benfield process is the LoHeat process, which claims significant savings in energy. The low energy requirements of the system is the result of recovering sensible heat supplied to the solution in the regenerator as flash steam by reducing the pressure of the solution after regeneration. This steam is compressed and recirculated to the regenerator.

Carbon dioxide can also be removed from the synthesis gas by physical absorption and the advantage of this process is that air rather than steam can be used for regeneration, which can result in additional energy savings. A disadvantage is the high cost of the solution.

Carbon dioxide recovered from ammonia plants has a number of possible uses and often one of the most convenient is together with ammonia as feedstock for the production of urea.

(6) Methanation: The gas leaving the carbon dioxide removal section still contains small quantities of carbon monoxide and carbon dioxide that must be removed before the ammonia synthesis, because these impurities would decrease the activity of the ammonia synthesis catalyst and cause deposition of corrosive ammonium carbamate in the system. The methanation reaction converts carbon monoxide and carbon dioxide into methane and water and is basically the reversion of the reformer reactions. Until the introduction of the LT - shift catalyst in the early 1960s, carbon monoxide was removed by using either a copper liquor wash or a liquid nitrogen wash and traces of carbon dioxide were removed with an alkali wash. A traditional nickel catalyst is now used and most of the research work on this stage has been directed to improving the selectivity and activity of the methanation catalyst.

(7) Ammonia Synthesis: Before passing to the synthesis loop, the outlet gas from the methanation stage are cleaned by cooling and drying. The cooling is achieved by heat exchange and finally by refrigeration. Condensed water in the cooled gas is separated and removed and the chilled gas is fed to a drier containing a solid desiccant or molecular sieves to remove ammonia, residual carbon dioxide and water. The dry gas is now mixed with recycled gas and circulated to a preheater after which it enters the ammonia synthesis reactor. The gases from the reactor are cooled by heat exchange with the inlet gases and then refrigerated to separate liquid ammonia. Inerts gases like argon, helium, and methane do not dissolve sufficiently in the product ammonia and are purged from the system. The purge gas contains about 60% hydrogen and can be used as a fuel, when natural gas is cheap. When natural gas is expensive, a hydrogen recovery system is usually installed. Hydrogen can be recovered either by membrane separators (i.e. molecular sieved) or by low temperature (i.e. cryogenic) separation. The hydrogen-rich stream is returned to the ammonia synthesis loop and the concentrated purge gas is available for use as a fuel.

The basic chemical reaction for the production of ammonia appears simple, but, in practice, it requires high temperature and pressure, and acceleration by a catalyst.

$$3H_2 + N_2 \quad => \quad 2NH_3$$

The equilibrium between the product ammonia and the reactants depends on temperature and pressure. The reaction is exothermic and in order to prevent the temperature in the catalyst bed from rising to a point where conversion would be unacceptably low, the reactor has to be cooled. The normal optimum operating pressure range for ammonia synthesis using conventional iron-based catalysts is between 150 and 300 atm, but catalysts have recently been developed that allow some of the new low energy processes to work with advantage at lower pressures, for example at 70-80 atm.

There are many different types of reactor designs available and the characteristic features are the gas flows through the catalyst bed, the method of temperature control in the bed and the recovery of the heat of reaction. Ammonia converters can be basically classified according to the method by which the reacting synthesis gas is cooled - quench converters, where cooling is achieved by injecting cool fresh synthesis gas directly into the system and indirectly cooled converters, where the reacting gases are cooled in a heat exchanger system. The new low energy ammonia plants usually use two bed converters with intercoolers; one of the advantages of the system is that steam can be generated in the synthesis loop.

New Energy Saving Ammonia Processes

The production of ammonia comprises a succession of high temperature gas-phase reactions from which a substantial amount of heat must be recovered. The major objective in recent ammonia plant design has been to recover heat in the most efficient way to provide the power requirements for the operation of the plant under normal conditions. The evolution of ammonia plant design by the major engineering and operating companies has resulted in a variety of energy recovery and plant utilities schemes.. Although the configuration of heat exchangers, drives, operating conditions etc. can vary significantly from one design to another, the overall integrated effect in all leading designs has been to produce a plant, reliable and capable of high utilization rates and with low energy consumption in the range 25 - 28 MMBTU (6.3 - 7.1 Gcal) per metric ton of ammonia.

Future Trends in Ammonia Plant Design

With energy consumption for ammonia production now approaching a practical limitation, increased attention is being given to plant design to save investment costs by rationalization of the utilities system and to save the cost of equipment by operating under less severe conditions. In time, improved catalysts will probably permit the reduction of temperatures in the reforming, shift and synthesis stages. There is already a trend to increase the flexibility of operation by moving from steam turbines to more efficient electric motor drives for small and medium size duties. In some cases, savings can be achieved by using gas turbine drives. The increasing use of computers to simulate and control the process will ensure more stable and efficient operating conditions.

Lately, the concept that larger plants must necessarily be the most economic is being challenged by some designers who are developing plants on a smaller scale, which are claimed to be competitive with larger plants in terms of thermal efficiency and unit investment cost. Some of these plants have been in successful commercial operation and the new design may not only prove attractive for new small to medium size plants, but also for the revamping of existing units.

IRR MODEL FOR AMMONIA PROJECTS

INVESTMENT INFORMATION	
Plant and Equipment	**US$**
Battery Limits plus Offsites	230,000,000
Infrastructure	50,000,000
Total	**280,000,000**
Investment Pattern	**Incremental Percentage**
Year 1.	30
Year 2.	50
Year 3.	20
Salvage Value	**Percentage of Total**
Year 20.	10
Working Capital	This is taken as one month's total production costs plus one month's accounts receivable US$ 8,297,946
Build-up, % of Total	**Incremental Percentage**
Year 4.	70
Year 5.	20
Year 6.	10
PRODUCTION DATA	Actual Production = Design capacity x Utilization Rate
Nominal Design Capacity	**Tons Product /Year**
Total	495,000
Utilization Rate	**Percentage**
Average Yearly	90
Production Rate	**Tons Product / Year**
Average Yearly	445,500
Production Phasing-In	**Cumulative %**
Year 4.	70
Year 5.	90
Year 6.	100

AMMONIA REALIZATION PRICES

Variation of IRR (%) with Ammonia Realization Price and Gas Price

Case 1 - Existing Site, Developed Location
(Investment US$170 Million)

Gas Price (US$/MMBTU)	Ammonia Realization Price (US$/Ton) 100	110	120	130	140	150	160	170	180	190	200
0.0	13.8	15.7	17.5	19.2	20.9	22.4	23.9	25.4	26.8	28.1	29.4
0.5	10.6	12.8	14.7	16.6	18.3	20.0	21.6	23.1	24.6	26.0	27.4
1.0	7.0	9.5	11.7	13.7	15.6	17.4	19.1	20.7	22.3	23.8	25.2
1.5	2.7	5.7	8.2	10.5	12.6	14.6	16.5	18.2	19.9	21.4	23.0
2.0			4.2	6.9	9.4	11.6	13.6	15.5	17.3	19.0	20.6
3.0					1.1	4.2	6.9	9.3	11.5	13.5	15.4
4.0								1.1	4.1	6.8	9.2

Case 2 - New Site, Developed Location
(Investment US$ 210 Million)

Gas Price (US$/MMBTU)	Ammonia Realization Price (US$/Ton) 100	110	120	130	140	150	160	170	180	190	200
0.0	10.5	12.3	13.9	15.5	16.9	18.4	19.7	21.0	22.3	23.5	24.7
0.5	7.6	9.6	11.4	13.1	14.7	16.2	17.6	19.0	20.3	21.6	22.9
1.0	4.3	6.5	8.6	10.4	12.2	13.8	15.4	16.8	18.3	19.6	20.9
1.5		3.0	5.4	7.5	9.5	11.3	13.0	14.6	16.1	17.5	18.9
2.0				4.2	6.5	8.5	10.3	12.1	13.7	15.3	16.7
3.0						1.7	4.2	6.4	8.4	10.3	12.0
4.0									1.6	4.1	6.3

AMMONIA REALIZATION PRICES

Case 3 - New Site, Developing Location
(Investment US$ 280 million)

Gas Price	Ammonia Realization Price (US$/Ton)										
(US$/MMBTU)	100	110	120	130	140	150	160	170	180	190	200
0.0	6.6	8.2	9.6	11.0	12.3	13.5	14.7	15.9	17.0	18.0	19.1
0.5	4.0	5.7	7.4	8.9	10.3	11.6	12.9	14.1	15.3	16.4	17.5
1.0			4.9	6.5	8.1	9.6	10.9	12.2	13.5	14.6	15.8
1.5				4.0	5.7	7.3	8.8	10.2	11.6	12.8	14.0
2.0					3.0	4.8	6.5	8.0	9.5	10.9	12.2
3.0								3.0	4.8	6.5	8.0

Case 4 - New Site, Remote Location
(Investment US$ 350 Million)

Gas Price	Ammonia Realization Price (US$/Ton)										
(US$/MMBTU)	100	110	120	130	140	150	160	170	180	190	200
0.0	3.8	5.3	6.6	7.9	9.1	10.2	11.3	12.3	13.3	14.3	15.2
0.5	1.4	3.0	4.5	5.9	7.2	8.4	9.6	10.7	11.8	12.8	13.8
1.0			2.2	3.8	5.2	6.6	7.8	9.0	10.1	11.2	12.3
1.5					3.0	4.5	5.9	7.2	8.4	9.6	10.7
2.0						2.2	3.8	5.2	6.5	7.8	9.0
3.0									2.2	3.8	5.2

AMMONIA REALIZATION PRICES

Variation of Ammonia Realization Price and IRR with Utilization Rate
(Gas Price US$0.5/MMBTU)

Case 5 - Existing Site, Developed Location
(Investment US$170 Million)

	Ammonia Realization Price (US$/Ton)										
Utilization %	**100**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**
100	12.5	14.7	16.8	19.7	20.5	22.3	23.9	25.5	27.1	28.6	30.0
90	10.6	12.8	14.7	16.6	18.3	20.0	21.6	23.1	24.6	26.0	27.4
80	8.6	10.6	12.5	14.4	16.0	17.6	19.1	20.6	21.9	23.3	24.6
70	6.4	8.3	10.2	11.9	13.5	15.0	16.4	17.8	19.1	20.4	21.6
60	3.8	5.8	7.5	9.1	10.7	12.1	13.5	14.8	16.0	17.2	18.4

Variation of Ammonia Realization Price and IRR with Utilization Rate
(Gas Price US$0.5/MMBTU)

Case 6 - New Site, Developed Location
(Investment US$ 210 Million)

	Ammonia Realization Price (US$/Ton)										
Utilization %	**100**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**
100	9.3	11.4	13.2	15.0	16.6	18.2	19.7	21.2	22.6	23.9	25.2
90	7.6	9.6	11.4	13.1	14.7	16.2	17.6	19.0	20.3	21.6	22.9
80	5.7	7.6	9.3	11.0	12.5	14.0	15.3	16.7	17.9	19.2	20.3
70	3.6	5.5	7.1	8.7	10.2	11.6	12.9	14.1	15.3	16.5	17.6
60	1.2	3.0	4.7	6.2	7.6	8.9	10.2	11.4	12.5	13.6	14.7

AMMONIA REALIZATION PRICES

Case 7 - New Site, Developing Location
(Investment US$ 280 Million)

	Ammonia Realization Price (US$/Ton)										
Utilization %	**100**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**
100	5.6	7.4	9.0	10.6	12.0	13.4	14.8	16.0	17.2	18.4	19.5
90	4.0	5.7	7.4	8.9	10.3	11.6	12.9	14.1	15.3	16.4	17.5
80	2.3	4.0	5.6	7.0	8.4	9.7	10.9	12.0	13.2	14.2	15.3
70	0.4	2.1	3.6	5.0	6.3	7.5	8.7	9.8	10.9	11.9	12.9
60			1.4	2.7	4.0	5.2	6.3	7.4	8.4	9.4	10.3

<u>Variation of Ammonia Realization Price and IRR with Utilization Rate</u>
(Gas Price US$0.5/MMBTU)

Case 8 - New Site, Remote Location
(Investment US$ 350 Million)

	Ammonia Realization Price (US$/Ton)										
Utilization %	**100**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**
100	2.9	4.5	6.1	7.5	8.8	10.1	11.3	12.5	13.6	14.6	15.6
90	1.4	3.0	4.5	5.9	7.2	8.4	9.6	10.7	11.8	12.8	13.8
80		1.4	2.9	4.2	4.5	6.7	7.8	8.8	9.9	10.8	11.8
70			1.0	2.4	3.6	4.7	5.8	6.8	7.8	8.7	9.6
60					1.4	2.5	3.6	4.6	5.5	6.4	7.2

AMMONIA REALIZATION PRICES

Case 9 - Variation of Ammonia Realization Price with Gas Price and Investment Cost
(IRR =15%)

Investment US$ Million	Gas Price (US$/MMBTU) 0	0.5	1.0	1.5	2.0	3.0	4.0	5.0
100	70	85	100	116	131	162	192	223
200	122	137	152	168	183	214	244	275
300	173	188	203	219	239	265	295	326
400	223	238	254	269	384	315	346	376
500	273	288	304	319	334	365	396	426

Case 10 - Variation of Ammonia Realization Price with Plant Size
(New Site, Developed Location)

Plant Size TPD Ammonia	1,500	1,350	1,200	1,050	900	750	500
Investment Cost US$ Million	210	195	181	164	147	130	97
Realization Price US$/Ton	142	147	154	160	169	181	208

Case 11 - Variation of IRR with Project Life

Project Life - Years	10.0	12.0	14.0	16.0	18.0	20.0	22.0	24.0	26.0
IRR %	11.7	13.2	14.1	14.8	15.2	15.5	15.6	15.7	15.8

IRR MODEL FOR UREA PROJECTS

INVESTMENT INFORMATION

Plant and Equipment	**US$**
Battery Limits plus Offsites	285,000,000
Infrastructure	
Total	**285,000,000**
Investment Pattern	**Incremental Percentage**
Year 1.	30
Year 2.	50
Year 3.	20
Salvage Value	**Percentage of Total**
Year 20.	10
Working Capital	This is taken as one month's total production costs plus one month's accounts receivable **8,986,104**
Build-up, % of Total	**Incremental Percentage**
Year 4.	70
Year 5.	20
Year 6.	10
PRODUCTION DATA	Actual Production = Design capacity x Utilization Rate
Nominal Design Capacity	**TonsProduct /Year**
Total	825,000
Utilization Rate	**Percentage**
Average Yearly	90
Production Rate	**Tons Product/Year**
Average Yearly	742,500
Production Phasing-In	**Cumulative %**
Year 4.	80
Year 5.	95
Year 6.	100

UREA REALIZATION PRICES

Variation of IRR with Urea Realization Price and Gas Price

Case 1 - Existing Site, Developed Location
(Investment Ammonia + Urea US$ 230 Million)

Gas Price (US$/MMBTU)	Urea Realization Price (US$/Ton) 90	100	110	120	130	140	150	160	170	180	190	200
0.0	16.71	19.0	21.1	23.1	25.0	26.8	28.5	30.2	31.9	33.5	35.0	36.5
0.5	13.75	16.2	18.5	20.6	22.6	24.5	26.4	28.1	29.8	31.5	33.1	34.6
1.0	10.49	13.2	15.7	17.9	20.1	22.1	24.1	25.9	27.7	29.4	31.1	32.7
1.5	6.8	9.9	12.6	15.1	17.4	19.6	21.7	23.6	25.5	27.3	29.0	30.7
2.0	2.43	6.1	9.2	12.0	14.6	16.9	19.1	21.2	23.2	25.0	26.8	28.6
3.0			0.7	4.7	8.0	10.8	13.5	15.9	18.1	20.2	22.2	24.2
4.0						3.1	6.6	9.6	12.3	14.8	17.1	19.3

Case 2 - New Site, Developed Location
(Investment Ammonia + Urea US$ 285 Million)

Gas Price (US$/MMBTU)	Urea Realization Price (US$/Ton) 90	100	110	120	130	140	150	160	170	180	190	200
0.0	13.04	15.07	16.97	18.78	20.5	22.14	23.72	25.24	26.71	28.14	29.52	30.87
0.5	10.35	12.57	14.62	16.55	18.37	20.1	21.76	23.35	24.88	26.36	27.8	29.19
1.0	7.38	9.84	12.09	14.18	16.12	17.96	19.71	21.38	22.98	24.52	26.01	27.45
1.5	3.98	6.82	9.33	11.61	13.72	15.69	17.55	19.31	20.99	22.61	24.16	25.66
2.0		3.34	6.25	8.81	11.13	13.27	15.26	17.13	18.91	20.61	22.23	23.8
3.0				2.03	5.08	7.75	9.85	12.34	14.38	16.29	18.11	19.83
4.0							3.87	6.66	9.14	11.4	13.49	15.44

UREA REALIZATION PRICES

Case 3 - New Site, Developing Location
(Investment Ammonia + Urea US$ 390 million)

Gas Price	Urea Realization Price (US$/Ton)											
(US$/MMBTU)	90	100	110	120	130	140	150	160	170	180	190	200
0.0	8.41	10.19	11.84	13.4	14.89	16.3	17.66	18.96	20.22	21.44	22.66	23.77
0.5	6.07	8.02	9.81	11.49	13.06	14.56	15.98	17.35	18.66	19.93	21.15	22.34
1.0	3.46	5.64	7.61	9.43	11.13	12.72	14.23	15.67	17.04	18.37	19.64	20.87
1.5		2.98	5.2	7.21	9.05	10.77	12.38	13.9	15.35	16.73	18.07	19.35
2.0			2.49	4.76	6.8	8.67	10.4	12.03	13.57	15.03	16.42	17.76
3.0					1.48	3.85	5.96	7.89	9.66	11.33	12.89	14.38

Case 4 - New Site, Remote Location
(Investment Ammonia + Urea US$ 490 Million)

Gas Price	Urea Realization Price (US$/Ton)											
(US$/MMBTU)	90	100	110	120	130	140	150	160	170	180	190	200
0.0	5.41	7.02	8.53	9.95	11.29	12.56	13.78	14.95	16.08	17.17	18.23	19.26
0.5	3.27	5.05	6.69	8.21	9.65	11	12.28	13.51	14.69	15.83	16.93	17.99
1.0		2.88	4.69	6.35	7.9	9.34	10.71	12.01	13.25	14.43	15.58	16.68
1.5			2.49	4.33	6.02	7.58	9.04	10.42	11.73	12.97	14.17	15.32
2.0				2.09	3.96	5.67	7.25	8.73	10.12	11.44	12.7	13.91
3.0							3.21	4.98	6.6	8.11	9.53	10.87

UREA REALIZATION PRICES

Variation of Urea Realization Price and IRR with Utilization Rate
(Gas Price US$0.5/MMBTU)

Case 5 - Existing Site, Developed Location
(Investment Ammonia + Urea US$ 230 Million)

	Urea Realization Price (US$/Ton)											
Utilization %	90	100	110	120	130	140	150	160	170	180	190	200
100	15.73	18.26	20.63	22.86	24.98	26.99	28.93	30.79	32.58	34.31	36	37.63
90	13.75	16.18	18.45	20.57	22.59	24.51	26.35	28.12	29.82	31.47	33.07	34.62
80	11.63	13.96	16.12	18.14	20.05	21.87	23.61	25.29	26.9	28.46	29.96	31.43
70	9.33	11.55	13.6	15.52	17.33	19.05	20.69	22.26	23.77	25.24	26.65	28.02
60	6.79	8.91	10.85	12.66	14.37	15.98	17.51	18.98	20.4	21.76	23.08	24.36

Variation of Urea Realization Price and IRR with Utilization Rate
(Gas Price US$0.5/MMBTU)

Case 6 - New Site, Developed Location
(Investment Ammonia + Urea US$ 285 Million)

	Urea Realization Price (US$/Ton)											
Utilization %	90	100	110	120	130	140	150	160	170	180	190	200
100	12.16	14.46	16.6	18.62	20.53	22.34	24.08	25.75	27.36	28.92	30.42	31.89
90	10.35	12.57	14.62	16.55	18.37	20.1	21.76	23.35	24.88	26.3	27.8	29.19
80	8.41	10.54	12.5	14.34	16.08	17.72	19.29	20.8	22.25	23.65	25.05	26.32
70	6.29	8.33	10.21	11.96	13.61	15.16	16.65	18.07	19.44	20.76	22.03	23.26
60	3.93	5.89	7.69	9.35	10.91	12.38	13.77	15.11	16.39	17.62	18.81	19.96

UREA REALIZATION PRICES

Variation of Urea Realization Price and IRR with Utilization Rate
(Gas Price US$0.5/MMBTU)

Case 7 - New Site, Developing Location
(Investment Ammonia + Urea US$ 390 Million)

	Urea Realization Price (US$/Ton)											
Utilization %	90	100	110	120	130	140	150	160	170	180	190	200
100	7.66	9.67	11.54	13.28	14.92	16.49	17.98	19.41	20.78	22.11	23.4	24.65
90	6.07	8.02	9.81	11.49	13.06	14.56	15.98	17.35	18.66	19.93	21.15	22.34
80	4.35	6.23	7.96	9.56	11	12.5	13.86	15.16	16.41	17.61	18.77	19.89
70	2.47	4.28	5.94	7.48	8.92	10.28	11.57	12.8	13.98	15.12	16.21	17.27
60	0.4	2.11	3.71	5.18	6.55	7.84	9.06	10.23	11.34	12.41	13.44	14.43

Variation of Urea Realization Price and IRR with Utilization Rate
(Gas Price US$0.5/MMBTU)

Case 8 - New Site, Remote Location
(Investment US$ 490 Million)

	Urea Realization Price (US$/Ton)											
Utilization %	90	100	110	120	130	140	150	160	170	180	190	200
100	4.73	6.56	8.26	9.84	11.33	12.74	14.08	15.36	16.6	17.79	18.93	20.05
90	3.27	5.05	6.69	8.21	9.65	11	12.28	13.51	14.69	15.83	16.93	17.99
80	1.69	3.42	5	6.46	7.84	9.13	10.36	11.54	12.66	13.75	14.79	15.8
70			3.15	4.56	5.87	7.11	8.29	9.4	10.47	11.5	12.49	13.44
60				2.45	3.71	4.89	6	7.06	8.08	9.05	9.98	10.88

UREA REALIZATION PRICES

Case 9 - Variation of Urea Realization Price with Gas Price and Investment Cost
(IRR =15%)

	Gas Price (US$/MMBTU)							
US$Million	**0**	**0.5**	**1**	**1.5**	**2**	**3**	**4**	**5**
100	74	86	98	110	123	147	172	196
200	104	116	129	141	153	178	202	227
300	134	146	158	170	183	207	232	256
400	163	176	188	200	212	237	262	286
500	193	205	217	230	242	267	291	315

Case 10 - Variation of Ammonia Realization Price with Plant Size
(New Site, Developed Location)

Plant Size TPD Urea	**2,500**	**2,250**	**2,000**	**1,750**	**1,500**	**1,250**	**830**
Investment Cost US$Mill.	285	265	245	222	200	177	131
Realization Price US$/Ton	112	116	120	125	131	140	160

Case 11 - Variation of IRR with Project Life

Project Life - Years	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**
IRR %	11.7	13.2	14.1	14.77	15.19	15.5	15.7	15.8	15.9

INVESTMENT AND REALIZATION PRICES FOR POTENTIAL AMMONIA PROJECTS

EXISTING SITE

Cost Item	USA	Netherlands	USSR	Venezuela	Saudi Arabia	Indonesia
Investment US$ Mill.	170	180	200	190	195	185
Gas Price US$/MMBTU	1.8	3.0	1.0	0.5	0.5	1.5
Gas Cost US$/Ton	54	90	30	15	15	45
Other Cash Costs	26	26	27	27	31	27
Total Cash Costs	80	116	57	42	46	72
Realization Price Ex-plant (US$/Ton)						
(1) @ 10% IRR	137	177	125	107	112	134
(2) @ 15% IRR	162	203	153	132	139	160
Terminal & Loading (US$/Ton)	5	5	5	5	5	5
Freight Costs (US$/Ton)						
(1) US Gulf Port		27	50	20	60	70
(2) NW Europe	27		25	27	50	60
(3) South Asia(India)	65	60	65	65	40	30
(4) East Asia (China)	70	80	80	70	70	30
Landed Cost (Cash)						
(1) US Gulf Port	85	148	112	67	111	147
(2) NW Europe	112	121	87	74	101	137
(3) South Asia(India)	150	181	127	112	91	107
(4) East Asia (China)	155	201	142	117	121	107
Landed Cost (@ 10% IRR)						
(1) US Gulf Port	142	209	180	132	177	209
(2) NW Europe	169	182	155	139	167	199
(3) South Asia(India)	207	242	195	177	157	169
(4) East Asia (China)	212	262	210	182	187	169
Landed Cost (@ 15% IRR)						
(1) US Gulf Port	167	235	208	157	204	235
(2) NW Europe	194	208	183	164	194	225
(3) South Asia(India)	232	268	223	202	184	195
(4) East Asia (China)	237	288	238	207	214	195

INVESTMENT AND REALIZATION PRICES FOR POTENTIAL AMMONIA PROJECTS

NEW SITE

Cost Item	USA	Netherlands	USSR	Venezuela	Saudi Arabia	Indonesia	Tanzania
Investment US$ Mill.	210	220	280	270	280	265	380
Gas Price US$/MMBTU	1.8	3.0	1.0	0.5	0.5	1.5	0.3
Gas Cost US$/Ton	54	90	30	15	15	45	9
Other Cash Costs	27	28	29	30	34	29	33
Total Cash Costs	**81**	**118**	**59**	**45**	**49**	**74**	**42**
Realization Price Ex-plant (US$/Ton)							
(1) @ 10% IRR	151	192	153	134	141	162	168
(2) @ 15% IRR	181	223	192	172	181	200	221
Terminal & loading US$/Ton	**5**	**5**	**5**	**5**	**5**	**5**	**5**
Freight Costs (US$/Ton)							
(1) US Gulf Port	0	27	50	20	60	70	45
(2) NW Europe	27	0	25	27	50	60	60
(3) South Asia (India)	65	60	65	65	40	30	50
(4) East Asia (China)	70	80	80	70	70	30	65
Landed Cost (Cash)							
(1) US Gulf Port	86	150	114	70	114	149	92
(2) NW Europe	113	123	89	77	104	139	107
(3) South Asia (India)	151	183	129	115	94	109	97
(4) East Asia (China)	156	203	144	120	124	109	112
Landed Cost (@ 10% IRR)							
(1) US Gulf Port	156	224	208	159	206	237	218
(2) NW Europe	183	197	183	166	196	227	233
(3) South Asia (India)	221	257	223	204	186	197	223
(4) East Asia (China)	226	277	238	209	216	197	238
Landed Cost (@ 15% IRR)							
(1) US Gulf Port	186	255	247	197	246	275	271
(2) NW Europe	213	228	222	204	236	265	286
(3) South Asia (India)	251	288	262	242	226	235	276
(4) East Asia (China)	256	308	277	247	256	235	291

INVESTMENT AND REALIZATION PRICES FOR POTENTIAL UREA PROJECTS

EXISTING SITE

Cost Item	USA	Netherlands	USSR	Venezuela	Saudi Arabia	Indonesia
Investment US$ Mill.	230	240	285	270	280	265
Gas Price US$/MMBTU	1.8	3.0	1.0	0.5	0.5	1.5
Gas Cost US$/Ton	43	72	24	12	12	36
Other Cash Costs	19	19	21	21	26	21
Total Cash Costs	62	91	45	33	38	57
Realization Price Ex-plant (US$/Ton)						
(1) @ 10% IRR	108	139	100	85	88	108
(2) @ 15% IRR	127	159	123	107	110	130
Terminal & Loading (US$/Ton)	5	5	5	5	5	5
Freight Costs (US$/Ton)						
(1) US Gulf Port		16	27	12	38	40
(2) NW Europe	16		12	18	22	42
(3) South Asia (India)	42	36	28	44	20	12
(4) East Asia (China)	34	46	38	36	28	10
Landed Cost (Cash)						
(1) US Gulf Port	67	112	77	50	81	102
(2) NW Europe	83	96	62	56	65	104
(3) South Asia (India)	109	132	78	82	63	74
(4) East Asia (China)	101	142	88	74	71	72
Landed Cost (@ 10% IRR)						
(1) US Gulf Port	113	160	132	102	131	153
(2) NW Europe	129	144	117	108	115	155
(3) South Asia (India)	155	180	133	134	113	125
(4) East Asia (China)	147	190	143	126	121	123
Landed Cost (@ 15% IRR)						
(1) US Gulf Port	132	180	155	124	153	175
(2) NW Europe	148	164	140	130	137	177
(3) South Asia (India)	174	200	156	156	135	147
(4) East Asia (China)	166	210	166	148	143	145

INVESTMENT AND REALIZATION PRICES FOR POTENTIAL UREA PROJECTS

NEW SITE

Cost Item	USA	Netherlands	USSR	Venezuela	Saudi Arabia	Indonesia	Tanzania
Investment US$ Mill.	285	300	400	390	400	380	500
Gas Price US$/MMBTU	1.8	3.0	1.0	0.5	0.5	1.5	0.3
Gas Cost US$/Ton	43	72	24	12	12	36	7
Other Cash Costs	22	22	24	24	29	24	26
Total Cash Costs	**65**	**94**	**48**	**36**	**41**	**60**	**33**
Realization Price Ex-plant (US$/Ton)							
(1) @ 10% IRR	120	153	125	111	118	138	135
(2) @ 15% IRR	144	178	158	143	151	170	176
Terminal & Loading (US$/Ton)	**5**	**5**	**5**	**5**	**5**	**5**	**5**
Freight Costs (US$/Ton)							
(1) US Gulf Port		18	27	12	38	40	40
(2) NW Europe	16		12	18	22	42	40
(3) South Asia (India)	42	36	28	44	20	12	30
(4) East Asia (China)	34	46	38	36	28	10	40
Landed Cost (Cash)							
(1) US Gulf Port	70	115	80	53	84	105	78
(2) NW Europe	86	99	65	59	68	107	78
(3) South Asia (India)	112	135	81	85	66	77	68
(4) East Asia (China)	104	145	91	77	74	75	78
Landed Cost (@ 10% IRR)							
(1) US Gulf Port	125	174	157	128	161	183	180
(2) NW Europe	141	158	142	134	145	185	180
(3) South Asia (India)	167	194	158	160	143	155	170
(4) East Asia (China)	159	204	168	152	151	153	180
Landed Cost (@ 15% IRR)							
(1) US Gulf Port	149	199	190	160	194	215	221
(2) NW Europe	165	183	175	166	178	217	221
(3) South Asia (India)	191	219	191	192	176	187	211
(4) East Asia (China)	183	229	201	184	184	185	221

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