Fertilizer Strategies

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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Preface

This document is an update of the FAO publication "Fertilizer Strategies" issued in 1987. In certain developing countries population growth is increasing faster than agricultural production. This theme is expounded in FAO's publication "World Agriculture: Toward 2010".

Fertilizer is known to be a powerful productivity-enhancing input. Indeed, one-third of the increase in cereal production worldwide and 50 percent of the increase in India's grain production has been attributed to fertilizer related factors.

However, fertilizer use is not an end in itself. Rather it is a means of achieving increased food production. Increased food production/availability can, in turn, be seen as an objective for the agriculture sector in the context of contributing to the broader macroeconomic objectives of society.

The environment in the fertilizer sector has changed considerably in the 1990s with the arrival of the long-term structural adjustment programmes. In order to develop a strategy, it is first necessary to set an objective. Though the specific objective will vary from country to country, it must be realistic, that is achievable. To know what is achievable, it is first necessary to analyze the present situation in order to highlight what is satisfactory and what is not; to identify the resources available; to understand the factors and constraints involved, their interrelationships and the ways and effects of intervening on them. On the basis of this knowledge of the starting point, it is then possible to set a valid objective and determine an effective strategy to achieve it.

The first two chapters of the document are devoted to this topic and its relevance to the mineral fertilizer sector. They provide guidelines at country level to permit the development of a fertilizer strategy by pursuing the recommended approach. The economic order and the accepted role of governments has changed dramatically since the first edition of this document was published, a decade ago.

The third chapter deals with the issue of fertilizers in the development of agriculture. The rapid response of the agricultural sector to increased crop prices indicates that it is able to meet the world's overall food requirements. The problem

lies more in the distribution of the agricultural output and the economic inability of a segment of the population to satisfy basic requirements. In sub-Saharan Africa, the number of under-nourished people has doubled during the past 30 years and, with deteriorating soil conditions and falling food production per person, and the number is increasing.

The next two chapters of the document are concerned with the structure of the fertilizer industry itself. There is no shortage of fertilizers in the world. During the past forty years there have been periods when the world fertilizer market has tightened, due largely to factors external to the agricultural sector, but the tensions have been of short duration as new capacities have been built in response to the apparent investment opportunities and/or concern about food security and/or a wish to utilize national resources. The production of the basic fertilizer materials is progressively trending towards regions with the cheapest and most plentiful supplies of raw materials. The natural resources required for the manufacture of fertilizers are sufficient for several centuries to come, although at an increasing cost. This is not, of course, a reason for using these materials wastefully since, at least in the case of phosphate and potash, the resource is not renewable.

Losses and wastage are, therefore, the subject of the next two chapters. A modern fertilizer factory is highly efficient and its negative impact on the environment is negligible. This topic is dealt with in other publications. It is after the fertilizer leaves the factory gate that the inefficiencies begin.

The next and longest chapter deals with the many issues involved in the efficient distribution and marketing of fertilizers, a much neglected sector in developing countries.

Chapter (7) deals with the issue of the efficient use of fertilizers in agriculture. In many developing countries the efficiency of the uptake by crops of the nutrients applied is very low, due largely to inappropriate techniques. The extent of the negative impact on the environment of these poor practices is debatable but the large economic cost, both in terms of the waste of fertilizers and of income foregone, is undeniable. Research identifies the most appropriate fertilization techniques and extension activities communicate them to the farmer. In recent years there has been a considerable reduction in agricultural research and extension services as governments have reduced their support.

The last chapter promotes the need for a coordination of policies and a combined effort on the part of all those involved in providing sufficient food, making it available to all and improving the status of the rural poor, in the context of a sustainable agriculture. Mineral fertilizers play an important role in this process and the co-operation of the fertilizer industry in observing the principles elucidated in this document would be particularly valuable.

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Glossary

AGSECALS	Agricultural Sector Adjustment Loans
AISCO	Agricultural Inputs Supply Corporation (Ethiopia)
AISE	Agricultural Inputs Supply Enterprise
BCR	Benefit / Cost ratio
c.i.f.	cost, insurance, freight
CCA	Certified Crop Adviser (Canada)
CNAMPGC	China National Agricultural Means of Production Corporation
DANIDA	Danish International Cooperation Agency
DAP	Diammonium phosphate
EFMA	European Fertilizer Manufacturers Association
ESCAP	Economic and Social Commission for Asia and the Pacific
FADINAP	Fertilizer Advisory, Development and Information Network for Asia and the Pacific
FELDA	Federation Land Development Authority (Malaysia)
FPA	Fertilizer and Pesticide Authority (the Philippines)
FSU	Former Soviet Union
IFA	International Fertilizer Industry Association
IFDC	International Fertilizer Development Centre
IPNS	Integrated Plant Nutrition Systems
KTDA	Kenya Tea Development Authority
NACF	National Agricultural Co-operative Federation (South Korea)

NFDC	National Fertilizer Development Centre (Pakistan)
NFIA	National Fertilizer Industry Agency (Ethiopia)
NGOs	Non Governmental Organizations
NIB	National Irrigation Board (Kenya)
NLNG	Nigeria Liquefied Natural Gas
OECD	Organization for Economic Co-operation and Development
SALS	Structural Adjustment Loans
SECALS	Sector Adjustment Loans
SINOCHEM	National Chemical Import and Export Corporation (China)
UNEP	United Nations Environment Programme
UNIDO	United Nations Industry Development Organization
USAID	United States Agency for International Development
VCR	Value / Cost ratio

"It is not from the benevolence of the butcher, the brewer or the baker, that we expect our dinner, but from their regard to their own self interest."
from *An Inquiry into the Nature and Causes of the Wealth of Nations by Adam Smith, 1776*

Chapter 1
Introduction

A main policy objective of government is to raise the general standard of living of the population. Other subsidiary objectives, particularly in developing countries might be to maintain or increase food security and the availability of agro-raw materials to industry, to protect the environment and fragile eco-systems, to increase the quantity, quality and variety of food grown. How have the developing countries done in recent decades particularly with respect to the general standard of living and food security?

On both counts, the overall performance has often been inadequate. Some countries have made progress, but many, particularly in sub-Saharan Africa, have made virtually no progress or have even fallen back.

Table 1. **Cereals production per caput, selected countries in Asia**

Country	GNP[1]	All Cereals (Kg/caput)		
	US$ per caput	1970	1997	%
Bangladesh	360	247	242	1
Cambodia	300	569	330	16
China	860	249	363	6
India	370	206	234	4
Indonesia	1 100	180	286	2
Malaysia	4 530	156	96	-13
Myanmar	< 785	299	414	3
Nepal	220	312	287	13
Pakistan	500	134	174	-7
Philippines	1 200	196	218	1
Sri Lanka	800	132	124	-11
Thailand	2 740	420	459	17
Vietnam	310	255	383	18

[1] World Bank Atlas Methodology, 1997

Population growth has often outstripped the rather meager growth in economic and food output. For many countries, there has been little or no improvement per caput - in effect, countries have been running to stand still. For example, the two most populous nations on earth, India and China had a GNP per caput in 1997 of US$370 and US$860 respectively. Between 1970 and 1997 the total production of cereals increased by 98% in India and 124% in China but production per caput increased by only 14% in India

and by 37% in China. Growth in the production of rice, the staple food for most of the poor, was less good in both countries and the amount available per caput is still well below 210 kg. GNP per caput in Malaysia and Thailand is US$ 4 530 and US$ 2 740 respectively and in Indonesia at US$1 100. Indonesia also stands out with cereal production per caput over the 1970/93 period rising by 59% to 286 kg. Meanwhile per caput production in Malaysia, Pakistan and Sri Lanka all declined, increased marginally in Bangladesh, Myanmar and the Philippines and between 13 and 18% in Cambodia, Nepal, Thailand and Vietnam.

In sub-Saharan Africa GNP per caput as a whole, excluding South Africa, is US$ 308. As in the case of Asia, countries with a small population, such as Botswana (US$ 3 260), Gabon (US$ 4 230), Namibia (US$ 2 000) and Swaziland (US$ 1 440), stand out. Nevertheless, for most of the other countries, income per caput remains at subsistence level or below. What is perhaps most alarming is that the growth in agricultural output has remained stagnant over the last three decades, averaging less than 2% while population growth continues at 3%. Per caput cereal production that averaged 147 kg in the period 1961/65 amounted to only 125 kg in 1997. Lessons learned of relative performance over the last few decades are the following:

- rigid central planning with an emphasis on import substitution and heavy industry rather than on agriculture; for most developing countries the emphasis should be the other way round with the focus on agriculture and rural development;
- state-ownership or collectivization of land coupled with state-run farms; this idea was tested out in Russia and East Europe and a number of developing countries with disastrous results: it leads to low productivity, a wasteful use of resources, soil degradation and ultimately collapse of the rural economy;
- favoring the urban population and urban elite by turning the terms of trade against agriculture: low administered prices for farm production (maize, rice, wheat etc) set against high administered prices for farm inputs (seed, fertilizer, pesticides); the resulting lack of profit in agriculture leads to low output which is then supported by a complex web of subsidies, both direct and hidden. These are mostly ineffective and ultimately unsustainable;
- further aggravating the terms of trade against agriculture by an artificially high exchange rate and by taxing agricultural exports;
- squeezing out the private sector at every level in favor of state ownership.

Over the period 1950-1970, many developing countries tried some or all of these policies with varying degrees of success. Countries in Asia, in particular, were fortunate to benefit from a remarkable “Green Revolution” which was based on

the successful development of new, high yielding, varieties of rice. The benefits of the Green Revolution were seldom fully realized because of the rigid planning and investment framework. Reforms became harder to introduce and by the 1970's it was clear that the whole process was suffering from economic fatigue with very limited success in alleviating poverty. Throughout the period, an obvious measure of the extent of rural distress was often the steady migration of rural people from the countryside, forced to eke out an existence on the edges of overburdened towns and cities.

By the 1980's the policies of many countries were running into sharply diminishing returns: overvalued exchange rates could no longer be sustained; there was an accumulation of unmanageable debt, record high interest rates and rapid rates of inflation. Further pressure came from the second oil price shock, in many cases external institutions were called in to provide emergency assistance and to devise long-term structural adjustment programmes. Based on lessons learned from more market-driven economies in East Asia, these programmes called for the unwinding of many of the previous policies and for market-driven solutions with the private sector taking a leading role.

Beginning in 1980, the international financial institutions provided quick-disbursing, policy-based Structural Adjustment Loans (SALs) to help countries over short-term balance of payments problems. The World Bank also initiated Sector Adjustment Loans (SECALs), including Agricultural Sector Adjustment Loans (AGSECALs) which started in 1985. By 1993, structural adjustment spending totaled US$ 222 billion or about 26% of World Bank lending. The loans were provided on the understanding that governments would initiate macro-policy reform, which usually involved currency devaluation, public sector reform usually through market liberalization and privatization and trade policy reform. Countries which adopted AGSECALs mainly between 1985 and 1991 accounted for about 12% of World Bank lending.

Other broad-based economic reforms were also underway. By early 1990, 16 trade and economic groupings had been organized in Africa, Asia, Latin America and the Middle East; more than 60 developing countries unilaterally lowered their import tariffs while also gaining improved access to developed country markets. Other long-term trade discussion began that culminated in the Agreement on Agriculture of the Uruguay Round, signed in 1994. This agreement provides for a general reduction in tariffs on tropical products averaging about 43%, a reduction of domestic production support measures in developed and developing countries, and a reduction of export subsidies.

Box 1. **Effect of structural adjustment policies in Africa**

From 1980 to 1990 inclusive, 33 countries in Africa adopted SALs and AGSECALs. Of the AGSECALs 95% included conditions relating to market reform of prices and subsidies and 85% required reform of government and parastatal organizations. All but two of the SALs had conditions relating to agriculture. 85% had conditions relating to market prices and subsidies and 90% had conditions on state-sector reform, particularly of the agricultural parastatals. The main policy measures were:

- devaluation and changes in the allocation of foreign exchange;
- reduction or suppression of subsidies on inputs;
- removal of price distortions for agricultural produce;
- changes in the pricing system for inputs - price liberalization;
- liberalization of the distribution of inputs - suppression of state monopolies;
- withdrawal of government or parastatals from input distribution;
- reduced government involvement in input production;
- reform of the credit system and changes in interest rates;
- reduction in import duties and taxes on inputs.

The changes are therefore profound and there are some encouraging developments. The World Bank reported in 1996 that savings and investments have increased, inflation has subsided, foreign exchange rates have been stabilized and fiscal deficits are much reduced and real interest rates established. An IMF report concluded in 1997 that "Countries that align themselves with the forces of globalization and embrace the reforms needed to do so, liberalizing markets and pursuing demand-led policies, are likely to put themselves on a path of convergence with the advanced economies, following the successful Asian newly industrialized economies."

Total external assistance to agriculture in developing countries declined from about US$ 18 billion per year at the end of the 1980's to about US$ 10 billion per year in 1995 (all in 1990 US$). The main explanations cited are: general complacency about world food security, the disappointing results of previous assistance programmes, increased attention directed to environmental projects, poverty alleviation projects that are disconnected from agricultural production and competition from other needs such as improving government operations, humanitarian and refugee assistance.

Given the framework of the new economic order and the decline in external aid, what is the role for government? While a new guiding principle might be to try to do less but better, government must effectively manage the process of transformation itself. In agriculture and the fertilizer sector in particular, there is a major role for government in setting the framework in which the private sector and others can operate effectively. This booklet attempts to provide guidelines for setting priorities and policies for an efficient fertilizer sub-sector to support food production.

Chapter 2
The role of government in the new economic order

Before looking in detail at the government's role, particularly as it affects the fertilizer sub-sector, it is useful to consider what "raising the general standard of living" means. The main points are:

- the total production of goods and services (output) must increase more rapidly than the growth of the population. This concept includes less easily measured outputs such as the general health of the population, the levels of literacy, education and improvements in roads and general communications[1];
- some degree of income re-distribution is also normally thought to be an essential feature even though this may reduce the rate of savings in the economy;
- capital accumulation is required; and this means forgoing some immediate consumption for a permanent step-up in consumption in the longer term (the mobilization of savings followed by productive investment);
- agriculture has a key role to play; in most developing countries the majority of people are employed in agriculture so that improving the output per caput of this sector will rapidly achieve the main objective;
- as economic growth proceeds, less people are required in agriculture and move to other occupations in towns;
- agriculture must provide much of the capital for the development of other sectors in the economy. A healthy agriculture will be in a better position to

[1]Other less easily measured outcomes that have a negative effect are pollution, soil erosion and soil salinization; some of these outcomes can reduce the potential of the economy. Damage to or loss of topsoil is particularly costly because it is almost invariably irreversible.

Table 2. **Performance indicators - selected developing countries**

	GNP/ caput *	Growth of GNP/ caput 1965-97	Population growth 1965-97	Infant mortality per '000 live births	Cereal yields (t/ha)	
	US$	%	%		1980	1996
Latin America	**3 940**	**1.3**	**2.1**	**32**	**1.8**	**2.6**
Brazil	4 790	2.3	2.1	34	1.5	2.4
Argentina	8 950	0.3	1.5	22	2.2	3.0
Chile	4 820	1.7	1.7	11	2.1	4.4
Mexico	3 700	1.5	2.4	31	2.2	2.6
Venezuela	3 480	-0.9	2.9	21	1.9	3.1
Peru	2 610	-0.4	2.4	40	1.9	2.7
Bolivia	970	n.a.	2.3	66	1.2	1.7
Sub-Saharan Africa	**510**	**-0.2**	**2.8**	**91**	**1.1**	**1.0**
Nigeria	280	0	2.9	77	1.3	1.2
Ethiopia	110	-0.5	2.7	107	n.a.	1.2
Ghana	390	-0.9	2.6	66	0.8	1.4
Kenya	340	1.3	3.4	74	1.4	1.6
Tanzania	210	n.a.	3.1	85	1.1	1.3
Uganda	330	n.a.	2.9	99	1.6	1.3
Malawi	210	0.5	3.0	133	1.2	1.2
Zambia	370	-2.0	3.0	113	1.7	1.6
Zimbabwe	720	0.5	2.9	69	1.4	1.1
South Asia	**380**	**2.3**	**2.2**	**77**	**1.4**	**2.2**
India	370	2.3	2.1	71	1.3	2.2
Pakistan	500	2.7	2.8	95	1.6	2.0
Bangladesh	360	1.4	2.3	75	1.9	2.7
East Asia	**970**	**5.4**	**1.8**	**37**	**2.8**	**4.2**
China	860	6.8	1.7	32	3.0	4.8
Thailand	2 740	5.1	2.1	33	1.9	2.4
Indonesia	1 110	4.8	2.0	47	2.8	4.0
Philippines	1 200	0.9	2.6	35	1.6	2.4
Malaysia	4 530	4.1	2.6	11	2.8	3.0
Viet Nam	310	n.a.	2.2	29	2.0	3.7

*Atlas Methodology.
Source: World Bank Development Indicators, World Bank, 1999.

do this - through savings deposited in banks, through fair taxation and through the provision of human capital.

Table 2 lists key economic and agricultural performance indicators for Latin America, sub-Saharan Africa, South Asia and East Asia and some of the key countries within each region.

Looking at the GNP/caput column, the greatest disparity is between the upper middle income countries, which are predominantly in Latin America and the countries with very low incomes per caput in sub-Saharan Africa and South Asia. Very low growth in GNP/caput, high rates of infant mortality and a negligible increase in cereal yield/ha between 1980 and 1996 also characterize Sub-Saharan Africa. Cereal yield/ha has grown moderately in Latin America and South Asia. Cereal yields in East Asia, predominantly in China, Indonesia and Viet Nam, have done better, rising from an average yield of 2.8 t/ha in 1980 to 4.2 t/ha in 1996. These average yields can be compared with some of the top yielding countries operating under similar climatic conditions, such as Egypt (6.4 t/ha), (Japan 6.1 t/ha), South Korea (6.3 t/ha) and Puerto Rico (6.8 t/ha).

WHAT WENT WRONG?

In the early 1950s and 1960s state planning and an interventionist approach to the economy had become common currency in many European countries and the newly independent countries in Africa and Asia quickly adopted these ideas. Many governments were motivated to intervene in the agricultural sector, due to a lack of confidence in market mechanisms and concerns about high margins in processing, distribution, or the low levels of food self-sufficiency. However, these interventionist policies often operated with a ratchet effect; when a policy (for example, of price control) failed to achieve the desired result, the interventionist response was not to abandon the failed policy but to extend it to new fields so that gradually the entire economy was converted into a *dirigiste* regime. State planning and collectivization always fail to coordinate individual activities as well as the competitive market, even when that too is imperfect.

Economic development at the time was often associated with industrialization fostered by a degree of protection (the infant industry argument) through overvaluation of the exchange rate and restrictions on imports of manufactures. These policies often penalized farmers, reduced agricultural exports and increased food imports. Consequently, compensating measures were devised such as subsidies on fertilizers, credit and irrigation but, of course, these subsidies

were costly and often benefited the wealthier farmers rather than the poor. Financing the subsidies required higher taxes and increased external borrowing that further increased the already overvalued exchange rate. Although these subsidies increased the use of fertilizer, the cost was very high. In many countries subsidies account for over 50% of the price (Knudsen et al). During the 1980s the direct subsidy bill as a proportion of the government's agricultural budget amounted to 29% in Zambia, 32% in Nigeria, 80% in Turkey and 8% in Colombia.

Box 2. **Price distortions**

Countries in which producer prices have been severely depressed have constantly found production declining. For example, in the early 1960s, Sri Lanka accounted for a third of world tea exports, while Kenya's market share was less than 3%. During the ensuing decades, however, Sri Lanka taxed the tea sector quite severely: average tax rates were 50% in the early to mid-1970s and over 35% in the late 1970s to mid-1980s. Kenya's taxation was much more reasonable: in 1985, rates were on a sliding scale, based on the world price, with the top average rate about 15%. By the early 1980s, Sri Lanka's share of the market had declined to 19% while Kenya's share had more than tripled to 9%.

Two additional common price distortions are worth mentioning, one of which is often applied to food grains to maintain prices at a constant level year-round, 'pan-seasonal pricing', irrespective of the proximity of the harvest or the state of stocks. This tends to discourage the private sector from holding stocks, since normally prices must rise when comparing the immediate post-harvest price to that just before the next harvest in order to cover the cost of carrying stocks. This leads to a chronic shortage of private storage facilities in many developing countries, leaving responsibility for storage largely to the parastatals.

The other price policy commonly applied to exports and food crops requires that the producers be paid the same price throughout the country, 'pan-territorial pricing'. This implies cross-subsidization of remote areas by consumers and by producers close to the consumption or shipment centres. In Tanzania, the pan-territorial pricing of maize generated losses for the National Milling Company of several hundred shillings on each tonne transported from the remote southern region where large maize surpluses were produced (Knudsen et al, 1990). Costs have also been shown to be quite high in Zambia, in terms of production foregone and government subsidies (Kydd, 1989).

According to recent estimates, the direct annual subsidy bill in India was typically about US$ 1.5 - 2 billion for most of the 1990s. The defenders of this expenditure draw attention to the much larger subsidies enjoyed by the agricultural sector in most developed countries.

Another aspect of the interventionist approach that affected some countries was the collectivization or state ownership of land. What was often not fully appreciated is that land is extremely variable: its location, soil type, amount of organic matter, slope, water table, climate and local microclimate. Land requires the special, intimate, knowledge and risk taking ability of the individual local farmer to assess the best cropping and cultivation pattern, usually based on long experience.

Because of the widespread adoption of state planning in developing countries there was also a general preference for state-ownership and management of fertilizer factories, fertilizer import and distribution. The manufacture of fertilizers requires heavy capital investment and fertilizer distribution absorbs considerable financial resources for an extended period, these costs were often well beyond the absorptive capacity of emerging financial markets.

In many countries the so-called parastatal enterprise, usually organized as a government-owned corporation, became the preferred business entity and often had a monopoly status. Management difficulties inherently affect parastatals. (Hopcraft, 1987). The lack of a strong profit motivation leads parastatal marketers to operate inflexibly. They are not induced to adapt readily to changing market circumstances. In Zimbabwe, Kenya and Malawi in 1986, for example, official maize prices were kept constant in spite of massive oversupply and budgetary losses that should have lowered the price. Conversely other countries, e.g. Ethiopia, maintained official prices at low levels even in times of shortage. The parastatals often created enormous distortions in incentives and were almost always a drain on the government's budget. Knudsen et al. have shown that these losses as a percentage of government current expenditure in a number of countries in the 1980s ranged from a high of 12.4% in Tanzania and 10.5% in China through 4% in Zambia and 5.6% in Zimbabwe to a low of 1.5% in Senegal and 0.3% in Niger.

Governments also often attempted to control domestic prices of tradable agricultural commodities in order to achieve price stability. This almost invariably requires measures to restrict trade with the outside world. Parastatals had exclusive authority to import or export crops and many governments had to resort to a variety of direct international trade controls that tended to put farmers at a

Box 3. **Kenya – the effects of liberalization**

Before liberalization in 1991, Kenya had a rigidly controlled economy and fertilizer market; as time went on, this produced severe market distortions and eventually severe pressure on government finances that could not be maintained. The main problem in the fertilizer market was that the controlled prices were usually insufficient to cover the full costs of importing and marketing and fertilizer was often totally unavailable. In most years the government was dependent on donor financed fertilizer to make up for the gaps in supply.

The government's liberalization programme included: decontrol of fertilizer prices and removal of subsidies, removal of import quotas, removal of import licensing, decontrol of foreign exchange, decontrol of interest rates, tax reforms, and liberalization of the cereals market. The changes to fertilizer prices occurred in 1991 while the changes in the financial and import sectors occurred in 1992; the cereals sector was fully liberalized in 1993.

The major effects of the liberalization programme were a) steady growth in imports and consumption b) a sharp decline in the co-operative sector's share of the market and an increase in the private sector's share c) a reduced need for donor financed fertilizer which has fallen from over 50% of the market in 1990 to less than 17% in 1996 and d) a more competitive transport system.

disadvantage. The most vibrant agricultural sub-sectors are those where the government plays little, if any, part in marketing - bananas and cocoa in Belize; fruits, vegetables and wine in Chile; fruits and vegetables in Mexico; cut flowers in Colombia.

Much of the fertilizer sector is liberalized and in most countries in Africa, fertilizer trade is open to the private sector with few exceptions. Egypt legalized private fertilizer trade in 1991. In Bangladesh, general trade reforms in 1991 brought a complete liberalization of fertilizer imports. However, in other countries such as India, Indonesia, Nigeria and China, direct and indirect government intervention in fertilizer marketing and/or imports is still extensive.

WHERE DO WE GO FROM HERE?

In order to make fundamental improvements, policy should consider:

- reduced emphasis on the State Plan, which under the new economic order is an indicative plan only and subject to change as events dictate;
- a much higher priority for agriculture and rural development; agriculture should be considered more important (or at least equally important) in relation to other sectors of the economy;
- wherever possible, private sector solutions and privatization of state-run factories, import organizations and distributors;
- where state farming still exists, give urgent attention to changing the land tenure system and improving individual property rights for farmers. The tenure system must encourage farm improvement, for example, through building up the long-term fertility of the soil, better irrigation and/or drainage systems, better tools and equipment.

Under the new economic order, the individual farmer (either private landowner farmer or tenant farmer) must become the focus of attention. Government policy should:

- establish a legal framework in which farmers can operate successfully;
- implement measures that will improve the terms of trade for agriculture; raise output prices and maintain them at a reasonable level; reduce or stop taxing agricultural exports; ensure that the exchange rate is not kept at an artificially high level; only accept food aid in emergencies. (A recent study showed that in African countries where producer prices for agricultural exports have improved, GNP growth is higher by two percentage points than that of countries where producer prices deteriorated (World Bank, 1994)) and
- give high priority in government expenditure (possibly from donor finance) to research into new practical methods of increasing long-term farm productivity, for example, through the development of new, local, seed varieties, new higher value crops, improved cultivation practices and increased and more effective use of fertilizers.

Chapter 3
Fertilizer in the development of agriculture

Given a relatively fixed amount of land, the expansion of food production depends on an interrelated package of improved policies and technologies leading to increased output per hectare of land. The necessary pre-condition is usually the provision of greater financial incentives to farmers - better farmgate prices for outputs and lower cost inputs. The technology package consists of:

- better extension services, backed up by adequate local agricultural research into productivity boosting methods;
- the availability of improved inputs: more responsive seeds, fertilizers, plant protection products and, if possible, irrigation;
- improved market access; and
- increased credit availability and access.

Fertilizers provide plants with the food they need for their growth and development. Plants live, grow and reproduce by taking up water and mineral substances from the soil, carbon dioxide from the air and energy from the sun. Plants contain practically all (92) natural elements but need only 16 for good growth. Thirteen of these are essential mineral nutrient elements, which must be provided either by the soil or by animal manure or mineral fertilizer.

Apart from carbon, hydrogen and oxygen, plants take their nutrients essentially from the soil. These mineral nutrients are often classified into the "primary" plant nutrients, nitrogen, phosphorus and potassium, which are required by plants in large amounts; the "secondary nutrients", calcium, magnesium and sulphur, which are need in smaller but still appreciable quantities; and the "micronutrients", boron, chlorine, copper, iron, manganese, molybdenum and zinc.

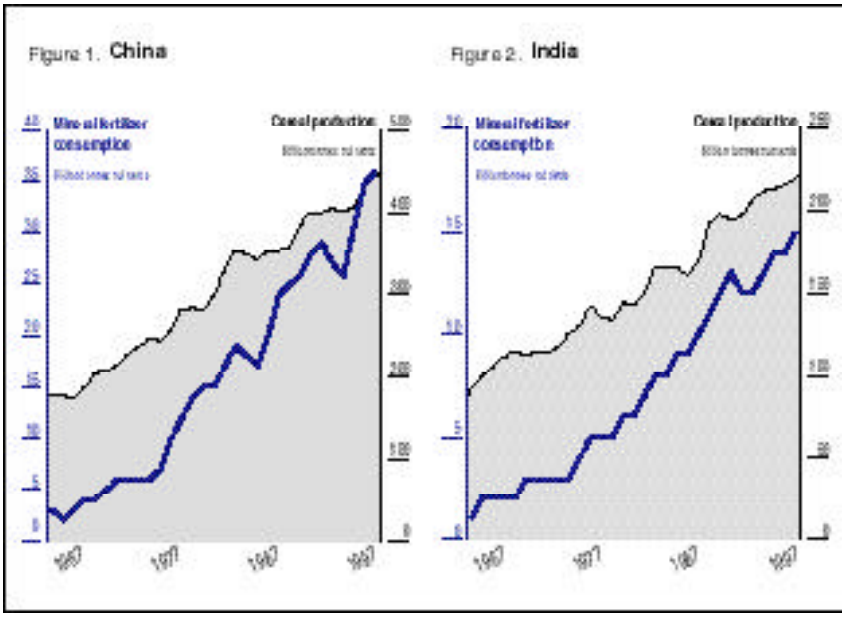
In a paper published in the mid-1970s, concerning cereal production in developing countries, Pinstrup-Anderson (1974) estimated that fertilizers contributed 55-57% of the rise in average yield per hectare and 30-31% of the total increase in production.

A BROADER PERSPECTIVE - ASIA

The countries of Asia taken together comprise a substantial proportion of the world's population, which in 1980 was estimated at 4.4 billion, of which 56% or 2.5 billion were in Asia. By 1998, world population had grown to 5.9 billion and the Asian population to 3.6 billion. Within Asia, the countries with the fastest growing populations - at or above 2% per annum - are Bangladesh, Cambodia, India, Indonesia, Iran, Laos, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines and Viet Nam.

It is noteworthy that China, the most populous nation on earth (1.2 billion), has managed to reduce population growth to 1.4% per annum but this is still an annual increase of some 16-17 million people per year. These population growth figures set a bare minimum level for agricultural output growth in each country

With the least favourable land per caput ratio of any large country in the world, China has been under more pressure than most developing countries to extend the use of fertilizers. Total fertilizer consumption increased from 2.6 million tonnes nutrient in 1965 to just under 36 million tonnes in 1997, with total cereal production rising from 165 million tonnes to 447 million over the same period. Similarly, in India with a population that is rapidly growing towards that of



China, consumption of fertilizer has increased from 0.8 million tonnes nutrient in 1965 to 16.1 million tonnes in 1997.

The most basic requirement for the production of food is, of course, land. Not surprisingly, those countries with the biggest populations have most of the arable and permanent croplands.

India and China taken together, for example, comprise about 67% of the available agricultural land in Asia. For many countries in Asia, there is little or no possibility of expanding the cultivated area except by expanding into fragile ecosystems. This often leads to losses of endangered species, the danger of flash flooding due to the loss of forest cover in sensitive watersheds or even the loss of the soil itself by erosion, which then renders the land totally improductive. A broad indicator of the need for intensification of agricultural output is the amount of land per caput of population.

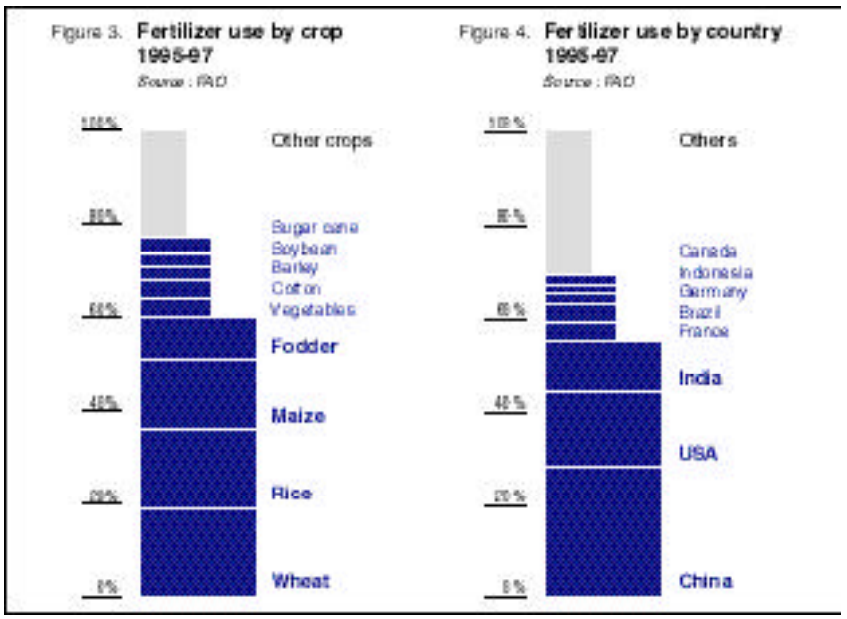
Table 3. **Arable land available per caput in Asia in 1991**

Category	Area (ha)	Countries
Moderate	0.4+	Afghanistan, Mongolia
Rather low	0.2-0.4	India, Laos, Malaysia, Cambodia, Iran, Myanmar
Low	0.1-0.2	Indonesia, Nepal, Sri Lanka, Pakistan,Papua New Guinea, Philippines
Very low	<0.1	Bhutan, Korea Rep., Korea PDR, Japan, Bangladesh, China, Vietnam

Source: Fertilizer use, production and trade in Asia: impact on crop production.

Figures 3 and 4 indicate an estimate of the average annual amount of fertilizer (nutrient tons of N, P_2O_5 and K_2O) used on the major crops and by major country during the 1995-97 period. Clearly wheat, rice and maize are the major users of fertilizer and collectively account for over 50 percent of all global fertilizer use. Similarly, countries in East Asia, North America, South Asia and West Europe accounted for nearly 80 percent of all fertilizer use during 1995-97.

For Figures 3 and 4, the FAO country-level aggregate fertilizer use estimates for 1995 through 1997 were aligned with the application rates' share in the aggregate fertilizer use data from the IFDC/IFA/FAO publication. The fertilizer use share distribution was used to allocate the FAO three-year average (1995-97) annual fertilizer use figure across 34 FAO crop categories within each country.



This assumes that the area of each crop and the application rates of fertilizer across the 34 FAO crop categories did not change significantly between the IFDC/IFA/FAO survey year and the 1995-97 period.

The fact that productivity increases may be falling off while fertilizer use is still increasing quite rapidly, particularly in countries such as China and India, suggests that either fertilizer is not being used efficiently or that urgent research into productivity boosting technology (new seeds, cultivation methods) is required.

Table 4. **Asian countries where crop yields show signs of stagnation since about 1985**

	Distinct Signs	Possible Signs
All cereals	Japan, Korea Rep, Myanmar, Sri Lanka	Indonesia, Malaysia, Bangladesh
Rice	Japan, Korea Rep, Iran,Myanmar, Papua New Guinea,Philippines, Sri Lanka	Indonesia, Malaysia

Source: Fertilizer use, production and trade in Asia: impact on crop production

A BROADER PERSPECTIVE - SUB-SAHARAN AFRICA

The performance of the agricultural sector in sub-Saharan Africa has been relatively poor for the past several decades. From the early 1960s to the late 1980s population growth was about 3% per annum whereas the growth in agricultural production was only 2% per annum. Agricultural production per caput therefore declined during this period so that the present food availability of about 2000 calories per person per day is now 10% below the minimum recommended daily requirement according to FAO-WHO standards. The World Bank estimates that, given present growth trends, Africa will have a food shortage of at least 250 million tonnes of grain equivalent by 2020; moreover, the region will not have the necessary foreign exchange to import such large amounts of food or the required infrastructure of ports, roads, grain stores, distribution networks etc to overcome the food shortage.

Larson and Frisfold (1996) discuss some of the necessary conditions that will be required to achieve a sustained 4% growth in agricultural output. This would be twice the rate of growth of the last three decades but essential if general malnutrition and poverty are to be overcome. As in Asia, there are essentially three ways: 1) expansion of the cultivated land area (extensification); 2) switch to high value crop production or 3) increase yields per hectare (intensification). The first method has already been widely used in Africa. In many areas farmers still practice forms of shifting cultivation. It now appears that for much of Africa this type of agriculture can no longer continue because new lands available are far less productive and land frontiers are mostly closed. As in Asia, land scarcity is now a common factor and improvements in agricultural output will come only from intensification and/or the growing of higher value crops. As in Asia, this will mean the much wider and intensive use of fertilizers.

PROJECTED FERTILIZER REQUIREMENTS

Daberkow et al. (1999) projected the outlook for fertilizer consumption requirements up to 2015 and 2030 in order to support FAO's projections of agricultural commodity production over the same period. The projection for 2015 shows that maize, rice and wheat are the crops using the most fertilizer and that total world consumption is likely to grow from 134 million tonnes nutrient in 1995-97 to 152 million tonnes nutrient in 2015. In absolute terms, the major growth regions are expected to be South and East Asia (added together +7.7 million t/a) and Latin America (+3.3 million t/a). Relatively modest growth is projected for

sub-Saharan Africa. The breakdown is as follows:

Table 5. **Projected consumption of fertilizer to 2015**

	Fertilizer Use, million t.		Change	Growth Rate
	1995-97	2015		%
World Total	133.9	152.2	+18.3	0.9
East Asia	45.6	49.2	+3.6	0.5
East Europe	3.0	4.3	+1.3	2.5
Former Soviet Union	2.2	2.5	+0.3	1.0
Latin America	9.0	12.3	+3.3	2.1
Near East and North Africa	4.8	6.0	+1.2	1.5
North America	23.3	25.0	+1.7	0.5
Oceania	2.6	2.6	-	-
South Asia	18.1	22.2	+4.1	1.3
Sub-Saharan Africa	1.3	1.7	+0.4	2.0
West Europe	17.9	18.8	+0.9	0.3

Using a different methodology, the European Fertilizer Manufacturers' Association, EFMA, expects that fertilizer consumption in West Europe will decline until 2006 and will remain stable thereafter. The decline is due largely to reforms in the European Union's Common Agricultural Policy but also to continuing improvements in nutrient management (EFMA, 1999).

FACTORS WHICH AFFECT THE USE OF FERTILIZERS BY FARMERS

Availability

An obvious but necessary condition for farmers to use fertilizers is that they should be readily available at the time when farmers want to buy and use them. Many farmers in developing countries will buy fertilizer (and other inputs) only if the shop or supply outlet is within easy walking distance (less than 2 km).

Many small farmers cannot afford to buy a 50 bag of fertilizer and so it is desirable in areas where small farmers predominate that fertilizers should be sold in smaller quantities - 1, 2, 5 and 10 kg.

Accessible markets for farmers' produce

In order to pay for fertilizer, farmers must also have access to markets to sell their produce. For example, in order to buy a small bag of fertilizer, a farmer may need

to sell one of his surplus chickens or a bag of rice. A major part of improving access is, of course, the provision of better roads, which is normally a government responsibility.

Profitability

Farmers will use fertilizer only if it is profitable; the three most commonly used measures of profitability are:

- the crop/fertilizer price ratio which measures the amount of produce in kilograms that is required to purchase one kilogram of fertilizer. This is fundamental to providing the economic incentives to farmers to use fertilizers that relate to government action (See Box 4).
- the value/cost ratio or VCR, which is calculated by dividing the value of the yield increases due to fertilizer by the cost of the fertilizer used. This is an indicator of farmers' willingness to accept production risks.
- the benefit/cost ratio or BCR which is calculated by dividing the value of the yield increase by all the costs that went in to producing it (fertilizer applied + cost of additional weeding + cost of high yielding seed + cost of collecting the fertilizer from the store etc).

Box 4. **The Philippines - crop prices and fertilizer demand**

The main objective of the Government's Medium Term Agricultural Development Plan (1993-1998) sought to optimize land use in agro-ecological zones according to the specific natural resources available. To make land available for crop diversification and production of high value crops for exports, the Plan required a reduction of about 50% in the areas currently planted with rice and maize. The Plan envisaged a concurrent increase in productivity of the remaining areas, with paddy and maize output rising to 5 t/ha.

The economic analysis showed that over the period 1986 to 1995 the paddy/fertilizer price ratio (the amount of paddy in kg required to buy 1 kg of urea fertilizer) varied from 0.95 to 1.47. For maize, the ratio varied from 1.00 to 1.85. At the end of the study period the paddy price had increased from Pesos 2.5 to Pesos 4.7 and the paddy/fertilizer price ratio stood at 0.95; there was a modest paddy yield increase to 2.87 t/ha in 1993.

The goal of producing 5 t/ha in 1998 could be achieved but only if paddy prices were allowed to increase further to Pesos 8-12 per kg, equivalent to an increase in domestic rice prices to Pesos 16-25 per kg. The increased paddy price would be adequate for farmers to purchase the required amount of fertilizers to support the projected yield of 5 t/ha. The fertilizer cost involved represents some 7 % of the cash income that a typical farm household spends on fertilizer purchases. Imports of rice were shown to have a significant depressing effect on domestic prices and would have to be restrained to 4-10% of the total rice supply to accomplish the projected paddy price increase.

Experience suggests that for small-scale farmers producing cereals or other food crops under irrigation, a VCR of 2 is generally satisfactory; where farmers are operating under favourable rainfed conditions a VCR of about 2.5-3.0 is required. In more drought-prone areas where the risk is much higher, a VCR of over 3.0 may be necessary.

Farmers' knowledge about the correct use of fertilizers

Lack of knowledge is widespread and is usually due to poor coordination between those working in research and those in the field working as extension officers. Local research work is required into soil and crop conditions, balanced fertilization, whether lime and micro-nutrients are required, the use of animal manure and compost, the use of improved seed, better cultivation and harvesting techniques, and the economics of fertilizer use. Extension workers must make use of demonstrations, preferably on farmers' fields and keep up a constant flow of information by farm visits and by the use of radio and television.

Lack of credit

Farmers often require credit at the beginning of the season to buy fertilizer and other inputs. They usually obtain it from banks, through informal arrangements with local traders or through their membership of a co-operative. A crucial factor from the policy point of view is that credit will only be provided if the agricultural sector is profitable, otherwise it will not be worth the risk.

FACTORS WHICH AFFECT THE DELIVERED COST OF FERTILIZER

Price paid for fertilizers

Although the crop price is the most important factor affecting the demand for fertilizers, the price paid for fertilizers is also significant. Governments have a major part to play in ensuring that farmers receive fertilizers at the lowest possible cost commensurate with a reliable and timely supply.

Cost delivered to port/border

In countries where fertilizers or raw materials are imported, the most significant factor is the cost delivered to the port or border. Table 6, based on data from Ethiopia, shows a cost build-up for fertilizer where there are major internal transport costs.

Table 6. **Cost build-up of DAP in Ethiopia - 1996, US$/tonne**

Delivered c.i.f., bagged and loaded, Assab	297.00
Bank charges	4.74
Clearing charges at the port	5.45
Transport from port to transit warehouse (TW)	42.00
Unloading and loading at TW	1.18
Re-bagging	0.06
Transport from TW to marketing centre (MC)	15.24
Unloading at MC	1.09
Incentive for marketing staff	-
Storage	0.95
Spillage	0.76
Interest	4.74
Overheads	4.11
Wholesaler margin	6.32
Contingency	-
Retailer margin	11.06
Total cost	***394.88***

Source: AISE

A very important item is evidently the cost of fertilizer delivered to the port - the cost of the fertilizer fob, the cost of shipping, discharging, bagging and loading to truck at the port of delivery. There is usually scope for reducing costs and government policy can help in numerous ways:

- a stable exchange rate will stabilize import costs in local currency; also an adequate supply of foreign exchange will make it possible to import at the right time to meet demand.
- import taxes, if necessary, should be kept to an absolute minimum and applied evenly to all imports, not just to fertilizers.
- port and agency charges should be kept under constant scrutiny and compared with charges in other, similar ports.
- in most cases, a single buyer will obtain the best price and achieve economies of scale in ocean freight, port warehousing, bagging and transport.
- donor financed fertilizer is almost invariably more expensive because of the rules that have to be followed and the length of time taken. European Development Fund procedures, for example, are extremely complex and usually take at least 5 months to complete. Where donor funding is available,

policy makers should make every effort to ensure that these are applied to the general foreign exchange fund rather than being tied to a specific item such as fertilizer to keep costs down.

- fertilizer companies producing for the domestic market already have an immediate supply advantage due to their geographic position and the fact that the brand name is usually well known. Unless there are compelling strategic reasons, they should not be given any further advantages (for example: extended tax holidays, the writing-off of debts, cheap feedstock), in order to foster competition with imports based on price and service to customers.

Internal transport cost

The next most important cost item is that of the internal transport cost, made up of labour costs; truck depreciation, maintenance and repair; insurance; fuel costs; taxes and duties. In many cases, costs increase due to high taxes, duties levied by the government itself and this may be an obvious area for policy action to reduce costs.

Competition

At the wholesaler/retailer level, policy should be directed to initiating or promoting a competitive market situation so that, at a minimum, farmers have a choice of two suppliers. While this may not always be possible in the outlying districts where the market is small and expensive to service, the main market areas, closer to the main towns, should provide good opportunities for competing suppliers to operate. In countries where fertilizer continues to be distributed by a single parastatal monopoly, it should be possible to open the market to private distributors to provide competition and choice and lower costs.

In order to promote this level of competition, the Ministry of Agriculture can provide a useful service by gathering and publishing reliable market prices for agricultural commodities and livestock at various locations around the country. Weekly prices of the main fertilizers and other inputs should also be published. This information can be circulated by newsletter to farmers and farmers' cooperatives and also by radio and television. In many countries there is a regular early morning radio programme covering topical farming issues and giving the latest market prices.

POLICY FOCUS FOR A DYNAMIC FERTILIZER MARKET

Allocation of foreign exchange

In numerous countries but particularly those in Africa and Latin America, foreign exchange and debt crises reduced the amount of fertilizer available during the 1980s and 1990s. In 1987, for example, 20 out of 40 countries in Africa were only able to use donor-assisted fertilizer. For some countries, the lack of foreign exchange also made it difficult to operate domestic fertilizer manufacturing capacity because of lack of raw materials and spare parts.

It is essential, therefore, that sufficient foreign exchange is allocated and that this is provided on time and in sufficient quantities so that farmers get the fertilizer that they need and local manufacturers operate efficiently. Foreign exchange allocated to the fertilizer sector can result later in the saving of foreign exchange by reducing food imports and the earning of foreign exchange from food exports.

Rapid inflation leading to devaluation

Rapid inflation normally indicates that the government's budget is in severe deficit and the government is overspending. Although the government may try to hold the exchange rate for as long as possible, devaluation is almost inevitable with devastating effects on the cost of imported goods such as fertilizers. Where rapid inflation is underway the government must give top priority to stabilizing the situation by reducing its expenditure and/or raising taxes and tightening monetary policy.

If devaluation occurs and domestic fertilizer prices increase, compensating increases in crop prices and the provision of additional credit must be allowed or the fertilizer market will collapse.

Import restrictions

Import restrictions have often been applied to protect infant industries but the result has frequently been to eliminate competition and permit gross inefficiency. In some cases, domestic state-owned fertilizer industries were protected in this way with annual trading deficits usually written off by the government at vast cost to the budget.

Studies have shown that tariffs rather than quotas are much more efficient in promoting industrialization. However, where industries are given protection

they should be kept under close scrutiny and the protection should be gradually reduced so that growing import pressure keeps up a momentum for efficiency and cost saving.

Subsidy policy

Many developing countries have used fertilizer and other subsidies to encourage the use of fertilizer and to offset the effects of low crop prices, often set by the government or the crop-purchasing parastatal. In a survey of 38 developing countries, FAO found that 68% of them used fertilizer subsidies.

Although subsidies can be a useful policy tool during the introduction of fertilizers to the market, the danger is that they become entrenched. Subsidies are difficult to phase out at a later stage when they are no longer required. Continuing with subsidies beyond the introductory phase encourages the wasteful use of fertilizers and it means that the bigger, wealthier farmers reap most of the benefits.

Experience in Bangladesh shows that a well managed phasing out of fertilizer subsidies can be achieved without causing a major setback to fertilizer consumption. The key is to synchronize the subsidy removal with the development of a competitive market, which promotes increased efficiency and lower costs. Another consideration is to phase the policy change at the beginning of a general downturn in the international fertilizer prices.

The importance of improving farmers' crop prices in stimulating fertilizer use and higher yield per hectare (rather than the possible alternative policy options such as subsidizing fertilizer) is supported by recent research in Greece by Mergos and Stoforos (1997) who estimated the demand function for fertilizer. Significant variables were the price of fertilizers, the price of labour, the price of other inputs, the price of crops and livestock products and the amount of irrigated land. The most significant factors were the price of fertilizers, the price of crops and the amount of irrigated land. It was highly significant, however, that change in the crop price had a far greater impact than changes in the fertilizer price. In other words, a 1% increase in the price of the crop will be far more effective than a 1% reduction in the price of fertilizer - in Greece about 35% more effective both in the short- and long-term.

Fluctuating world fertilizer prices

There is no effective way of isolating an individual country from the inevitable fluctuations in the international fertilizer market. However, government policy can help to minimize any consequent problems. The timely provision of foreign

exchange will help importers to buy at the most opportune moment and realistic market pricing. The absence of pan-territorial or pan-seasonal pricing will give traders and dealers the incentive to build adequate storage and strategic stocks at up-country locations.

From time to time, the government may need to consider carefully targeted subsidies. For example, to outlying high cost areas or for subsistence farmers, particularly if a shortage of fertilizer is likely to lead to real hardship or to the even greater expense of importing and transporting emergency food supplies to isolated areas.

Market friendly and market sensitive pricing policies

Policy decisions need to reinforce the market rather than undermine it. A market price is an indicator of the balance between supply and demand. Suppressing a high price does not remove, it merely blunts the market mechanism so that the problem (for example, inadequate food production leading to high food prices) is made worse.

Reduce the amount of bureaucracy and discretionary controls

Myrdal (1972) argued the need to reduce the amount of positive discretionary control and bureaucracy. Classic examples are the issuing of import licenses, licenses for new buildings or a change in location, endless government directives to industrial enterprises, powers given to tariff commissions to fix the prices of protected industries and limit profits. The result of all these discretionary powers is that virtually few business decisions can be taken before obtaining permission from the relevant administrative authority and there is always the risk of government disapproval. This, of course, stifles any active entrepreneurship except by those businessmen who are well connected or who know their way round the system. As the controls multiply, so does the need to supervise those officials who administer them and in turn to supervise the supervisors.

Areas for government support

The main areas for active government support and expenditure are:

- in encouraging and extending prudent banking services to rural areas;
- the development of an improved infrastructure - mainly roads, telecommunications and electricity;
- agricultural research, particularly into new, more productive seed varieties and more productive cultivation practices given local conditions;
- institutional support by introducing and enforcing a farmer-friendly legal framework. A specific legal framework is also required for the fertilizer sector.

Chapter 4
The international fertilizer industry

This chapter looks at factors that affect the location of production capacity and also recent changes in capacity for urea, diammonium phosphate (DAP) and potash.

The main factors that determine and will continue to determine the location of fertilizer production are: the location of raw materials, the location of demand and the economics of fertilizer production. Each of these is affected to an increasing extent also by environmental concerns.

THE LOCATION OF RAW MATERIALS

The main fertilizer raw materials are hydrocarbons for energy and ammonia feedstock (today mostly natural gas), phosphate rock, sulphur and potassium salts.

Natural gas

Natural gas is generally viewed as the cleanest of fossil fuels - practically sulphur-free and with less nitrogen oxide and carbon dioxide emissions than both coal and oil per unit of energy produced. Stricter environmental regulations make natural gas in general the industrial fuel of choice.

World energy consumption seems certain to expand rapidly with the projected growth of the world economy; and this is especially true in the most populous, industrializing parts of the developing countries, for example in China, India, South-East Asia and much of Latin America - precisely those areas where fertilizer use is also expected to grow fastest. In numerous countries where ammonia producers have hitherto enjoyed cheap gas, this is causing new competition between the various gas users.

Many of the largest recent discoveries have been in remote areas such as Siberia, the Arctic and offshore, where operating conditions are difficult or where the distance to markets is great.

In 1997, proven reserves were estimated at nearly 150 trillion (thousand million) cubic meters (M^3), or roughly 59 years of production at present rates. In 1980, the corresponding figures were 77 trillion M^3 and 44 years i.e. as time has passed the proven reserves have increased despite the increasing consumption. Ultimate resources are thought to be roughly three times higher than reserves and rising. Most of the newly discovered gas is in the Former Soviet Union (FSU) and the Middle East, which together account for 70% of reserves.

Consequently, though international gas prices may rise, numerous countries, particularly in the Middle East, will still have an abundance of low-cost gas, much of it associated with their oil production. Some of this gas will be supplied directly to developing countries, either through pipelines or as liquefied natural gas.

In Latin America, the countries bordering the Caribbean, Mexico and Venezuela and to a lesser extent Trinidad have substantial reserves. The cost of gas for fertilizer production is also relatively low in Indonesia and Malaysia.

In sub-Saharan Africa, Nigeria has the largest oil and gas reserves, the tenth largest gas reserves in the world, much of it associated with the oil fields. There is an US$ 8.5bn programme of projects to extend development of Nigeria's gas reserves and end the wasteful and environmentally undesirable flaring of associated gas from oil fields. Once the investment programme is complete, by 2008, some 75% of Nigeria's gas will be utilized. Although it has taken 30 years to come to fruition, development of the Nigeria Liquefied Natural Gas (NLNG) export complex is now progressing rapidly, the first train coming on-stream in 1999.

The entire world fertilizer industry uses less than 2% of world energy consumption and this is overwhelmingly concentrated in the production of ammonia. Globally the ammonia industry used 5% to 6% of natural gas consumption in the mid-1990s. Consequently, it has little or no influence on world energy prices and only rarely on local energy prices.

Phosphate rock

Almost all phosphate fertilizers are derived from phosphate rock. The "reserves" of phosphate rock i.e. deposits which are or could be profitably mined under prevailing costs, market prices and technology are rather limited. However, the

"resources" which are at present not economically exploitable, but which could potentially become so, are much larger.

In 1998, the US Geological Survey estimated that world phosphate rock reserves amount to about 11 billion tonnes, with a larger reserve base of about 33 billion tonnes. These reserves are concentrated in Morocco.

At the present rate of mining, world phosphate reserves should last for about 80 years. This is based on a production cost of US$ 36 or less per tonne. At a production cost of up to US$ 90 per tonne the "reserve base" is sufficient for about 240 years consumption. As the need arises, a doubling or trebling of the present real price of phosphate would produce a very large increase in the economic reserves of numerous countries. However, the reserves and reserve base of Morocco at current rates of mining are sufficient for 280 and 1000 years respectively, whereas the figures for the rest of the world are only 45 and 100 years.

Potash

Potassium salts occur as underground deposits or in salt lakes. Commercially economic sources are less widely distributed than in the case of phosphate. North America, largely Canada and the former Soviet Union presently have 85% of known economic reserves and a similar share of the reserve base. Although potash, like phosphate, is a non-renewable resource, the known reserves and resources are much larger than for phosphate. Nevertheless, over the next 50 years, some potash producers will be obliged to mine lower grade ores, deeper layers or more distant regions.

Sulphur

Whereas phosphate and potash are used overwhelmingly as fertilizers, about half the world's sulphur production is used for fertilizers, the other half in other industries. Sulphur is a necessary plant nutrient but most sulphur is used in the fertilizer industry in the form of sulfuric acid to solubilize phosphate rock in the production of phosphate fertilizers. In 1996, 67% of world sulphur was produced as elemental sulphur. Sulphur produced from mineral pyrites accounted for about 15%, the remaining 18% coming from various other sources. About 85% of the elemental sulphur was recovered from hydrocarbon sources as a non-discretionary by-product from petroleum refining, natural gas processing and other processes, and only 15% is mined. As long as the non-discretionary production of sulphur continues to increase, it is unlikely that there will be a

world shortage of this element. Some producers have access to by-product sulphuric acid at a very economic cost.

Phosphoric acid is produced from phosphate rock and sulphur. Nearly a ton of sulphur is required for each ton of P_2O_5 produced. Hence the price of sulphur is an important constituent of the cost of producing phosphoric acid.

THE LOCATION OF DEMAND

At present, South and East Asia account for 48% of the world's fertilizer consumption, North and South America together for 25%, Europe and the Former Soviet Union for 18%, the Middle East for 5% and Africa and Oceania for about 2% each.

Developed countries

In 1960, Europe, the USSR, North America, Oceania, South Africa and Japan, accounted for 88 % of the world fertilizer consumption. By 1999 their share had fallen to 39%, although of a much larger total.

From 1980 to 1989 fertilizer consumption in the developed countries tended to stabilize. Population growth had leveled off, almost everyone was adequately fed and world agricultural exports had stagnated due to economic problems in the importing countries. Then, between 1989 and 1994, fertilizer consumption in developed countries fell from around 84 million tonnes nutrient to 52 million tonnes nutrient. In East Europe and the FSU, consumption fell by 70%. Consumption also fell in West Europe, although to a much lesser extent. Phosphate and potash consumption was affected more seriously than nitrogen.

Developing countries

In 1999, fertilizer consumption in the developing countries amounts to some 83 million tonnes nutrient or 61% of the world total, compared with 12% in 1960. The increase is particularly strong in the case of nitrogen. In 1991, fertilizer consumption in developing countries for the first time exceeded that of the developed countries.

Outlook

Between 1998/99 and 2003/04 fertilizer consumption is forecast to increase at a rate of 2.4% per annum, rising from 136 to 152 million tonnes total nutrient. 31% of the increase is expected to be in East Asia, mostly China, 22% in South Asia,

mostly India and 15% in Latin America. An increase of 11% is expected in East Europe and the FSU but this mostly represents a recovery, with levels remaining well below those of 1990. A gradual decline of fertilizer consumption is expected in West Europe and Japan. The forecasts assume a relatively stable global economy; in the past, major, unpredictable shocks to the global economic system have had an important impact on fertilizer demand.

ECONOMICS OF FERTILIZER PRODUCTION

The profitability of the fertilizer industry depends on a combination of circumstances, all of which can vary considerably both in time and place: the cost of investment, the cost of energy and raw materials, the cost of transportation, marketing and distribution, and the selling price of the products.

The cost of investment in a modern, large-scale primary fertilizer complex runs into hundreds of millions of dollars. Moreover, this cost varies significantly from site to site. For the same type and size of plant, the cost at a remote, undeveloped site in a developing country could be double that at a developed site in an industrialized country. It can also vary considerably according to the chosen process and the workloads of contractors and equipment vendors. In the case of ammonia, the choice of feedstock is also critical. For example, if, for reasons of availability, coal is chosen, the plant investment cost could easily be twice the cost of a similar plant based on natural gas.

The size of the plant has an important influence. For example, in the USA in 1998 the production cost of ammonia amounted to US$ 119 per ton in plants with a capacity of under 1000 tons per day, US$ 96 for plants with capacities higher than this figure. In the case of phosphoric acid, the production cost amounted to US$ 238 per ton for plants with a capacity of under 1200 tons per day per day, US$ 185 for plants higher than this figure. In most other countries the differential would probably be higher than this. Economies of scale in distribution and marketing also increase the advantage to producers with large capacity plants.

Also, the cost of infrastructure such as roads, port facilities, rail access, housing, social services and local industries to supply equipment and services is a major cost factor. However, since this infrastructure often serves not only the fertilizer plant but also the development of the whole local economy, some sharing of the cost with the government is inevitable and usually justified.

The lack of local experience, skills and facilities in many of the less industrialized countries also tends to make plant construction inherently more

costly. For similar reasons, plants in such countries sometimes fail to achieve consistently high operating rates, which are all the more important when the capital investment is comparatively large. Low operating rates can have a drastic effect on profitability.

This said, numerous developing countries now have large, long established fertilizer industries at sites with developed infrastructures and some have the advantage of very low energy and raw materials costs, abundant reserves and proximity to growing markets. As investment costs at such locations approach those in developed countries, they are likely to capture the bulk of future investment in the industry.

Approximately 99% of the global nitrogen supply is produced from ammonia and the cost of feedstock accounts for two thirds to three-quarters of the total cash cost of producing ammonia. The feedstock element also accounts for more than 80% of all input costs for urea production. Because the European and North American fertilizer industries face heavy competition for natural gas and have relatively high natural gas costs, they have been forced to import large amounts of ammonia from low-cost producers rather than to invest in new or replacement ammonia production.

In some developing countries, the use of gas for ammonia production accounts for a large proportion of national gas consumption. In India, for example, this proportion is roughly 40% compared with the global average of 5% to 6% of the total gas demand. Consequently, where fertilizer producers must compete for gas on equal terms with energy suppliers, it is the balance of supply and demand in the energy market, which governs the price of their gas, unless they receive preferential treatment. In the present economic climate, preferential treatment for fertilizer producers may be harder to acquire or maintain.

At present, the price of gas to fertilizer producers varies very considerably from region to region and from country to country. In locations remote from large energy markets, the use of gas for petrochemical feedstock - essentially for either ammonia or methanol production - has often been seen as the most practical, reliable or economic way of developing and adding value to gas resources. In such cases, gas has been provided to ammonia producers at very low prices.

FERTILIZER PRICES

At the beginning of the 1980s, prices for phosphoric acid and DAP were relatively high and this encouraged an expansion in capacity. World phosphoric acid capacity increased between 1980 and 1985 from 28 to 35 million tonnes P_2O_5. Demand was insufficient to absorb the increased production potential and financial returns in the phosphate industry were low or even negative.

Then the global phosphoric acid capacity scarcely changed between 1985 and 1995. The financial results of the phosphate fertilizer industry improved in the mid-1990s and more money became available for maintenance, improvements and debottlenecking. A significant number of projects materialized in both exporting and importing countries.

As regards urea, in 1986 and 1987, urea prices were at very low levels; then urea prices gradually increased to a peak in 1991. A significant short-term factor impacting the 1991 urea price was the Gulf war when exports coming from Kuwait, Iraq and other Middle East countries decreased and energy prices increased. The recovery was short-lived and urea prices dropped by about a third between 1991 and 1993. Following the political changes around 1990, fertilizer demand had collapsed in the countries of East Europe and the FSU. Fertilizer production also fell but to a lesser extent. The disruption of domestic markets diverted fertilizer supplies from domestic markets to export markets. The devaluation of currencies in these countries also encouraged relatively more exports to the global markets.

In China, nitrogen production increased from 17 Mt N in 1994 to almost 22 Mt in 1998, due to a substantial increase in new capacity and higher production from existing plants. The increase in supply greatly exceeded the increase in demand and China virtually ceased urea imports as from mid-1997. Indian production capacity for urea increased by 1.5 Mt N between 1995 and 1998 and was able to reduce imports substantially in 1998. These developments together with the commissioning of new export capacities in other countries, resulted in surplus supplies and low prices. This affected all sectors of the nitrogen industry, including ammonia exported as such and ammonium nitrate.

The world urea price, which had increased from US$ 150 per tonne in 1994 to over US$ 200 per tonne in 1995 and 1996, boosted by the low level of investment in new capacity in the preceding years and by a substantial increase in world grain prices, fell to US$ 99 in 1998 and there was a further fall in 1999.

Of the three main fertilizer nutrients, potash prices have been relatively stable over the last 20 years but on a slightly rising trend.

THE LOCATION OF PRODUCTION

Nitrogen

Up to the 1960s, the development of the nitrogen industry took place in West Europe, North America and Japan. In the late 1970s and early 1980s, rising energy costs in the industrialized market economies, lack of demand and low - or even negative - capital returns combined to cause the shut-down of millions of tonnes of ammonia and nitrogen fertilizer capacity. In the 1970's and early 1980's, the construction of new plants shifted to the gas-rich countries of the Caribbean and Near East and also to some large consuming countries such as China, India, Indonesia and Pakistan. Two thirds of the urea capacity growth in the 1980s was in Asia, where capacity increased from 33 to 51 million tonnes N. India, China and Indonesia accounted for most of the increase. West Europe's share fell from 20% in 1980 to the 11% in 1996.

World ammonia capacity grew from 119 million tonnes in 1980 to a peak of 141 million tonnes in 1989. Virtually all the growth in capacity occurred in the FSU and Asia. Between 1989 and 1995 capacity remained relatively flat, with increases in Asia being offset by closures in Europe and the FSU. Improved financial results between 1994 and 1997 and a very tight ammonia supply in early 1995, caused many producers of ammonia and nitrogenous fertilizers to implement

or consider projects for debottlenecking of existing capacity or building of new plants. The new projects were located in both key exporting regions and key consuming and importing regions.

Ammonia plants are often, although not necessarily, associated with urea plants, thus utilizing the by-product CO_2 resulting from the production of ammonia. Hence an increase in urea production capacity has accompanied that of ammonia.

Extremely populous countries such as China and India evidently have wished to retain control over production of this product which is essential for their food supplies.

Table 7. **Ammonia capacities**

Region	Ammonia ('000 MT N)			
	1985	1990	1995	2000
West Europe	14 274	13 756	11 078	11 308
East Europe	11 099	9 474	7 727	7 871
FSU	n.a.	22 114	20 792	19 238
North America	16 794	16 079	16 183	19 448
Latin America	5 833	5 988	5 415	8 548
Africa	1 437	1 752	1 976	1 882
Near East	4 952	6 769	7 199	8 824
South Asia	8 704	10 405	12 979	15 812
East Asia	21 872	27 002	30 730	33 774

Phosphate

Over the past two decades there has been a trend towards the processing of phosphate rock in countries with substantial natural resources of this material, especially in North Africa and the USA, but also in the Near East and South and West Africa. Integrated phosphate mining and processing offer significant technical and economic advantages, quite apart from the obvious economy in shipping high value, highly concentrated fertilizers, compared with phosphate rock. There have been numerous plant closures in West Europe where phosphoric acid production capacity and output have fallen by 60% since 1980, for economic and environmental reasons.

In 1968, 52% of world phosphoric acid production was located in North America, 26% in West Europe, 7% in the USSR and 6% in Japan i.e. they accounted for 91% of total world production. By 1998, 83% of the capacity was located in regions with phosphate rock resources.

Table 8. **Phosphoric acid capacities**

Region	Phosphoric aid ('000 MT P_2O_5)			
	1985	1990	1995	2000
West Europe	4 257	3 386	1 877	1 797
East Europe	2 045	2 048	1 781	1 725
FSU	5 975	5 941	6 306	6 198
North America	12 170	11 677	11 945	12 757
Latin America	1 339	1 772	1 593	1 958
Africa	4 244	5 355	5 446	6 363
Near East	2 213	2 255	2 122	2 743
South Asia	726	553	773	1 836
East Asia	1 063	1 357	2 130	3 700

During the past thirty years, in general the increment in the consumption of phosphate fertilizers has been supplied by fertilizers based on phosphoric acid. The following table demonstrates the fall of capacities in West Europe, for economic and environmental reasons, the substantial increase in Africa and the Near East, with their reserves of phosphate rock, but also the current substantial increase in South Asia, despite very limited domestic supplies of rock. There is also a substantial increase in China, which has phosphate rock resources although they are rather inconveniently located in relation to the main consumption areas.

Potash

Potash is produced where the ores are located and thus, like phosphate rock, potash production is highly concentrated in a few countries. A large proportion of mined potash enters international trade. About 70% of world deliveries are exported as such and a further 10-12% is exported in multi-nutrient fertilizers. Canada and the FSU account for two thirds of world exports.

Conclusion

Shortages of fertilizers on the world market have never lasted for very long, but short-term price increases have often encouraged over-investment in new capacity. The phosphate fertilizer industry took two decades to recover from the investment resulting from big price rise in the mid-1970s. A surge in investment in nitrogen facilities following the price increase in the mid-1990s could result in the closure of substantial nitrogen capacity, perhaps but not necessarily of less

efficient plants and less efficient products (such as ammonium bicarbonate in China).

Globally, fertilizer demand continues to increase and there will be a continuing need to replace or re-vamp older plants. The following factors seem to be conducive to profitable investment in the basic raw materials and intermediates for fertilizer production:

- ample supplies of the basic raw materials;
- a large and growing domestic market;
- investment in large scale plants.

Additional value can be added to the basic materials by the supply of customer services and the development of improved products.

Chapter 5
Purchasing and supply - the strategic issues

IMPORTING VERSUS MANUFACTURING

For countries at the early stages of fertilizer market development, importing the total requirement is usually the only viable option and there may be no medium-term alternative if there are no suitable raw materials. However, importing is expensive in terms of foreign exchange and this can become acute when international fertilizer prices are high. Total reliance on imports also has the disadvantage that domestic fertilizer prices will tend to be fully harmonized with international market prices; domestic supplies will also be entirely dependent on the smooth running of the purchasing and supply chain from the foreign supplier to the importer's main warehouse and any unexpected hold-up could cause a local shortage and at a later stage a lower harvest and lower food security. This problem is clearly worse for land-locked countries than for those on the coast with good ports and good infrastructure.

For many countries, therefore, fertilizer is often considered to be a strategic commodity and the question to be looked into is the mix of domestic manufacture and/or imports providing the basis for some security of supply. Again, for those countries with no suitable raw materials the answer is easy although the government should always ensure that comprehensive raw material surveys are carried out and that these are regularly reviewed in the light of new technical developments. Countries in this position should also keep their stock holding policy under constant review. For those countries that do have raw materials, the question becomes mainly technical and economic.

Over the years, many developing countries have promoted their own domestic fertilizer capacity and, besides the need for security of supply, various

other arguments have been used particularly when economics are unclear:

- to develop the fertilizer industry as a means to industrialization;
- to save foreign exchange by import substitution;
- to earn foreign exchange from exports.

In many cases where the economic justification was weak or project management and subsequent plant operation was poor, projects have proved to be very costly and a heavy drain on the government's budget.

Box 5. **Expensive fertilizer projects**

- A phosphate fertilizer project in SouthEast Asia which originally cost US$ 120 million but now has an accumulated debt of US$ 833 million.
- An ammonia/urea project in West Africa where construction costs were at least twice the original estimate and where subsequent operating rates have been poor.
- An ammonia/urea plant recently built in SouthEast Asia which suffered regular feedstock interruptions and unscheduled shutdowns. After 5 years of operation the total losses are US$ 110 million.
- A nitrogen fertilizer plant in southern Africa which only produces intermittently and was recently saved from closure by the injection of additional funding from the government.
- plants in a number of countries in Latin America that regularly operate well below design capacity and therefore at high cost per tonne.

There are also numerous fertilizer factories in East Europe and the FSU which were built under central planning and which are now so inefficient and rundown that many will not survive in a competitive market environment without massive government support. For many the only future is eventual closure or, for those plants where there is an economic case, a total re-vamp.

China and India have placed a very high premium on self-sufficiency and have built up massive fertilizer industries based on relatively high cost raw materials. The cost to the government's budget over the years has been very high. Both countries are also very large importers of fertilizers and changes in their purchasing from one year to the next have an immediate impact on international prices.

STRATEGIES FOR SUCCESSFUL PROJECTS

In the new economic climate, fertilizer projects can be successful only when they are based on low cost domestic raw materials available in substantial quantities. Where the project is dedicated to exports or it is planned to export a substantial part of the output, the gas feedstock price will need to be in the region of US$ 1 per million BTUs or lower.

Box 6. **Cost of an ammonia/urea project, Bangladesh**

Feedstock Requirement	
Natural gas:	about 62 million cu feet/day
Installed Capacity	
Ammonia:	1,500 t/d (500 t/d for export)
Granular Urea:	1,725 t/d (mostly for export)
Financing	
Export credit - Japan	US$ 173 million
Export credit - Italy	US$ 33 million
Commonwealth Dev Corp	US$ 22 million
Contractor's Loan	US$ 50 million
Commercial syndicated loan	US$ 100 million
Equity	US$ 130 million
Total	US$ 508 million
Jetties and Storage	
Ammonia loading jetty	20,000 DWT
Urea loading jetty	20,000 DWT
Ammonia storage (refrigerated)	20,000 tonnes
Urea storage	80,000 tonnes
Finished Products Loading Rates	
Ammonia	250-500 t/h
Bagged urea	120 t/h
Bulk urea	500 t/h

Source: Karnaphuli Fertilizer Company Limited, 1994

There are normally three study phases for projects:

- the pre-feasibility study takes an overview of the potential market, the availability of raw materials, technical feasibility and cost of production.

- the detailed feasibility study usually looks at the market in much greater detail but primarily focuses on the technical detail and the total cost of the project including the cost and technical aspects of any additional infrastructure required.
- the final ("bankable") feasibility study often has the mass of technical detail in (a) separate volume(s) with the main report focusing on the financial aspects. This report must be suitable for submission to banks and other potential investors.

Box 7. **Phosphate project at Yichang, China - feasibility study**

Feedstock

Phosphate rock:	local deposit has proven reserves of 90 million tonnes which is sufficient for about 25 years operation. Run-of-mine grade is 23% P_2O_5 which can be beneficiated to 30% P_2O_5. Planned mine capacity: 2.5 million t/a of beneficiated rock.
Sulphur:	210 000 t/a to be imported. New sulfuric acid plant to be built
Ammonia:	to be purchased.

Plant Capacity (phase 1)

Diammonium phosphate (DAP):	500 000 t/a
Phosphoric acid:	230 000 t/a P_2O_5
Sulfuric acid:	650 000 t/a 100% H_2SO_4

Total Project Cost

Phase 1:	US$ 360 million

In order to create the right climate, government policy should:

- help in identifying possible fertilizer resources,
- give positive encouragement to private sector development,
- keep planning restrictions to a minimum commensurate with protecting the employees and the environment,
- consider providing some basic infrastructure,
- develop a reasonable taxation/royalty policy that is fair to the investors.

In all but the most minor projects, the government will need the advice of a specialist in order to be as well briefed on the project as the investors.

Box 8. **Private sector development in Thailand**

The private sector developers of a proposed potash mine are required to obtain

- a *Special Prospecting Licence* covering the likely mine site;
- a *Mining Licence* which permits and controls the amount of ore to be mined;
- an *Environmental Licence* which controls the disposal of effluent and other pollutants from the mine site and provides stringent water quality and emission standards;
- a *Board of Investment Certificate* which gives them an 8 year tax reduction and other incentives in order to get the project underway.

At each stage the developers are required to submit detailed plans and proposals which must be reviewed by well informed government staff. The reasons for acceptance or refusal must be clear and logical and subject to a legal process of review.

An alternative to building domestic capacity which some countries in Asia, e.g. India, Pakistan, Malaysia are actively supporting, is joint-venture projects in countries that are rich in low-cost raw materials, particularly phosphate rock and/or natural gas. This helps to provide a dedicated market for the project and also gives the importing country some control over its fertilizer supply. Other joint ventures are underway in Jordan, south-east China, Viet Nam, Venezuela, Sri Lanka and Thailand.

REHABILITATION OF EXISTING CAPACITY

Numerous studies are currently underway, particularly in East Europe and the FSU, to look at the possibility of rehabilitating existing capacity. But rehabilitation is really no different to building a new plant from scratch except that some of the infrastructure is already available and the total cost may be lower. As with any new investment, essentially the same criteria must apply.

Any savings in foreign exchange expected through operating the plant must be weighed against foreign exchange costs in actually rebuilding the plant, particularly if the country concerned has no plant construction capacity of its own. Note that in the case of both China and India, domestic constructors can build most new plant and equipment and only the very largest reaction vessels and compressors may have to be imported.

PRIVATIZATION OF PRODUCTION CAPACITY

In a review of privatization it appeared that some 75 000 state-owned companies have been privatized in over 100 countries (Nellis, 1999). Privatization leads to improved performance in all industrialized and middle-income countries. There is also increasing evidence that privatization yields major benefits in low-income countries but usually after a slow start. Recent successful fertilizer industry privatisations include those in Trinidad, Mexico, Brazil, Chile, Egypt and India and numerous other privatization proposals are under consideration. The increase in the number of joint-venture projects with up to 50% of the shares owned by private sector partners is beneficial; they also contribute management, technical and marketing expertise.

For the countries in transition most of the positive results from privatization come from countries in East Europe and the Baltic States. So far the evidence from FSU countries is less encouraging and privatization is usually only successful when firms are sold to foreign investors or where there is a substantial foreign investor component. Box 9 illustrates an example of some of the problems encountered .

The countries that have run into major difficulties are those that have weak administrative skills and where the institutional structure is still not favourable to private enterprise.

Box 9. **Privatization in some countries in transition**

The Russian Federation

The mass privatization programme of 1992-94 transferred ownership of more than 15 000 firms by distributing free vouchers. The "insiders" - managers and workers combined - eventually gained control of, on average, two thirds of the shares of the privatized firms and very little actually changed because:

- the "insiders" deeply distrusted outside ownership and the loss of control that this might entail;
- the financial and physical conditions of many firms were unattractive so that outside investors were not keen to buy shares;
- there was no real definition of property rights and no really effective way of trading in the shares now acquired, discouraging outsiders;
- the government failed to put in place supporting policies such as non-inflationary budgets; reasonable but compulsory taxes; and services and mechanisms to encourage new business entrants.

The Czech Republic

The privatization programme consisted of:

- voucher schemes for all citizens who usually exchanged their free shares for shares in the big investment funds which ended up in control of many of the privatized firms;
- many of the larger investment funds were actually owned by state-owned banks, thus little change.

Romania

- Although the two most attractive factories have been privatized in 1998/99, other factories have problems:
  - location of factories not convenient;
  - low ammonia and urea prices;
  - supply and prices of gas feedstock.

Chapter 6
Marketing and credit

The marketing function has two essential parts:

- efficient distribution so as to ensure that the right products are available to the farmer at the right time and at the optimum price, consistent with the provision of a reliable service;
- active marketing which is a continuous process whereby the distributors are constantly looking for new ways to increase sales of fertilizer to benefit not only themselves but also the farmers.

While physical distribution is relatively easy to organize, particularly under a government-controlled system, genuine marketing is more elusive and practical experience suggests that it can only occur when there is an element of competition and choice.

Access to credit is important for the farmer because of the long waiting period between the time when inputs, such as fertilizer, are purchased and the time when the harvested crop is finally sold. Finance is also required by fertilizer distributors to enable them to hold sufficient stocks to meet seasonal demand. Finally, to ensure that farmers are promptly paid for their produce, adequate crop purchase finance for all produce marketing agencies is also necessary.

The establishment of effective fertilizer marketing and credit systems to meet farmers' requirements, to ensure the promotion of efficient fertilizer use and to meet national goals of food self-sufficiency and export growth raises many important policy issues.

Box 10. **Advantages and disadvantages of marketing channels and systems**

	Advantages	**Disadvantages**
Public	National interest paramount Unprofitable and/or areas at introductory stage can be catered for	Can be high cost and inefficient Lack of performance incentives Tend to survive after original objective has been met
Private	Very responsive to price signals and therefore helps to balance supply and demand Constantly seek to reduce costs and raise efficiency Tend to avoid remote areas with low immediate potential	Unwilling to take a long-term view, particularly when interest rates are high.
Co-operative	Interests of members paramount Can provide extended retail network and other services Staff motivated to provide fair dealing	Tend to have higher costs Can become inefficient and/or provide poor quality services. Management may be inadequate in various ways
Competitive	New entrants provide choice Greater flexibility and relatively fast reaction to changing market conditions Cost-efficient distribution System promotes maximum marketing effort and new distribution methods	Prices may vary considerably from one part of the country to another due to different costs Tendency to cover profitable market areas only Quantity discounts for bigger, commercial farms or larger co-operatives only Weak competition or shortages may lead to price gouging and/or product adulteration
Administered	Wider market coverage Easier to administer subsidy and/or price control programme May reduce or prevent unfair competitive practices	May reduce marketing effort by favouring certain channels New entrants discouraged Often less efficient because of controls
State monopoly	Maximises government control Ensures similar service to all regions May reduce or prevent unfair practices Centralised quality control	No choice particularly when service is poor Rigid and slow reaction to market changes Often inefficient because of the layers of bureaucracy and lack of incentives Unrecovered costs increase government's budget deficit

MARKETING SYSTEMS POLICY

In general, existing fertilizer marketing systems can be categorized into three classes:

- the competitive system;
- the administered (or controlled) system; and
- the state monopoly system.

The main differences between these three categories lie in the degree of influence of government policies on the system's functioning, the extent of the government's own involvement in actual marketing operations through its ministries, parastatals, marketing boards and government controlled co-operative organizations. Box 10 shows the advantages and disadvantages of different marketing systems and different marketing channels.

In most developing countries, the government's involvement is concentrated in the areas of pricing, import procurement, wholesaling and infrastructure (for example, storage and transport). Policies pertaining to these aspects of marketing affect all types of marketing organizations and channels equally.

Marketing systems have originated under different circumstances in the past and developed according to changing agricultural, economic and political conditions. If policy changes in the existing system in any one country are contemplated, the goal should be both to enhance effectiveness by providing farmers with fertilizer on time and to improve efficiency by lowering or eliminating unnecessary costs of marketing and distribution operations. It is also essential to consider the market sectors already existing in the country - large scale commercial farmers, plantations and estates, export crops, food crop subsistence farming, etc. The fertilizer marketing set-up that is required for one sector is often quite different from that of another. For example, a private import trading house may best serve the interests of the plantation and estate sector, whereas the co-operative or service society may be the better choice to distribute inputs to the small-scale subsistence farms. No one system is best nor would it be advisable to introduce certain marketing elements that worked in one country unchanged into another country, because of different circumstances. Nevertheless, a few guidelines are proposed.

Clarify functional responsibilities and develop appropriate market structures

In general, there are a number of tasks that inevitably fall to government or government agencies - overall planning of the industry, fertilizer law and the registration of fertilizers (and registration of importers and distributors, if thought necessary), fertilizer testing and quality control, the administration of any subsidies. Most of the other tasks can normally be left to private agents and the free market or, depending on circumstances and local ideology, to state-owned agencies, parastatals and cooperatives or a mixture of all four types.

Governments need to take a view on the appropriate market structure. For those countries at the early stages of market development, relatively small tonnage will be handled and it usually makes little sense to allow fragmentation of the market, particularly at the purchasing and warehousing/wholesaling level where economies of scale are significant. While this tends to suggest that functional monopolies may be the most attractive option, at least in the early stages of development, these need not necessarily be state-owned although in actual practice state-ownership is the usual pattern.

The necessity for fundamental change in the marketing structure was widely recognized in the early 1990s as many countries struggled with severe financial pressures and there was a widespread shift towards market solutions, privatization and the dynamics of competition.

Promotion of the integration of input marketing and produce marketing

Wherever possible, use should be made of the same infrastructure (particularly transport and storage) for both functions. In some situations, credit can be linked to an input-output or barter system. Examples of such a system on a national scale can be found in African countries with export-oriented agricultural production, for example, Burkina Faso, Cameroon and Guinea. In Kenya notable examples of the integration of input and produce marketing are provided by the private sector, Kenya National Traders Corporation, Kenya Tea Development Authority (KTDA) and the parastatal sector. KDTA provides credit and fertilizers to farmers through 44 factories under its control and payment for fertilizers is recovered from the sales of tea delivered later in the season. Similarly, the NIB distributes fertilizers and recovers the cost from rice delivered by farmers to NIB for milling at the end of the season. In Malaysia, the Federation Land Development Authority (FELDA) is involved in fertilizer imports and distribution to its member estates.

Box 11. **Functional responsibilities**

The Philippines is a good example with relatively light government control with a large private sector. The Fertilizer and Pesticide Authority (FPA) is in charge of issuing import licenses, compiling national fertilizer statistics and development of the fertilizer industry and market in general. It is also responsible for registering fertilizers under the law and for checking quality, particularly amongst the smaller dealers, where adulteration and under weighing is often a major problem. Other tasks are with the private sector.

South Korea, by contrast, has pervasive government control at all levels. The Ministry of Agriculture estimates aggregates demand and sales in each market area via a national survey. The state-owned National Agricultural Co-operative Federation (NACF) which has a 25% share in the largest domestic fertilizer company (also state-owned), issues annual competitive tenders to the domestic fertilizer industry for the supply of the entire annual fertilizer requirement for the following year and handles all aspects of distribution.

Ethiopia provides an example of a fully state-owned system now in process of major change. Before deregulation, the Agricultural Inputs Supply Corporation (AISCO) controlled the market and carried out an annual demand survey. AISCO was responsible for the import function, distribution to transit warehouses, distribution to secondary and tertiary stores and finally distribution to service cooperatives or kebele association stores. The market was deregulated to some extent in 1992 and again in 1995. The National Fertilizer Industry Agency (NFIA) became responsible for demand estimation, import and distribution planning estimation, import and distribution planning.

Liberalization of fertilizer retailing

Providing an element of choice or extending the existing level of choice to the farmer is probably the single most important factor in improving the performance of the market. In India, Pakistan and Sri Lanka consumption increased considerably when the market was opened to participation by the private sector. To complement the private sector, India and Sri Lanka opened service centres in areas where input supply was greatly below the national average. Linked to officially designated suppliers, these received financial and other support from the government.

Purchasing

A single, specialized agency to undertake the purchasing of fertilizer and to provide a central base for distribution to the main transit warehouses is generally favoured by importing developing countries. This offers scope for:

- securing lower import prices by purchasing large quantities; this is particularly important for phosphates and potash;
- port warehousing and transport to main transit warehouses provides economies of scale;
- specialization in fertilizer procurement; enables the purchasing agency to build up skill and experience in assessing demand, negotiating prices, planning the arrival of supplies, minimizing product losses during port handling and forwarding and obtaining market intelligence; and
- equalizing the prices of successive consignments to maintain price stability throughout the year.

The designated purchasing agency could be a private company, (current examples include the Crown Agents), a state-owned company (examples include SINOCHEM in China, FELDA in Malaysia) or a co-operative (examples include the National Agricultural Co-operative Federation in South Korea).

Two state-owned examples from developed countries include the old Australia and New Zealand Phosphate Commissions which were at one time responsible for supply of phosphate rock and sulphur to the superphosphate companies and also for holding the reserve stockpiles of phosphate rock.

A further option is for parallel procurement with, for example, a centralized agency importing for the small holder sector and private companies handling fertilizer for larger farmers and export oriented estates.

Whatever procurement option is adopted, the availability of foreign exchange is likely to affect efficient procurement procedures. In many countries, imported fertilizer often arrives too late for the season for which it was intended because procurement was delayed by foreign exchange difficulties. Policies that facilitate the issue of foreign exchange and liaison between the Central Bank, Ministry of Finance and the importers need to be developed.

Fertilizer aid, of course, is extremely welcome to many developing countries. However, aid, in turn, raises a number of policy issues:

- are the donors' terms acceptable to the importing government?

Box 12. **China - purchasing liberalization**

In China, the distribution of fertilizers is government-controlled. The China National Agricultural Means of Production Corporation (CNAMPGC) and the All China Federation of Supply and Marketing Cooperatives manage the distribution of agricultural inputs. Fertilizers have been sold at fixed prices to farmers. However, increases in distribution costs together with rigid trading and pricing mechanisms have resulted in marketing inefficiencies.

The China National Chemical Import and Export Corporation, SINOCHEM, is the state-owned import/export trading company in China with a total turnover in 1995 of US$18.2 billion. In 1996, Sinochem imported about 18 million tonnes of fertilizer including 6 million tonnes of urea, 4.5 million tonnes of DAP and 3.5 million tonnes of potash. In 1997, total imports were somewhat lower at 16 million tonnes as urea imports fell away to only 3.5 million tonnes. CNAMPGC distributed (at both national and provincial level) about 83 million tonnes of fertilizer in 1990 and about 105-115 million tonnes in 1996 and 1997.

In 1993, backed by a technical assistance grant from the Asian Development Bank, the Chinese authorities began to develop the legal and regulatory framework to establish a fully market-based fertilizer industry and distribution system.

In mid-November 1998, the State Council issued a circular calling on implementation of a new fertilizer distribution system to increase profitability for fertilizer producers and guarantee fertilizer supplies for farmers. The reform has given fertilizer producers the freedom to set prices in line with market fluctuations and to sell products directly to farmers.

In this reform, SINOCHEM was granted the right to engage in internal trade of mineral fertilizers. CNAMPGC was granted importing rights for mineral fertilizers as well as SINOCHEM.

- how can fertilizer aid be imported and distributed in such a way as to avoid disturbance of the existing marketing channels? Disruption can easily happen if special pricing or distribution policies are adopted for aid consignments.
- who is to administer the aid programme and how should the proceeds from fertilizer aid sales be used? Often the counterpart funds are not properly collected or are lost in various ways or simply channeled through government accounting system. Such funds should normally be used to finance further fertilizer purchases, carry out fertilizer promotion campaigns and develop the fertilizer-marketing infrastructure.

PRICES AND MARGINS

Price setting

When governments seek to control prices, a choice must be made as to whether to implement a universal pricing system or differentiate between various market segments.

In some cases, it is possible to have a dual pricing structure where, for example, a parastatal marketing organization sells subsidized fertilizer to the small farm sector and other private firms sell fertilizer at full cost to the estate sector.

Pan-territorial pricing where the price of one or a number of fertilizers is fixed at the same level in all parts of the country can be criticized for "penalizing" the fertilizer users near the distribution centres by charging them a higher price than necessary in order to provide farmers in remote areas with heavily subsidized fertilizer.

An alternative to pan-territorial and differential pricing is fixing prices at the major distribution points with cost-plus margins for onward distribution and sales, if necessary in combination with a price ceiling, which allows for trade and volume discounting and seasonal early delivery rebates. The advantage of this form of pricing is that each geographical region pays a slightly different price, according to the actual costs incurred by the dealer and/or retailer to move the fertilizer up to the farm-gate, without the difference becoming too large, thereby avoiding black marketing of fertilizers across geographic boundaries. Moreover, it provides the lower level distributors with enough financial incentive to engage in the business of selling fertilizer, probably alongside other inputs.

A fourth method is for the government to incur the extra transport costs through a special subsidy for distributors operating in remote areas of the country. Transport subsidy schemes are cost effective to administer but expensive to monitor.

Pricing of imports and domestic production

As developing countries establish fertilizer factories, they find themselves having to face the major policy issue of how to set prices when the ex-factory cost of local fertilizer is different from the c.i.f. cost of imported material. This is a particularly vital issue when world market prices are depressed and local production costs may be more than double the cost of imported fertilizer.

Frequently, this basic problem is not considered at the time of the decision to proceed with the construction of a fertilizer factory.

A common solution is to follow a policy of price equalization which, in effect, usually means that imported fertilizer is sold at a higher price and domestic production at a lower price than is justified by actual costs. Such a system normally requires either that the fertilizer pass through a central purchasing agency or that the manufacturer(s) also handle imports. However, this can be incorporated with competitive distribution at the wholesale and retail stages, as is the case in India. An alternative approach is for imports to continue through the normal channels, with the government operating a variable price equalization import duty to protect the domestic manufacturer.

Marketing costs and margins

Studies of marketing costs and margins in Asia and Africa have shown wide variations in costs incurred in moving fertilizer from the factory or port to the farmer. For example, FADINAP (the Fertilizer Advisory, Development and Information Network for Asia and the Pacific, part of ESCAP/FAO/UNIDO) has shown that total marketing costs and margins can range from US$ 13.7/tonne in Bangladesh to US$ 46/tonne in the Philippines and higher still for land-locked Nepal. Marketing costs in Africa are also generally at the higher end of the range and in land-locked Ethiopia were estimated at US$ 97-US$ 140/tonne in 1996.

In most cases, the assessment of costs is complicated by the involvement of the public sector and open and hidden subsidies. The hidden subsidies may be in the form of special transport rates from state-owned rail and truck companies, reduced storage costs and losses written off by state-owned companies. A particularly difficult situation can arise when, during liberalization, the old state-owned distributor continues to have access to Ministry of Agriculture stores and agents or has privileged access to credit and may be able to write off any losses incurred.

Marketing systems that include the private and/or independent co-operative sectors will only be effective in market development if an adequate margin is built into the price structure to cover actual costs of transport, storage, administration and overheads as well as the mark-up to return a reasonable profit and to compensate for the risks that any business venture faces.

It is essential that policy-makers realize that a sufficient gross margin is needed to stimulate trade and fertilizer consumption and that parsimony on this item will not generate any substantial savings to help lower the real cost of the

fertilizer. Growth in fertilizer consumption will only come about if traders receive sufficient incentive for their efforts and the marketing cost can only be lowered by careful monitoring and strict control of the marketing operations undertaken by the public import and wholesale agencies.

Policies relating to fertilizer marketing margins should thus ideally include:

- a flexible price structure, based on local market conditions and consumer purchasing power;
- strict control over marketing and distribution costs incurred by government-controlled organizations;
- an adequate margin to enable independent distributors to recover actual costs and to encourage the provision of extra services;
- an adequate mark-up to return a fair profit.

TRANSPORT AND STORAGE

The first criterion of effectiveness in fertilizer distribution is that the product be available in adequate quantities when and where it is needed. This depends on the existence of suitable transport modes and storage facilities. It also reflects managerial capacity in ordering, stock movement and sales territory allocation. With good management and advance planning, economical ways around transport and storage bottlenecks may often be found. Governments should be able to foster investment in the provision of needed physical facilities and to employ operations specialists in important distribution management positions.

Port or railhead facilities

Effective procurement planning can reduce excessive peaks in deliveries, but the unloading facilities must be sufficient to deal smoothly and efficiently with the expected rates of delivery. Where delays have become endemic, consideration should be given to using additional ports for fertilizer imports. Mechanical off-loading equipment for fertilizers in bags or in bulk may have to be installed or improved and dockside storage may need to be expanded. Handling methods, which result in damage to bags when using hooks, must be eliminated. Storage facilities must be clean and dry and there must be sufficient space to keep the different products separate and to permit easy removal from store.

Where fertilizer is imported in bulk and bagged either at the port or at inland centres, adequate controls are needed to ensure that the quality and weight of the bagged fertilizer conform to the desired specifications. This applies

particularly to the weight of individual bags. The practice of filling bags manually and weighing a complete rail wagon or lorry load, or a tonne at a time, often gives rise to complaints and may even result in farmers being unwilling to accept certain types of imported fertilizer. The sealed bags ought to be universally recognized as a guarantee of correct weight and quality. Alternatively, a system must be devised by which individual bags are weighed and those outside the permitted tolerance limits are either rejected or labeled and priced accordingly. The rate of bagging at the port should not become a new bottleneck in fertilizer movement. This can often happen where actual rates fall below planned rates.

Internal transport

Rail: Rail is usually preferred for haulage over long distances if the cost per tonne is lower than by road. The important factor is the reduction of the turn-around period of the rail wagon. This is possible through movement in a full trainload to a single destination. A prerequisite of this is the establishment of central railway heads at various points in the country that can receive and handle the necessary trainloads within the specified period. In India, more than 100 of these so-called nodal points have been identified for this purpose. Then develop them in such a manner as to make them capable of handling full trainloads within five to six hours. Since a number of trainloads are expected to arrive each week, a transit storage point will also have to be developed at each nodal point.

Road: Transport by road is economical on short distances because it is generally quicker, there is less handling, losses in transit are lower and there are better possibilities for return loads and competitive pricing. To obtain the maximum benefits from road transport, petrol costs per tonne kilometre can be reduced by proper route planning and by ensuring return loads. In many instances, vehicles travel only partly laden or make long detours to deliver only small quantities, thereby adding unnecessarily to the unit cost.

Water: movement of fertilizers by water transport is usually cheap and millions of tonnes are satisfactorily shipped every year in this way. Water transport, even with its limitations, offers a low energy/low cost alternative and is a particularly attractive option in the Philippines with its requirement for many inter-island movements. More use of coastal and river shipping is envisaged in a number of other Asian countries.

However, demurrage, wharfage and insurance costs, delays due to inadequate loading and unloading facilities and substantial losses in transit may tend to balance out the theoretical savings in some countries.

There are various policy decisions that may be taken to help streamline physical distribution:

Firstly, several competing manufacturing facilities may be located in or near a given market area, as in India and each factory supplies the nearest market. Secondly, where common markets are shared, factories may exchange materials as well as share intermediate storage facilities collectively, to cut down on transport and storage costs. To reduce the number of intermediate stores and numerous fertilizer handling operations, direct transport should take place from factory, port or major warehouse to dealers and retailers, mainly by standard size trucks, as is practiced in Thailand.

Seasonal overloading of the transport facilities can be avoided by introducing attractive off-season prices for early delivery of fertilizers. Off-season discounts can also be given in the form of reduced transport rates, reduced storage charges or higher margins for dealers.

Consideration should be given to the ownership of fertilizer transport fleets. Frequently, fertilizer companies insist on having their own fleets, but the hiring of transport from specialized transport companies may be more efficient and may reduce capital overheads. Additionally, transport companies have a greater incentive and ability to seek back loading than do fertilizer-marketing organizations.

Storage

The seasonal demand for fertilizer means that the need to hold considerable quantities in primary or secondary storage for subsequent more dispersed distribution is difficult to avoid. This can be undertaken at the port, by manufacturers and/or throughout the distribution channel.

Port: storage time at port must be minimized if conditions are humid. Nevertheless, there must be sufficient space to permit quick reception of the ship's cargo. Port storage is generally in the hands of the port authority or a rail company and rather expensive because of competition for space from other incoming goods.

Factory: factories generally have a warehousing capacity equivalent to four to five weeks of production. In times of product scarcity, stocks move quickly into distribution channels. In times of product glut, the onus of warehousing tends to shift to the manufacturer or the wholesale trader. Successive stages in the distribution chain must share the responsibility of inventory holding, the expenses of storage, interest on capital tied up and the handling charges. Possible

approaches to achieve this are:

- store-building assistance schemes; for example, in Sri Lanka, dealers and retailers were provided with store plans, partly "free" capital and partly soft loans to build their own stores;
- utilization of storage space when not used for other purposes, for example, grain storage;
- careful planning of location and size of regional stores;
- adequate margins for wholesale and retail distributors to enable them to assume the burden of storing fertilizers outside peak times;
- contracting warehousing out to private or public warehousing companies to reduce capital overheads.

Buffer stocks

Large fertilizer importing countries can have a major impact on world markets if forced to vary their purchases substantially from one year to another, due to shortfalls in domestic production or variations in farmers' aggregate demand. They are also vulnerable to substantial changes in world demand and supply. The Government of India judges it advisable to hold a buffer stock of 20 percent of annual consumption and provides storage for this. Smaller importing countries may be able to count on the world market meeting their orders promptly. However, they are also vulnerable to price- and supply fluctuations and to supply shortfalls arising from higher than expected demand. Some buffer stocks are therefore advisable. For landlocked countries subject to interruptions in transport access, such as Nepal, Zambia and Malawi, advanced ordering and some carry-over stocks are particularly advisable.

FINANCE AND CREDIT

Financial requirements

If total fertilizer consumption is to increase by the amount required, considerable additional financing will be needed to cover the corresponding investment in infrastructure, i.e. feeder roads, rolling stock, vehicles, warehouses, trained workforce. Finance for permanent transport infrastructure, e.g. roads, bridges, etc., has generally to come directly from the government. Investment in vehicles, stores and handling equipment must be made by the enterprises that operate and use them. Governments must provide long-term assurances on these points, if they are to count on timely investment decisions by independent enterprises.

They must also make the required foreign exchange available for external purchases and/or obtain the necessary aid and loans from donors and the international development banks.

Credit for small farmers

Credit availability largely dictates the marketing of fertilizers. Most governments have initiated pilot programmes and set up agricultural bank and co-operative credit systems to help meet this need. They have tended to serve the large and medium-scale farmers, because of the nature of credit procedures and eligibility requirements. In this way, they have been able to reach only a small proportion of the small-scale farmers, whose only source of credit would normally be traders or moneylenders. Evidence from many countries is that loan repayment rates of as low as 40 percent are quite common.

Integration of credit with crop purchasing

The most efficient fertilizer distribution systems in West Africa have been those linked with crop collectors, i.e. companies in charge of extension, assembly and marketing of the product. These companies may be state-owned or private. Typical crops include coffee and cocoa (Cameroon, Côte d'Ivoire, Mali, Senegal, Chad and Burkina Faso). Many marketing boards supply fertilizer on credit against purchases of the crop for which it is intended. In the Republic of Korea, a Fertilizer-Food Exchange Programme was implemented until the late 1970s. Farmers received fertilizers on credit and paid back the loan with paddy or barley after the harvest at predetermined prices.

Commitments to sell through a particular outlet

This involves an outlet undertaking to collect credit repayments for fertilizer supplied by another organization. Arrangements of this kind are being tried in many places. Usually, such "stop order" arrangements relate to credit advanced for a particular crop. They are easiest to manage in a one-channel market controlled by a marketing-board or co-operative system. Another device, applicable under controlled marketing arrangements, is the credit identity card. Holders must sell their produce to an official buyer who is obliged to check the credit card and deduct payments on loans indicated on it.

Mobilization of local authority or moral pressure

Where crops are grown by many small-scale farmers, partly for local consumption as in the case of most food crops, collection of credit repayment via the crop

buyers is not feasible. Under such circumstances, the involvement of some local authority or the inducement of collective (group) responsibility should be encouraged. An interesting example in this category is the Grameen Bank in Bangladesh, which offers micro-credit to groups of poor villagers, usually women. The success of the Grameen Bank has stimulated the development of other micro-credit facilities now supported by the Asian Development Bank.

Use of traders with local knowledge

It is common for governments to belabour "merchant money-lenders" and even to initiate legislation making their activities illegal, though by reducing the supply of credit this may be to the direct disadvantage of the farmers. These moneylenders play an important role in the village although their interest rates are often very high. Their money is rarely used for such items as fertilizer purchases. However, village rice/grain millers and food traders often provide credit to farmers for fertilizers in order to secure their supplies of foodstuffs for sale to their other clients. Their first concern is to protect the throughput of their business rather than to earn exorbitant interest. Moreover, small-scale, individually run village enterprises generally operate credit extension more flexibly and at less cost than larger, more elaborate mechanisms with bureaucratic procedures and heavier overheads. They are also close to the small-scale farmers and much more sympathetic to their needs.

Supervised credit schemes

Under such schemes, a farmer's credit line is established based on his farm plan. Loan release is in two or three installments on the recommendation of extension officers who certify that the farmer has prepared his land, is ready to use fertilizer, is ready for harvest, etc. It must not be forgotten, however, that farmers who are obliged by circumstances to buy fertilizer on credit, will find it difficult to repay their loan in a poor season when yields are depressed or prices low. The need for new credit returns with each new growing season and without it fertilizer consumption will decrease. Crop insurance or loan guarantee schemes have been seen as ways of overcoming farmers' inability (as opposed to unwillingness) to meet their credit obligations in case of crop failures due to natural causes.

For policy-makers the main aims are:

- to provide farmers with credit in the most cost-effective way;
- to extend credit at "normal" commercial rates by the banks and credit institutions through marketing agencies, enterprises and traders, who can apply more pressure via input-output exchange systems on loan repayment

rather than through bank and credit officers not daily involved in, or living and working among, the small-scale farming sector;

- to replace the present collateral requirements with group or collective responsibility for loans.

Credit for distributors

Suppliers customarily give credit to dealers because sales are not for immediate cash but for payment within a specified, sometimes interest-free, period (e.g. one to two months after delivery). An extension period may be granted subject to a higher interest rate and against adequate security. In an expanding market, dealers' financial needs will increase in tandem with the larger volume of business. To meet these needs, they require recourse to commercial and/or government banks and other institutional lending agencies. A problem in many countries is the limited amount of credit such institutions will provide and the formalities involved will deter many traders. In consequence, many have to depend on private sources and this keeps the cost of their credit high. A regular institutional credit facility for commercial fertilizer traders is needed along the lines of those already existing for state and co-operative channels.

Savings mobilization

Given past problems with short-term credit for the small farmer, attention is increasingly being turned to alternative ways of generating the necessary funds. One approach is to encourage rural savings mobilization. There are a number of successful grass-roots mutual self-help organizations in Africa. A good example of this is the Savings Club movement in Zimbabwe which, to encourage utilization of the savings, has designed packages to cover major farming operations, such as seed and fertilizer input, pest control, storage and marketing.

TRAINING

For the implementation of fertilizer marketing policies, availability of an adequately trained workforce is a prerequisite, yet few governments or domestic fertilizer industries have a specific policy on this. Three levels of training are required for effective implementation of fertilizer marketing policies:

- Training of senior managers must emphasize how each of the fertilizer marketing functions can be carried out effectively and how each can be integrated into a total fertilizer marketing system.

Box 13. **Poland – new distributors system**

Probably the most dramatic result of the economic changes starting in 1989 was that farmers virtually stopped buying fertilizers due mainly to the high cost of credit. In early spring 1991 and stimulated by the government's offer of cheaper credit for a 2-3 week period, fertilizer demand increased sharply but many farmers went direct to the factories to pick up material, thus cutting out the distributor completely.

As from 1997, each manufacturer deals with about 100 wholesalers, controlling at least 10 "points of sale". The government subsidises interest rates down from 20% to 9-12% and provides technical assistance to farmers through local advisory centres. A number of dealers now also buy farmers' products and this helps to increase the availability of credit. Prices for fertilizers are set during negotiations between factory and wholesale distributors who act as commission agents. The commission agent undertakes to receive and store the fertilizer and manage sales to farmer clients or to other retailers. Because the new system mostly works on a commission basis, all the points of sale are referred to as "factory points of sale" and the fertilizer remains the property of the factory until sold on to the final client. The retail price is set by the factory and is normally the same for the entire country. Commission agents are required to provide financial cover to the factories equivalent to the value of the fertilizer in their stores.

The new private wholesale commission agents now account for about 60% of sales. Direct sales appear to receive preferential treatment because they provide immediate cash infusion whereas the wholesale/retail route ties up valuable credit.

- The fertilizer distributors, i.e. private dealers and/or staff of cooperatives, must be trained to operate a fertilizer retailing business and be provided with appropriate knowledge of fertilizer use, thus enabling them to assist their farmer customers to make sound fertilizer purchasing and application decisions.
- Technical staff and labourers need to be trained in necessary skills, ranging from sales estimation and store-keeping to the more menial tasks of loading and offloading fertilizer without damaging the bags and spilling fertilizer material.
- Training is a specialized activity and is best conducted by professional organizations. The private sector should envisage appropriate training packages.

MARKET DEVELOPMENT

The organization of an effective fertilizer marketing and credit system will be aided by distinguishing three broad stages of fertilizer use development, illustrated by examples from Asia and Africa (Table 9).

Table 9. **Stages of fertilizer use**

Stage I	Introduction	Nepal, Cambodia, Madagascar, Togo, Côte d'Ivoire
Stage II	Take-off	Vietnam, Bangladesh, Indonesia, Pakistan, Thailand, India, Philippines, Ethiopia, Morocco
Stage III	Maturity	Republic of Korea, Japan

The division is based on the average fertilizer nutrient consumption attained in the country on arable land and land under permanent crops.

It is possible to distinguish in a similar manner, between different market zones within a country, each with its own low, medium or high average nutrient consumption potential, namely:

Zone A. High potential, good infrastructure, modern technology available, assured irrigation, high awareness of fertilizer use benefits.

Zone B. Good potential with a fair amount of infrastructure facilities, intermediate technology, adequate rainfall and growing awareness of fertilizer use benefits.

Zone C. Latent potential, e.g. semi-arid area, with scope for profitable development of agriculture or food self-sufficiency.

The three stages of fertilizer use development and the segmentation of markets into zones provide a good base for fertilizer market development. For example, creating awareness of the benefits of fertilizer use and demonstrating application techniques in Stage I and Zone C stimulates demand for fertilizer. In Stage II, Zone B, advanced and mass media extension and promotion techniques may be used to increase per hectare consumption. In Stage III and Zone A, a major stimulus should be given by the government, its extension services and public agencies, to the private sector to cater for these markets and to continue to increase fertilizer consumption.

Fertilizer off-take and increases in demand depend on a combination of factors, all to some extent linked with the fertilizer marketing effort. These factors are:

- accurate assessment of demand;
- effective organization of the inputs procurement and delivery system;
- efficiency of marketing enterprises;
- adequate logistics facilities and operations;
- customer-oriented extension and promotion activities;
- fair prices;
- profitable value:cost ratios; and
- credit availability on affordable terms.

A few guidelines on policy making for fertilizer use promotion are:

1. Promotion costs money. Thus, where governments wish to control fertilizer distributors' margins they must ensure that these are, nevertheless, sufficient to encourage the manufacturer, importer, wholesaler, retailer to carry out effective promotion.
2. Study of the experience of India in fertilizer promotion programmes, of the Philippines and Bangladesh concerning private retailer development programmes and of Pakistan on fertilizer development planning.
3. Medium-term plans for fertilizer use promotion by government must be developed and adhered to. These should include budgets, objectives to be achieved, division of responsibilities and careful monitoring of progress.
4. The role of the village-level fertilizer distributor, i.e. retail outlet, is of utmost importance for the successful completion of any promotional campaign. A special fertilizer retail support unit may be established in the government or industry, with an appropriate budget and mandate to initiate, coordinate and implement fertilizer sales programmes through the dealer/retailer.
5. An important aspect in organizing promotion programmes is the ability of governmental and non-governmental organizations to work together, as demonstrated by the "National Agricultural Inputs Fortnight" campaign in India. This promotes the adoption and use of essential farm inputs.

Box 14. **Stages of fertilizer use development and marketing policy variables**

Physical availability	
Introduction (Stage I)	Village-level stock of straight fertilizers, especially in priority areas.
Take-off(Stage II)	Introduce quality control legislation. Increase village-level retail outlets and storage facilities. Introduce complex and other fertilizers.
Maturity(Stage III)	Expand the range of available new products. Strengthen regional-level supply points.
Farmer awareness	
Introduction (Stage I)	Basic demonstrations and farmers' trials. Introduce educational programmes via mass media.
Take-off(Stage II)	Intensify educational programme via mass media. Train fertilizer dealers to provide technical advice to farmers. Shift government extension efforts to technical matters.
Maturity(Stage III)	Extensive use of fertilizer dealers for basic technical training. Shift extension efforts to advanced technology and products.
Credit	
Introduction (Stage I)	Introduce supervised credit scheme in demonstration areas. Provide low-cost credit for fertilizer purchase.
Take-off(Stage II)	Increase farmers' production credit and relax conditions for collateral. Introduce fertilizer loans and produce marketing link. Gradually increase interest rates and services.
Maturity(Stage III)	Use dealers for credit to farmers and provide marketing credit to dealers. Provide medium-term capital loans to farmers.
Price and economics	
Introduction (Stage I)	Provide large price subsidy to farmers. Restrict retail margins.
Take-off(Stage II)	Introduce measures to reduce marketing costs. Allow gradual increases in retail margin with more responsibility given to retailer. Reduce subsidies.
Maturity(Stage III)	Eliminate subsidies. Relax restrictions on retail margins. Maintain optimum fertilizer/produce price ratios.

GOVERNMENT SUPPORT SERVICE

Central unit

For a fertilizer-marketing system to develop to the best advantage there must be a focal point to provide and coordinate support services. This central unit must be independent of any government involvement in the import, production and distribution of fertilizers. The first responsibility of such a unit is to advise the appropriate ministries and departments on fertilizer policies and strategies. A second task is to monitor performance. Related to the monitoring function should be the authority to implement controls, to instigate changes when and where necessary and to operate an incentive scheme for above-standard performance. The latter is of particular importance in the case of public and co-operative marketing enterprises.

One good example of such a unit is the Fertilizer and Pesticide Authority (FPA) in the Philippines, which was responsible for the administration of the fertilizer production and marketing subsidies until they were abolished. Some of the areas on which such a unit should focus are:

- import procedures, tendering and handling at port;
- national fertilizer production;
- coordination of foreign exchange requests;
- advice to the government on pricing policy, margins, etc.;
- registration of distributors;
- market development;
- preparation and analysis of statistics of fertilizer use, sales, prices, etc.

Quality control

The quality of fertilizer cannot be judged by its appearance so that the buyer depends on information supplied by the manufacturer and distributor. Quality control of fertilizer is normally a government responsibility and bags of fertilizer for sale should normally be required to carry the following basic information:

- name of the fertilizer;
- brand name or name of the manufacturer;
- percentages of primary nutrients;
- other characteristics;
- total weight (gross or net).

Legislation on the quality and packaging of fertilizers is effective only to the extent that it can be enforced. Qualified people must be appointed as inspectors and given the necessary authority to examine stocks of fertilizer offered for public sale and to take penal action against offenders. This does not mean that a special core of fertilizer inspectors is required. Quality control of fertilizers can be combined with that of agricultural products and supplies, such as seeds, pesticides and veterinary medicines.

FERTILIZER IN BULK OR IN BAGS

Fertilizer is usually packed in 50-kg bags although over the last 20 years there has been a substantial growth in sales in big bags (normally 500 kg) and in bulk, particularly in the more mature markets in Europe and North America. In developing country markets, the 50-kg bag is still the preferred container and this is usually of the woven polypropylene type with a low-density polyethylene

Box 15. **Bags versus bulks**

ADVANTAGES	DISADVANTAGES
Bags	
Easy to handle Good product identification Weight and quality control is easy Simple to measure out quantities Good product protection Can use traditional transport Easy to store Suitable for low technology agriculture Good for small-scale usage	Costs of bags and bagging Mechanized handling may be more difficult
Bulk	
No bags or bagging cost Easy mechanical handling Savings in transport, handling and storage costs Bulk blending at local level is easy	Risk of product deterioration and/or contamination High investment costs - handling, transportInfrastructure required
Bulk with port bagging	
Importing in bulk lowers shipping cost Reduced port and handling costs if well managed Less foreign exchange needed Can increase speed of loading and unloading	Bagging operation at the port needs careful management. If there is insufficient port storage, unloading speed depends on speed of bagging and truck dispatch

liner. Bags are normally handled loose whereas in West Europe the normal pattern would be to handle bags on pallets usually with shrink-wrapping. The advantages and disadvantages of bags versus bulk are described in box 15.

CONCLUSION

- In countries with a poor balance of payments and shortage of foreign exchange, food aid is often preferred to fertilizer aid and is given priority in the allocation of infrastructure facilities. It must be recognized, however, that food imports are a short-term solution, whereas fertilizer could eventually ensure self-sufficiency.
- In many developing countries, fertilizer is still mainly used on plantations and for export crops. As the pattern of demand changes and small-scale farmers become more significant users of fertilizer, the established marketing channels has to adjust.
- When consumption has increased to such an extent that most farmers are using fertilizers, the role of the government can be sharply reduced, particularly in wholesale and retail distribution; subsidies can also be reduced or eliminated. The main role of the government at this stage should be to encourage the growth of the domestic industry and private sector involvement.
- The quantities of fertilizers which farmers wish to use may well be much higher than the actual supply because of the inability of the country and farmers to pay for inputs. Apart from the problems of finding the requisite foreign exchange, the most important factor is the development of farmer credit either through the banks or through the improved integration of fertilizer supply with the purchase of farmers' crops.
- The realistic forecasting of demand is still a problem in many countries. Government estimates are often targets rather than forecasts. Frequent updating of assessments (say, every six months) for longer-term planning is required as well as more reliance on subjective assessment by the industry, trade and the farmers themselves for short-term demand expectations in order to improve the accuracy of planning and to increase confidence in investment decisions.
- The choice of distribution channels is quite often based on historical developments and political considerations. Whether private, state-owned or co-operative, each channel type has its own strengths and weaknesses and the best solution is often a mix of types, based on economic considerations pertaining to each channel's relevance to a particular market segment.

- In many developing countries, interest charges, import duties and local taxes, constitute a major part of the total marketing cost. Efforts to reduce overall marketing costs should therefore consider this type of cost. Limited preferential treatment, like the waiving of import duties, may provide benefits to the national economy, which outweigh the treasury's reduced income.
- Fertilizer use will not increase unless there are adequate financial incentives for manufacturers, importers, distributors and users alike. The public agencies need some reward system for having realized cost savings or having worked within the budgetary limits; private and co-operative enterprises need adequate margins and a profit mark-up to remain interested in fertilizer trading. Farmers, obviously, must be assured of a profitable return on their input investment cost.
- Governmental controls and regulations, which were enacted in times of supply shortages in the past should be reviewed periodically in order to prevent them from obstructing new efforts to improve marketing efficiency.

Chapter 7
Fertilizers and agricultural extension

BALANCED AND EFFICIENT FERTILIZATION

A particularly important issue in the case of mineral fertilizers is the efficiency of their use. The most efficient techniques are discovered by research and the findings are communicated to the farmers by the extension services. Efficient fertilization is synonymous with the minimization of nutrient loss to the environment, without sacrificing crop yields. Excess nutrients, especially nitrogen, not taken up by the crop, are likely to be lost to the environment. Uneven fertilization means over-fertilization (pollution) of some areas, under-fertilization (loss of yield/quality) of others. Evidently, correct fertilization must be accompanied by other proper agricultural practices.

If fertilization is to be efficient, it must be balanced. In fact world nitrogen consumption has increased much faster than that of phosphate and potash, not to speak of the other nutrients, since 1960. Between 1960 and 1998, the world use of nitrogen increased from 12 to 81 million tonnes N, a seven-fold increase in 38 years, despite a substantial fall in the countries of Central Europe and the Former Soviet Union since 1990. The ratio between N, P_2O_5 and K_2O changed from 1:0.95:0.73 in 1960 to 1:0.38:0.27 in 1998.

The increase in the consumption of nitrogen in relation to the other nutrients is due to several factors. The price of nitrogen relative to phosphate fell after the developments in nitrogen fertilizer production in the 1960's, especially with the implementation of the steam reforming of natural gas. Much larger manufacturing plants gave economies of scale. There was a large increase in the production capacities and hence in the availability. Increased consumption in large developing countries often coincided with increased supply from new nitrogen fertilizer plants. New varieties of cereals, very responsive to nitrogen, were

developed and in countries with a climate favourable to intensive grassland, the nitrogen fertilization of grass increased considerably.

Nitrogen is an important constituent of plant chlorophyll, protein, nucleic acids etc. It increases the growth and development of living tissues. The effects of nitrogen application to a crop are normally rapid and evident. Under good management and favorable climatic conditions, yield response to nitrogen is large and predictable. Renewed applications of nitrogen fertilizers are necessary since, apart from the crop up-take, a substantial proportion of the nutrient is lost through leaching, denitrification and volatilization. At times of economic stress, the farmer prefers nitrogen because of the immediate and evident return. The same may apply where the farmer's financial resources are limited, his tenure of the land is insecure etc., which is the case in many developing countries.

However, the other plant nutrients also play an essential role. If any plant nutrient, whether a major nutrient or a micronutrient, is deficient, the utilization efficiency of the applied nitrogen is reduced and crop growth is affected. Phosphorus, for example, is a constituent of proteins, enzymes, amino acids etc. It stimulates root development and is necessary for cell division. Potash is of vital importance for cells and their enzymatic and metabolic functions.

Research at IRRI in the Philippines has shown that while the application of an adequate quantity of N increased the yield of rice paddy 2.9 times, it also resulted in the removal of 2.6 times more P, 3.7 times more K and 4.6 times more S from the soil, compared to the amounts removed from unfertilized soil. In due course, these nutrients have to be replaced if the yields are not to suffer. The same applies to micronutrients.

AGRICULTURAL RESEARCH AND EXTENSION

In almost all countries, agricultural research and extension is seen as a prime government responsibility and can be remarkably cost effective, providing it is well managed and has strong and effective leadership.

In many countries, basic agricultural research and extension is often tied in with graduate and post-graduate training at universities and agricultural colleges. Probably the best example of government funding for agricultural research and training can be found in the setting up of the so-called Land-Grant Colleges in the USA.

Many countries also have a government sponsored extension service which usually provides independent agricultural research, technical bulletins, soil testing and general advice. Again, if these facilities are well managed they can be very effective in providing new techniques and basic information for farmers.

The International Rice Research Institute (IRRI) which is based in the Philippines provides an excellent example of highly effective publicly funded research which is also outstandingly good value for money. IRRI employs 975 scientific and support staff of whom about 80% are Filipinos. Since it was founded in 1960, IRRI has recorded numerous outstanding achievements including the development of the IR8 variety of rice which helped to launch the "Green Revolution" throughout Asia. IRRI is now aiming for a second "Green Revolution" for the new millennium. Research into new rice varieties continues and new developments such as IR72 are currently under test in Wuhan, China.

Policy-makers should give high priority to the funding of good agricultural universities and colleges and also for effective government research and extension services. Funding could come partly from the government budget (for example, from making savings on fertilizer subsidies) and partly from donors.

Extension

The development of fertilizer use by farmers may be classified into three stages:

- introduction where few farmers have any experience in the use of fertilizer; the main objective is to encourage small-scale farmers to use relatively small quantities of fertilizers for the first time;
- take-off where farmers have become accustomed to using fertilizers; and
- maturity where farmers have become acquainted with the agronomic and economic implications of fertilizer use and integrated plant nutrition.

The required extension staff to farmer ratios will be subject to change as fertilizer use moves from through these stages. Currently there are wide variations in staff:farmer ratios. An FAO survey carried out in the early 1980s in conjunction with member countries in Africa showed, for example, ratios varying from around 1:300 to 1:2500, whereas between 1:500 to 1:1000 is generally regarded as a minimum requirement. The situation has deteriorated since then.

Box 16. **Extension**

It is difficult to generalize concerning the desirable extension staff to farmer ratio. This is exemplified by the following two contrasting situations.

First Situation: There are well-established, research based recommendations for a particular crop, generally involving high-yielding cultivars together with fertilizers, pesticides in some cases and recommended application rates and cultural practices, tested by well-controlled field trials to confirm their 'domain'.

Where there are large areas of more or less homogeneous farming under similar agro-ecological conditions, as in South Asia, e.g. the Ganges Plain or delta areas of Bangladesh, these relatively standard recommendations may have very wide application, at least in physical terms, to thousands of small-scale farmers. Extension, in such cases, may consist largely of the communication of these uniform recommendations or extension 'messages' and any updates that are determined at a higher level on the basis of research. Moreover, if market facilities are equally well developed throughout such an area and input and farm prices are at much the same level throughout the area, the calculation of VCRs or gross margins by extension staff and farmers as indicators of profitability will be relatively straightforward. Finally, if reliable and adequate irrigation and drainage are available, the risk of seasonal fluctuations in yield through moisture stress or flooding, with corresponding negative effects on profitability, will be largely removed and advice on these issues will seldom be needed.

In these circumstances, one trained extension worker using group extension methods with village assistants or lead farmers may be able to serve 1 000 to 2 000 farmers.

Second situation: In dry-land farming areas with widely dispersed farms in many parts of the tropics and subtropics in Africa and in mountain regions such as the Himalayas or the Andes, agro-ecological conditions are very diverse. Therefore research-based recommendations involving purchased inputs, such as improved seed and fertilizer, may give widely differing results - some profitable, others marginal or even unprofitable. Year-to-year fluctuations in yields may also be high, as in the semi-arid areas of Africa.

In these circumstances, the promotion of fertilizers through the extension services, even in the introduction stage, may aim chiefly at identifying the circumstances in which fertilizer and related inputs would be profitable. Farming systems research, with close collaboration between researchers and extension staff, should also play a more crucial role than is frequently

assigned to research in the introduction stages of fertilizer use, even where application rates are generally low.

Under these conditions, a relatively highly trained extension worker is needed who, where farms are widely dispersed, might be able to serve 500 farmers at the most, even when using group extension methods as far as practicable.

Between these two extremes there is an infinite range of intermediate situations.

Training of extension staff

The extension service provides a vital link between research institutions and farmers. The specialist staff of this service must therefore be capable of discussing the scientific findings of research workers and converting them into simple recommendations that can be understood both by field extension workers and by farmers. They must also be capable of explaining clearly to research workers the problems encountered by farmers in the field. Once they gain the confidence of the farmers and research workers alike, they can help the research staff to see whether their findings are confirmed in practice and, if necessary, to modify their investigations.

Adequate training is an essential requirement for successful extension activities and some years of practical experience for extension staff are desirable. To ensure that new entrants obtain good experience as quickly as possible, it is worthwhile placing them under the most able supervisors, rather than simply filling the nearest vacancies. The first year or so in a job may have a crucial bearing on subsequent performance as it is then that attitudes and standards of work are formed.

If a completely new service is established or a new programme places more emphasis on fertilizer advisory work in an existing service, all extension workers should be properly trained before the start. It is of the greatest importance for the extension worker to have self-confidence and to feel adequately prepared before being required to advise farmers. Failure to be taken seriously by farmers or loss of self-confidence undermines effectiveness for a long time or even permanently.

Regular training and briefing sessions are necessary for all extension personnel in order to keep them informed of the latest research findings pertaining to their work and to promote an exchange of information between different branches of the service.

It is essential that the fertilizer part of extension services be adaptable and adjustable to needs arising as plant nutrient use intensifies. The technical and other features of this adaptation have been indicated earlier. The qualifications of extension personnel must move in line with these changes.

The involvement of fertilizer producers and distributors

The fertilizer retailer is in direct contact with the farmer and is well placed to give advice on the use of the products he sells. In France, for example, farmers receive approximately 70% of their advice from the distribution sector, especially the co-operatives. In order to give correct advice, the distributor must himself be well informed.

Whether or not the private sector has played a significant role in promoting fertilizer use in the introduction stage, if it is not restrained by official policy it will gain in importance as the take-off stage progresses in market economies. As demonstrated by experience in many developed and developing countries, the private sector is capable of making an important contribution to fertilizer extension. In its simplest form, dealer involvement in extension may consist of nothing more than handing out and, where necessary, explaining government extension literature to clients. For fertilizer companies taking a more innovative role, however, close liaison with government at the policy level is necessary to ensure that official policy is fully understood and followed. Close contact with government extension personnel is also required to ensure that activities at field level are adequately coordinated, thereby avoiding overlapping or conflicting advice. The sharing of information and experience, joint training and collaboration in the preparation of extension material may also be beneficial.

Fertilizer and related inputs retailers are usually consulted by their customers on the properties and correct use of the produce. This makes training of retailers particularly important. Apparently, such training has so far been neglected in many developing countries. Besides know-how on their products, retailers are taught the existing recommendations for use and the business skills related to planning, procurement, stock management, handling and related financial matters. All sectors are served as appropriate: cooperative, parastatal, statal and private. The agricultural extension services participate prominently in the training, appreciating that the retailers are to supplement their tasks, not to replace them.

In at least three developed countries there are now programmes to provide certification schemes for persons giving advice on fertilizer use to the farmer. These advisors are often personnel of the distribution organizations. In the UK, the Fertilizer Advisers Certification & Training Scheme has been established

jointly between the Fertilizer Manufacturers' Association the distribution sector and the Ministry of Agriculture, Fisheries and Food for the certification and training of farm advisers. In order to be registered the advisor has to pass an examination. It is possible that such certification will ultimately become a legal requirement. In the United States and Canada, a Certified Crop Adviser Program has been implemented. It is administered by the American Society of Agronomy.

The involvement of farmers

The participation of farmers in the extension process is essential. In order to improve the coverage provided by extension staff and its impact, carefully selected 'lead' or 'contact' farmers should be involved as aides in extension programmes. Their selection is a sensitive point since, on the one hand, they need to be respected within the local community, but on the other, if they are drawn predominantly from amongst the larger, better educated and more articulate farmers, they may not reflect the requirements of the less well-endowed farmers, whose needs for extension and access to credit may be greater.

Farmers may form groups for jointly purchasing inputs and marketing of produce. A group of farmers elects a chairman a secretary and treasurer. The inputs are purchased on credit. Thus the group as a whole carries the responsibility and guarantees repayment of the credit into a collectively owned group account.

After harvest, each participating farmer has to repay to the group the value of the inputs received plus interest, management fee and inflation factor. Repayments are deposited in the group's account with the village unit bank. The deposit serves as a revolving fund for the purchase by the group of new inputs. The group keeps records of repayments, interest and other transactions.

The approach proved to be efficient and successful for:

- acceleration of sustained adoption of improved or new technologies.
- creation of a sound group approach toward the supply of inputs, credit, cooperatives and other activities facilitated by the group approach;
- increased participation by farmers in the agricultural and economic development process. Group members or their representatives participate in the planning exercise for the cropping seasons and in their evaluation;
- arousing a positive reaction in the surrounding farmers not participating in the scheme, which results in adoption of its methods.

To produce the desired impact, this approach requires the availability qualified field extension workers and private sector staff in sufficient numbers to provide

the necessary assistance for the correct use of the inputs and application of the recommended practices.

Extension methods

Within most developing countries, there are very wide variations in fertilizer use between and even within farming communities. An effective fertilizer extension programme needs to reflect the stage reached within the target area, as this affects not only the extension methodology adopted, but also the level of extension personnel required, as well as support services such as soil analysis.

Farmers' field days may be held at demonstration sites during the cropping season, preferably at a time during the growing period when the visual effects of using fertilizer are most marked and again at harvesting. At harvest time, either a representative sample or the complete plot for each treatment should be harvested and weighed and the benefits per unit area and the value-cost ratio, VCR, should be calculated on the spot. In this way, farmers not only see the increase in yield resulting from fertilizer use but they also form a good idea of the financial implications.

Farmers' meetings may be arranged by extension workers to which farmers, preferably with their wives, are invited, as well as meetings organized by well-established farmer groups or associations. In many countries, especially in Africa, where women play a major role in agriculture, it is important that as many women as possible participate. Meetings should therefore be arranged at times when it is convenient for them to attend. Adequate time and encouragement should be provided for farmers to raise issues, which they consider important.

Radio and television programmes directed at farming audiences can be used to supplement the message conveyed in demonstrations, field days and meetings to stimulate interest and to reach a wider public. These media are especially well suited to communicating topical announcements, pest attacks, prices, the right moment for top dressing, etc.

Printed material, ranging from simple charts and posters to leaflets, bulletins and handbooks, can be widely used to support meetings, demonstrations, exhibitions and individual contacts, etc. They should convey a clear message and be attractively produced. Depending on the degree of literacy of the intended target group, the message may be expressed through pictures or diagrams or in the appropriate local or national language. Mass mailing can serve as a means of reaching agricultural extension workers, officials, fertilizer dealers and, in some instances, leading farmers.

CONCLUSION

- Innovators in the farming community need to be fully involved. Commercial fertilizer suppliers and dealers should also play a significant role in support of extension programmes and should be encouraged and assisted to do so.
- Continuous training and motivation of extension staff is very important and career opportunities and incentives should take full account of the generally difficult conditions in which they work and live.
- There should be both a national unit appropriately located in the government structure and subject-matter specialists with particular responsibility for all fertilizer related matters, including extension and associated activities.
- An efficient link between research and extension is essential. Recommendations originating from research must be confirmed under farmers' conditions and experience must be fed back from extension to research. The economics of fertilizer use and risk factors require serious attention. Back-up services provided by research include also soil and plant analysis.
- Extension worker:farmer ratios depend on the stage of fertilizer use, the degree of dispersal of farms and other factors. Where there are well-established, research-tested recommendations applicable to large homogeneous areas, ratios can be much larger with group extension predominating. Where this is not applicable, extension workers cannot serve a large number of farmers effectively. They may need to learn from the most successful farmers and help disseminate their practices.

Chapter 8
Coordination of fertilizer policies

National coordination

The previous chapters have dealt with various aspects of fertilizer policy: purchasing and supply; marketing and credit; fertilizers and agricultural extension. The present chapter is concerned with the institutional framework for the integration of these different aspects into a comprehensive fertilizer policy.

Long-term planning and monitoring must aim at reconciling three main objectives:

- Agronomic and economic efficiency in the use of plant nutrients to maximize agricultural output from available fertilizer supplies; this includes providing farmers with new high yielding techniques and other information about the use of fertilizers;
- Efficient supply and delivery of fertilizers; this is likely to be best achieved through privatization and deregulation of fertilizer supply and marketing;
- Social objectives for which interventions in the fertilizer market may be justified.

There may, in addition, be important issues relating to operational management of production, marketing and the legal framework.

Diversity of public sector influences

Responsibilities for decisions concerning the fertilizer sector are frequently divided between various ministries and subject to final approval by a designated authority. For instance, capital investment may be the responsibility of a central planning ministry or commission, while subsidy and pricing policies, usually budgetary items, are approved by a Ministry of Finance, sometimes in

consultation and agreement with the ministries of agriculture and planning. A price control commission may also be responsible for fixing or advising on the prices of farm produce, basic consumer goods and major agricultural inputs, such as fertilizers. In many smaller countries, the only source of specialist advice on fertilizers to governments is generally the Ministry of Agriculture, although imports and local fertilizer production facilities, where these exist, may be under a Ministry for Trade and Industry. Where a parastatal or state corporation holds responsibility for fertilizer marketing, the Ministry of Agriculture is likely to be its "parent". A Ministry of Cooperatives may also be involved at some stage. On the other hand, the "parent" Ministry for a fertilizer-manufacturing parastatal is normally the Ministry of Industry.

The kind of situation described above frequently leads to strongly polarized views, particularly on prices and priorities for resource allocation. There may, for example, be a direct clash between the interests of farmers for better crop prices and the interests of consumers for cheaper food which would be the concern of the ministries of home affairs or health and nutrition. Reconciling all these views is, therefore, a permanent task for governments. Also, while adjustments have to be made in the light of changing circumstances, there must be consistency in macro-policy and this must not be undermined by conflicting macro- or micro-policies in other sectors, or by partial implementation.

A FOCAL POINT FOR FERTILIZER ADVICE AND PLANNING

In view of the above, it is essential that a focal point be established for the formulation of a well-integrated fertilizer policy, or to provide coordinated advice at the highest level. In a number of small countries such a focal point consists of a committee set up by the Ministry of Agriculture, with appropriate representation from other ministries. It performs a valuable function in estimating import requirements, identifying research and extension priorities and providing a link between research and extension.

For larger countries the National Fertilizer Development Centre (NFDC) in Pakistan provides a useful model. This body was established in 1978 to study all fertilizer related problems and to advise the government and industry as required. In view of its policy-advisory role, the NFDC was located in the Planning and Development Division of the Ministry of Planning at the federal level.

Box 17. **The main functions of NFDC**

1 To provide objective and comprehensive advice to all levels of government, to the fertilizer industry and to other parties as may be relevant, on all matters related to the fertilizer sector in Pakistan and its relations with the international fertilizer community.

2 To prepare studies on deregulation and privatization of the fertilizer sector in order to provide the government with information to facilitate policy decisions.

3 To conduct fertilizer use surveys at farm level; to monitor fertilizer use by crops, assess the impact on productivity, and identify problems faced by farmers.

4 To advise government on pricing policies and issues related to subsidy.

5 To help achieve the planned targets for fertilizer consumption and in doing so to improve the economic efficiency of the domestic factories, of transport and of bulk blending facilities.

6 To help improve the marketing infrastructure for fertilizers so as to reduce the cost per unit at farm level.

7 To introduce and popularize Integrated Plant Nutrition Systems (IPNS) to improve crop response and the efficiency of fertilizer use in order to maximize returns and farm income.

8 To prepare a programmed series of studies on fertilizer demand, supply and price trends and to maintain a fertilizer statistics database.

Other influential bodies in Pakistan are the Pakistan Standards Institute, the Fertilizer Research and Development Institute, the National Agricultural Research Centre, the Agricultural Extension Service and the Soil Testing Laboratories.

Cooperation and effective links need to be established between all stakeholders, including the farming community, research institutions, agricultural extension and training services, international and regional organizations, as well as the fertilizer manufacturing sector, in order to further the goals of the efficient and environment-friendly use of mineral fertilizers.

International organizations and the fertilizer manufacturers must also assume an effective role in providing material support of governmental research and extension systems in order to enable them provide the farmers with the adequate knowledge on fertilizer use, for the maximum protection of the environment.

FOCUS OF NATIONAL POLICY

National governments and the private sector (producers, financial institutions and agribusiness firms, among others) need to interact and this will require new attitudes and working assumptions. According to a recent World Bank report, governments must be market partners and facilitators by providing legal foundations, an effective macro-policy environment, investment in basic social services and infrastructure, comprehensive safety nets for vulnerable citizenry and basic environmental protection.

Given the rapidity of change and the legacy of central government-controlled programmes, the need for extensive participatory efforts between government, rural residents and the private sector should be stressed, along with decentralized operations and the promotion of local organizations.

Many developed-country stakeholders, including the private sector, universities and NGOs, are in a position to provide essential technical, marketing and business capabilities to producers and key institutions in developing countries. Mechanisms that can certify the capabilities of developed-country service providers need to be considered. Donor responsiveness to this dramatically different environment must be established in a way that is flexible and reflects institutional comparative advantage. The World Bank's new programme, "Rural Development: From Vision to Action" provides a framework for advancing these new themes (World Bank 1997).

INTERNATIONAL ASSISTANCE

National-level public-sector spending priorities have recently influenced donor allocations. As developing countries made particularly tough budget cuts during the 1990s that affected agriculture, less donor assistance was available to the agricultural sector. The World Bank's AGSECAL programme, for example, declined from an average of 12 percent of the adjustment lending portfolio to 4 percent by 1991. Total World Bank agricultural sector lending declined by 50 percent from 1986 to 1996. Similar reductions occurred throughout the donor community.

However, important complementary activities by some other donors are under way. DANIDA has taken probably the boldest step by deciding that agricultural assistance should rise to 20 percent of its expanding portfolio. The Inter-American Development Bank completed two strategy exercises that supported the expansion of agricultural and rural development. The United

Kingdom's Department for International Development (formerly the Overseas Development Administration) also decided to strengthen its agriculture portfolio in response to the "special relationship between agricultural development and poverty reduction". Norway has also completed a new development assistance strategy document that focuses on improving the capacities in agricultural production areas. Germany is taking a comprehensive look at how it can best support agricultural research and the sector as a whole. In addition, USAID recently announced that agricultural growth would be the strategic objective of one of its programmes "Economic Growth and Agricultural Development".

INTERNATIONAL POLICY

The fertilizer industry consists of many interlocking organizations, institutes, programmes and associations, as well as individuals. Each organization or individual is to some extent constrained in what he can do because part of the supply chain is outside his control. Yet there is no common view of how synergies can be created, nor is there an outline of useful roles for each group so that their contribution adds to a collective movement in the direction of sustainable development.

In some fields, a more global vision is being adopted. For example, the 1994 inter-governmental conference in Cairo on world population examined the food-population equation not in simple rich-poor; north-south; hungry-overfed terms, but as a series of complex relationships between (1) development to maintain and enhance living standards (2) reduced population growth and (3) greater environmental protection.

The fertilizer industry cannot be considered in isolation. It is an important but not the only agricultural input and the purpose of all the inputs is to enhance the production of agricultural products. The market for the latter is subject to the demand of consumers. Consumers have a responsibility to society and to their environment.

At least twelve categories of institutions are involved:

1. Farmers' associations. Given their very large numbers, it is difficult to communicate directly with individual farmers, particularly small-scale farmers.
2. Fertilizer manufacturers and distributors.
3. Fertilizer associations, national and international.
4. Other input suppliers and their associations; seeds, plant protection products.
5. The agricultural marketing sector, food processors, distributors and retailers.

6. Banks and credit institutions.
7. Educational establishments
8. National Governments. Ministries of agriculture and of environment - but other ministries such as planning, health, labour can play a regulatory role.
9. Governmental research and advisory services are particularly relevant to the fertilizer sector.
10. Inter-governmental and United Nations organizations such as the European Commission, FAO, OECD, UNEP, UNIDO, World Bank.
11. Non-government organizations (NGOs).
12. Donors - bilateral and multilateral.

In the case of mineral fertilizers, there are significant problems associated with under-use, over-use and incorrect use. In many countries there are inadequate research and advisory facilities in place. Neither the private sector nor the public sector alone can resolve the problems. Co-operation and participation by the entire supply chain is needed for sustainable development. The participation and vision of the entire supply chain is needed for sustainable development.

CONCLUSION

The successful development of national fertilizer production and consumption requires adequate involvement and forward planning in a wide range of areas, as well as the continual upgrading of technical and professional skills. These tasks involve several government agencies and fertilizer-related institutions in the private sector and organizational arrangements are needed to foster coordinated policies and active collaboration between all concerned. In this connection, the international agencies and other bodies mentioned above, are well qualified to provide assistance within their areas of competence.

The main purpose of this document is to stress the need for the timely consideration of these areas so as to plan and operate a consistent and comprehensive fertilizer policy in the medium and longer, as well as in the short term.

On the one hand, a consistent and comprehensive policy must aim at the efficient use of fertilizers from an agronomic point of view. On the other hand, fertilizers and other inputs cannot be considered in isolation and fertilizer policy must therefore be a part of agricultural policy as seen in relation to a country's overall social and economic policy objectives.

Annex
Practical policy issues and some examples

STABILIZING THE MACRO-ECONOMY

One of the pre-conditions to the successful development of agriculture and the fertilizer market is general economic stability - steady economic growth, low inflation and a reasonably stable exchange rate. A good example of a successful stabilization plan was that of Ghana during the 1980s.

Box 18. **Ghana - stabilization plan**

Over the decade up to 1983, the Ghanaian economy was under great strain.

1973 - 1983:

- income decreased by 74% to US$366;
- inflation increased to 125.

1983: Economic Recovery Programme (ERP):

- realignments of relative prices
- liberalization of imports.

1985:

- removal of remaining structural barriers;
- shifting the economy onto a faster growth

Result:

- increased exports 8 - 9 % annually;
- annual economic growth 5.3%;
- annual growth of agricultural sector 2.6 %;
- inflation only 30% annually;
- financial situation of government positive.

An unfortunate result of the price liberalization policy and the phasing out of subsidies was a sharp rise in fertilizer prices which were not entirely offset by the rise in crop prices. This made fertilizer less attractive and fertilizer consumption declined. Policy options to reverse this trend include a) re-establishing the subsidy or b) allowing crop prices to increase further by restraining grain imports which were forecast by the Ministry of Agriculture to reach 75 000 tonnes by 2000. The second of these options coupled with increased spending on research and extension into productivity boosting practices would be the preferred market-friendly option and would keep the government off the damaging subsidy escalator.

IMPROVING AGRICULTURAL PRODUCER PRICES

Improved producer prices are the most effective weapon for increasing agricultural output and at the same time encouraging farmers to use more fertilizer. In the developed countries this has been well recognized for decades and throughout the 20th century many countries, particularly those in West Europe have encouraged output by increasing prices to farmers.

In many developing countries the possibility of providing a top-up payment to farmers is probably very limited due to the effect on the government's budget deficit. However, countries should ensure that farmers at least receive the world market price equivalent.

Box 19. **Viet Nam - stabilization plan**

1980 - 1989:
- inflation up to 700%
- centrally planned economy.

1988:
- stabilization through doi moi, a comprehensive programme of economic and financial reforms

Results:
- price and trade liberalization;
- tax reform;
- land reform;
- restructuring of public enterprises;
- control of budget;
- inflation 13%;
- agricultural output growth about 5%.

The process of price liberalization in **Viet Nam** is a good example of the beneficial effect this can have on poor farmers. Under the restructuring plan, the old system of procurement of farm output at pre-determined prices was abolished along with restrictions on the movements of goods within and across the provinces. Farmers were able to dispose of their outputs through the market of their choice at the going price. The result was a surge in output to the extent that Viet Nam is now a regular exporter. In fact the government encouraged this development again by abolishing export quotas and licenses as well as export taxes and mandatory fixed export prices. Although the government still maintains a safety-net price for when prices fall, by and large producer prices now reflect world market prices.

Market liberalization in **Uganda** has also had a beneficial effect on cotton and coffee production. Prior to 1992, the state-run Coffee Marketing Board controlled coffee exports and farm-gate prices had very little relation to world market prices. The export business was progressively opened to cooperatives and the private sector with the result that the farm-gate price greatly improved and production increased rapidly to its highest ever level of 4.2 million 60 kg bags in 1996. Cotton marketing was also liberalized and production increased from 33 000 bales in 1994/95 to 100 000 bales in 1996/97. Fertilizer input supply was also reported to have improved.

In 1997 the **Egyptian** government abandoned the policy of state quotas on agricultural production and imports. The import/export market for food was to be open to market forces with the objective of stepping up agricultural output, diversifying production towards higher value crops, encouraging greater investment and encouraging increased exports. Prior to the policy change the country had a trade deficit of US$10.5 billion of which food imports accounted for US$2.1 billion.

In **China** official grain procurement prices at the farm-gate were increased by about 40% in 1996 in order to compensate for the previous phasing out of fertilizer subsidies. At that time farmers were required to sell an agreed portion of their crop to the state at the procurement price and were then allowed to sell the remainder in the open market. While this arrangement meant that farmers could profit from any surplus production most were happy to sell at the official price which was often about 65% higher than the open market price. The effect of the official price rise was a substantial increase in grain production and fertilizer use. In fact several major grain producing provinces had over-production of grain and most of the granaries were full.

On the other hand, 1998 data from **Pakistan** indicate that procurement prices were still below world market prices with the result that most crops -

except for sugar-cane - were unprofitable or at least had a negligible profit to the farmer. The 1997/98 Fertilizer Use Survey showed that the typical Value:Cost ratios (VCRs) were wheat 2.56, IRRI-rice 2.27, Basmati-rice 3.67, cotton 3.59, maize 3.81 and sugar cane 10.76. The conclusion of the Pakistan Agricultural Price Commission was that when total costs were taken into consideration, farmers made a loss on IRRI-rice (- Rs 709 per acre), wheat (- Rs 99 per acre) and cotton (- Rs 533 per acre). Basmati rice had a small profit of Rs 47 per acre while sugar cane was the most profitable crop at Rs 4638 per acre. Sugar cane receives the most fertilizer (about 60 kg/acre) while IRRI-rice tends to receive only 37 kg/acre and is mostly used by the subsistence and semi-subsistence sector.

UNIFORM TARIFFS ACROSS SECTORS AND AMONG PRODUCTS

Some of the best examples of uniform tariffs come from the policies adopted by new international trade groupings.

Box 20. **International trade groupings**

European Union:

- zero duty on all trade between the member states;
- import duties on fertilizers and raw materials from outside the Union have been simplified and are generally much lower than those that were previously levied by the separate member states;
- At various times anti-dumping duties or Minimum Import Prices have been imposed, for example, against Russian potash and ammonium nitrate and these apply across the Union.

Andean Pact (Venezuela, Colombia, Ecuador, Peru, Bolivia and Chile):

- internal trade for members duty free;
- fertilizer imports from outside the area vary from one country to another between (zero and 15).

MERCOSUR:

- internal trade for members duty free;
- duties for fertilizers imported from outside the region are either zero (Uruguay, Mexico and Surinam), 1% (Paraguay) or 2-6% (Argentina and Brazil).

Mexico is also a member of the (NAFTA) and does not impose any import duties on fertilizer or agricultural inputs from other NAFTA members (USA and Canada) or from elsewhere.

In the **Philippines** a minimum import duty of 3% was imposed in 1994 which was also applied to fertilizers. But quotas on imports were reduced at the same time so that they only covered 5% of all imports as compared to 37% in 1980. A notable exception to this was maize which is used in the rapidly expanding poultry industry and was subject to a 100% tariff. However, this was expected to be phased out in favour of a 5% import tariff to apply to all agricultural imports which when adopted would be a very low level of protection for agriculture by global standards.

In order to stabilize the export markets and to generate funds for the federal budget, the **Russian Federation** approved a decree in early 1999 that extends export tariffs to all mineral fertilizers. The Ministry of Trade stated that a 5% tariff would be levied on the customs value of all fertilizer exports.

ABSENCE OF RESTRICTIONS ON FOREIGN TRADE

Most developed countries have very few restrictions on foreign trade although where a domestic industry is under threat from very low cost imports it is sometimes possible for the company or industry concerned to present a case (of unfair competition) to the relevant authority to get anti-dumping duties imposed. Many countries including the EU, USA and some East European countries have also considered or have actually imposed anti-dumping duties on the Russian Federation's imports for this reason.

For a number of developing countries, foreign trade is restricted by government monopoly (for example, Viet Nam and China for fertilizer imports; Pakistan for the rice trade, the cotton sector in Mali); others impose a system of licenses or quotas (for example, Indonesia and Bangladesh for fertilizer exports). A number of other countries restrict fertilizer imports and distribution to domestic companies only (for example, Ethiopia). But for most developing countries the main restriction on international trade is the absence or difficulty in obtaining foreign exchange.

In order to encourage the flow of additional funds through legal channels and to improve the operation of the exchange system, the government at a fairly early stage, allowed the opening up of foreign exchange bureaus (Forex), licensed by the Bank of Ghana and subject to the Banks rules.

The **Philippines** government also abolished foreign exchange regulations in 1992 as part of its trade liberalization process and the currency is now fully convertible.

FERTILIZER SUBSIDIES

Fertilizer subsidies have been widely used both in developed and developing countries to promote the use of fertilizer.

The Sustainable Community-Oriented Development Programme (SCODP) for smallholders in Western **Kenya** is an interesting example. SCODP's methodology aims to quickly stimulate demand for fertilizer amongst small farmers, who are too poor to purchase fertilizer in large (50 kg) quantities and who have no access to credit. Demand is created simultaneously through three main methods:

i) Farm input supply in which a network of farm input shops is established, through which the appropriate fertilizer types are made locally available in small, affordable quantities, according to small farmers' preferences;

ii) Farmer-participatory research to maximize profitability of fertilizer use whereby the appropriate fertilizer types are determined in the catchment areas of the shops by farmers, schoolteachers and extension workers and on the basis of the most readily available fertilizers. Results are fed back to the shopkeepers to ensure that the customers are given the correct advice;

iii) the Fertilizer "mini-pack" method in which small packets of 100 g and 200 g of the appropriate fertilizers are sold outside shops, in market places on market days, at schools and outside churches. "Mini-pack" encourage all community members to experiment with fertilizer on their own plots of land in an affordable way.

Because the fertilizer is used effectively and there is a constant feedback of advice and research the value:cost ratio often rises rapidly to 8 and above and the use of fertilizer becomes very profitable. The market then also becomes self-sustaining. This type of programme, of course, is also appropriate for bigger farmers.

Subsidies might be phased out once their initial objective is achieved. In **China** subsidies were effectively removed by simultaneously increasing producer prices to compensate. In **Bangladesh** fertilizer subsidies were phased out as part of the overall market liberalization. Through a USAID programme, considerable effort was made to introduce high yielding seeds and other productivity boosting methods with the aim of raising agricultural production growth to 4% per annum. While the subsidy was phased out, fertilizer marketing margins fell due to increased competition amongst the new fertilizer marketers and although retail fertilizer prices increased, offtake of fertilizer actually increased rapidly from 750 000 tonnes in 1978 to 2.3 million tonnes in 1993. Again, the key is good technical advice and practical demonstrations to the farmers.

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This document presents guidelines for governments on the development of fertilizer strategies. It illustrates the differences before and after the involvement of the private sector and offers solutions for improvement. It discusses the role of fertilizers in the development of agriculture among with the factors that have an impact on their use by farmers, gives practical suggestions for decision-makers regarding production of import of fertilizers and then deals with the many issues involved in the efficient distribution and marketing of fertilizers and, finally, with the institutional framework for the integration of all these aspects into a comprehensive fertilizer policy.