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Workshop on Appropriate Strategies for
Fertilizer Technology and Development *

Lahore, Pakistan, 29 April - 3 May 1991

REPORT **

* Organized by UNIDO in co-operation with National Fertilizer Corporation of Pakistan (NFC)

** This document has not been edited.

PREFACE

The system of industrial consultations is a device by which the United Nations Industrial Development Organization (UNIDO) can serve as a forum for developed countries and developing countries in their contacts and consultations directed towards the industrialization of developing countries. Among those taking part in the consultations are representatives of the governments, industry, labour, consumer groups and so forth of the countries concerned.

The advantages of the system are, *inter alia*, an ability to identify obstacles in the way of the industrial development of the relevant countries, to observe trends in the world economy and thereby to work out practical measures for increasing the industrial production of the developing countries as well as to seek new forms of industrial co-operation in North-South and South-South relations.

Since the system was first established in 1975, ^{1/} the consultations have involved 16 industrial sectors and two main topics. The system of industrial consultations brings together the decision-makers and offers them an opportunity of deliberating on and proposing specific measures promoting the industrialization of developing countries. Numerous innovations (technological alternatives, integrated development and model contracts) have been formulated under the programme, opening up possibilities for devising technical assistance, investment promotion and technology transfer projects.

On account of their consensual and regulatory nature, the consultations have proved to be an efficient way of balancing different interests in the area of international industrial co-operation, thereby considerably helping member countries to develop strategies and policies for industrial development.

The system of consultations is under the permanent and direct supervision of the UNIDO Industrial Development Board. In addition to the annual review and periodic study of the results of its work, in 1989 the system underwent a thorough examination, which showed that it was also conducive to the development and definition of UNIDO's policy and programmes.

^{1/} Report of the Second General Conference of the United Nations Industrial Development Organization (ID/CONF.3/31), chap. IV.

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INTRODUCTION

1. The Workshop on appropriate strategies for fertilizer technology and development was held in Lahore, Pakistan from 29 April 1991 to 3 May 1991. The workshop took place in conformity with the recommendations of the Regional consultation on the Phosphatic Fertilizers and Pesticides Industries in Africa (Yamoussoukro, Côte d'Ivoire, 12-16 December 1988) and those of the Expert Group Meeting on the Processing and Utilization of Phosphates (Dakar, Senegal, 3-6 January 1990). One of the main aims of the workshop was to make a material contribution to the sector by bringing together the suppliers of technology, technological know-how, machinery and equipment, engineering and consultancy services with those responsible of the developing countries desirous of establishing or expanding their fertilizer manufacturing capacities.

A. Background to the workshop

2. Selfsufficiency in food production, a declared policy target of developing countries, cannot be achieved without the appropriate use of agrochemicals and notably fertilizers.

3. In spite of recent achievements of the developing countries in this industry, fertilizer supply problems remain a strategic bottleneck in incremental yield increase of a number of regions. Many developing countries in these regions continue to import a certain, albeit, relatively small amount of fertilizer products at considerable expense in foreign exchange. However, the effective usage of imported fertilizers is detrimentally affected by numerous problems of quality, delivery, distribution and infrastructure, agronomic inadequacies for crop-soil systems, etc. Furthermore, many of these countries possess abundant indigenous resources of fertilizer raw materials such as natural gas and phosphate deposits. UNIDO's five Consultations held on this industry have clearly demonstrated that the creation and the development of a domestic manufacturing/formulating capability in the sector, remains the key element in increasing fertilizer application by the farmer. One of the major impediments to the establishment of manufacturing units in these developing countries has traditionally been the rising construction and equipment costs of imported technology. The causes of excessively high capital cost of fertilizer projects in developing countries involving complex escalation factors have been identified and detailed in terms of their occurrence and control possibilities in previous work undertaken by the Consultation process in the sector. Among these causes, the importation, adaptation and assimilation of foreign technology, machinery and equipment, engineering and consultancy services play a significant part, alongside the domestic capabilities of fabrication and manufacture of electronics, instrumentation and ancillary equipment.

4. To counteract the prohibitive costs of conventional fertilizer projects in developing countries the concept of small-sized units has been thoroughly scrutinized. The technological feasibility and commercial viability of the mini-plant have now been generally accepted as reflected in the conclusions and recommendations of Consultations. These plants enjoy considerable advantages with respect to capital outlays, utilization of indigenous resources, man-power requirements, infrastructure, market absorption, technological complexity etc., when compared to traditional large plants. However, there is still a wide spread lack of awareness of the technological capabilities of scaled-down process available in both engineering companies of the industrialized but also increasingly in the developing countries.

B. Objectives of the workshop

5. The objectives of the workshop were as follows:

- To provide the fertilizer industry and governments of the Afro-Asian regions with assessed information on the whole spectrum of technological options, including innovative ECDC approaches for the development of the sector in order to facilitate decisions for the future development of the fertilizer industry.
- To increase awareness of the potential of the manufacturing and technical capabilities of developing countries in respect to equipment used in the fertilizer industry.
- To draw-up a synopsis of the technical presentations and verbal communications summarizing the recent field experience gained from the construction and operation of small-scale fertilizer production unit.
- To provide an opportunity to diagnose and suggest solutions to the problems faced by the developing countries in setting-up or expanding national fertilizer industries.
- To examine possibilities for regional co-operation between Asia and Africa in mutually beneficial areas of the fertilizer industry with the aim of exploiting both natural resources and technical capabilities.
- To compile an up-dated list of suppliers of machinery/equipment, technical and engineering know-how and ancillary services required for the construction and operation of small-scale fertilizer manufacturing and blending units.
- To explore industrial and agricultural uses of fertilizer raw materials. this would include direct use of rock phosphate on soil and beneficiation.

PREAMBLE TO CONCLUSIONS AND RECOMMENDATIONS

6. With the beginning of the 90's, the situation of the global fertilizer industry could be summarized as follows:

- a) Basic fertilizers are produced in Mega Plants generally located near the raw materials sources.
- b) International traders supply these products in bulk quantities through main world harbour outlets at very competitive prices.

7. The situation is in principle favourable for the increase in fertilizer use with strong regional variation. However, this could lead to an oligopolistic situation as some companies already combine production and trade.

8. To confront these developments in the most appropriate way, some possibilities are considered hereunder:

- a) To counteract the marketing edge of powerful companies an equally strong purchasing power should be established. This would be possible for large fertilizer consumers if they concentrate their efforts in one channel. This is indeed the case for SINOCHEM in China and MMTC in India.
- b) To avoid total dependence on fertilizers imports at least part of the fertilizer needs of developing countries should be locally produced. Here two possibilities exist:
 - If the market is located within reach of international harbours, the local production will have to compete with international market prices; in that case, the only possible route is to set up fully competitive world scale plants.
 - If, however, the area of consumption is remote, the fertilizers from world market will have to face a high logistics cost to reach that area (storage, handling, transportation and distribution) where its cost could double or triple. If local resources are available, we have a case where a mini-fertilizer plant can be economically set up provided that its capacity does not exceed the absorption to the local market so that it does not face high logistics cost. Moreover, the plant should be as simple as possible to avoid any undue strain on financial, industrial and human infrastructure.

CONCLUSIONS AND RECOMMENDATIONS

Process Technology

9. The workshop was exposed to a number of new/revised process technologies of particular interest to the developing countries' application. It should be noted that some of these technologies originate in the same group of countries. In this context the workshop recommended that UNIDO undertake appropriate action to compile, review and disseminate this information particularly through:

- a) Updating of UNIDO's Fertilizer Manual:
- b) Convening of Expert Group Meetings. the delegate of Tunisia expressed his willingness to host the first meeting on this subject:
- c) The expedient publication and dissemination of full proceedings of the current workshop containing the technical presentations. NFC has offered to implement the above.

10. The workshop reconfirmed the viability of mini-fertilizer plant concept, especially in view of conditions prevailing in many developing countries. In this context work undertaken by UNIDO should continue with a view to implement small-scale fertilizer plants in developing countries. This concept equally covers NPK blending units.

Equipment Manufacture

11. The workshop acknowledged that creation of local capabilities for the manufacture and fabrication of plant machinery, equipment and parts is an indispensable condition for the smooth development of the chemical sector. The existence of such capabilities will also make a material contribution to enhanced operations as well as to the improvement of local technological know-how.

12. The workshop took note of the existence of such capabilities in several developing countries and requested UNIDO to compile and disseminate assessed information on the above.

13. In order to facilitate cross-border exchange of equipment manufactured in developing countries, efforts should be made to introduce and adopt common standards and specifications.

14. The field of equipment manufacture offers many opportunities for economic and technological co-operation between the developing countries some of which were identified by the workshop. In this context the delegation from the People's Republic of China offered to host an Expert Group Meeting to review available technological options and expose their country's considerable capabilities in manufacturing of components of small fertilizer plants.

Consultancy Services

15. The workshop underlined the crucial importance of national consultancy services for successful development of the sector.

16. The need for comprehensive feasibility studies was unanimously recognized as a critical element for implementing viable fertilizer projects. In this context UNIDO's packages for the preparation and evaluation of feasibility studies (COMFAR) was acknowledged.

17. The workshop noted that proper contractual arrangements for the construction and operation of fertilizer plants play an important role in achieving the objectives set for these projects. UNIDO's efforts in this field were commended by the participants, who recommended that an assessment of their application so far be made as a preliminary stage for their readaption and up-dating to reflect the changing industrial realities.

18. The workshop recognized that local/national capability in the field of engineering design was essential to maintain satisfactory operation of existing fertilizer plants and to introduce improvements in their operations.

This impact would be greatly enhanced by the existence of local manufacturing capabilities.

19. Although various technological processes for phosphatic fertilizers are known yet problems arise when their economic comparisons are made. It would, therefore, be advisable to developing countries if information for example, on economics of different phosphatic processes is put together, with UNIDO assistance, for the benefit of both policy makers and the prospective investors.

Construction and Operational Experience

20. A pre-requisite for successful operation of fertilizer plants is the adequacy of trained man-power which includes not only formal training but equally as important operation experience.

21. The above was well-illustrated by the fact that rehabilitation and revamping of existing plants to upgrade their performance is generally less costly and more effective than the establishment of new manufacturing units.

22. Analysis should be undertaken to identify causes of under-utilization of fertilizer plants in many developing countries. It was suggested by the workshop that exchange of experience among plant/operations managers would provide an effective means to achieve the above objective. The participant of Islamic Republic of Iran expressed his wish to host an Expert Group Meeting on operational aspects of fertilizer plants in his country in 1992.

23. Many countries represented at the workshop gave an account of their technical training facilities for operators in the fertilizer industry. In this context NFC of Pakistan, after organizing a technical visit to their Technical Training Centre at Multan offered these facilities to the nationals of other developing countries for tailor-made training schemes. UNIDO was requested to assist in designing such training programmes and also in examining the possibilities of converting the centre into a Regional Training Centre for Process Industries.

Other Considerations

24. Apart from the conclusions and recommendations specific to the four issues treated by the workshop, participants also addressed other topics of common interest which are of relevance to the long-term development of the sector. The most important elements of which are summarized below:

- a) Although the production of single fertilizers has obvious advantages of simplicity, the workshop notes that there is a growing trend towards using multinutrient and compound fertilizers in order not to merely increase plant yield but to also preserve and up-grade soil fertility.
- b) In the context of preserving a healthy environment and preventing its deterioration and maintaining safety the workshop noted the present level of fertilizer application in developing countries as a whole does not pose any serious danger, nevertheless it recommended that adequate regulatory measure be implemented to safeguard the long-term maintenance of environmental standards.
- c) The workshop is aware of the impact of government agricultural policy on the development of the sector, and recommended that balanced pricing policies be adopted to provide the necessary incentives to both fertilizer manufacturer and the farmer.

25. The necessity of appropriate linkages between the fertilizer industry and the academia was underlined. In this context it recommended that close contacts between the two be maintained to provide the necessary inputs to the industry as well as field experience and feed-back to the universities.

26. In view of the crucial importance of market intelligence and other technical information for national and regional development as exemplified by the activities of FADINAP in Asia and the Pacific region, the workshop recommended the establishment of a similar set up in other developing regions, particularly in Africa.

27. A sub-group of the workshop was set-up with the view to examining practical modalities of assisting Togo to develop its phosphates processing industry. The workshop requested UNIDO to co-ordinate and implement this activity.

ORGANIZATION OF THE WORKSHOP

28. The Workshop on appropriate strategies for fertilizer technology and development was held in Lahore, Pakistan, from 29 April to 3 May 1991 in close co-operation with the National Fertilizer Corporation of Pakistan (NFC). The workshop was attended by 114 participants from 18 countries and from 4 international and other organizations (Annex II).

A. Opening of the Workshop

29. The workshop was officially opened by H.E. Mr. Islam Nabi, Federal Minister for Production, Government of Pakistan. He reminded the audience that UNIDO and NFC had already co-operated closely on four previous occasions, i.e. on draft model forms of contract for the construction and operation of fertilizer plants, on considering the role of mini-fertilizer plants in developing countries, on exchange of experience on the use of the model contracts and finally in convening the Asian preparatory meeting for the Regional Consultation in Africa on phosphatic fertilizer and pesticide industries. This last meeting took place in October 1988 in Lahore and he expressed his desire for the continuation of this collaboration in the future in the interest of the development of this vital sector. He then stated that one of the greatest challenges which the developing countries faced today was to feed the existing and growing population. This in turn had led the governments to focus on agriculture, on which the bulk of the population was dependent as a source of livelihood and employment. In order to achieve this policy goals, agricultural production had to increase substantially. A major part of this increment would have to come from intensive use of agro-chemicals including the wider and better application of chemical fertilizers. The current use of modern high-yielding and fertilizer responsive crop varieties had further increased the need for more fertilizers.

30. In this context he remarked, UNIDO was playing a crucial role as a facilitator in the development of the fertilizer based infrastructure for developing countries. The fora such as the present one set-up by the organization had served to identify real constraints and proposed concrete solutions for their removal. These UNIDO activities also involved and encouraged inter-industry contacts with a view to co-operating on the basis of long-term arrangements covering technical assistance, joint ventures, supply of raw materials, training and marketing. In conclusion he extended his warmest wishes of welcome to all participants who had travelled from all corners of the globe to ensure the success of the workshop.

31. Mr. Zahur Khan, the Chairman of National Fertilizer Corporation (NFC) of Pakistan then addressed the inaugural session by stating that the present event was the fourth which UNIDO and NFC were holding jointly in Pakistan concerning the fertilizer industry. This collaboration had, in the past, yielded fruitful results and he expressed his conviction that the present workshop would also have far-reaching effects on the development of the industry in the region. He then proceeded to recall the salient point of previous meetings jointly convened and underlined the tangible results obtained. The current workshop, he continued, carried particular significance and interest for experts and senior planners of the fertilizer industry. The in-depth discussions and deliberations and the strategies drawn-up by the experts would go a long-way towards assisting and establishing a strong platform for the development on the fertilizer industry. He identified the lack of proper infrastructure for high-tech industry in most developing countries as one of the major constraints hampering industrialization. As modern fertilizer plants increased in complexity and technological sophistication, the question arose as to what extend local capabilities could be utilized to reduce capital costs. This was only possible on a strong technological base existed and as such the problems of creating local engineering know-how and development of allied industries assumed greater importance. He further argued that another field in which developing countries had to depend heavily on the developed ones was the acquiring of process know-how, licenses, detailed engineering, construction supervision, etc. All these elements further aggravated the investment costs. He drew the attention of the experts attending the workshop on the revamping of old and technically outdated fertilizer plants in developing countries in view of their competitive cost structure when compared to the establishment of new production units. In summary he advocated that a thorough reappraisal of the industry's traditional strengths and current weakness was necessary to evolve suitable strategies for its resurgence. He concluded that international forums like the present one was an important link in acquiring the relevant lessons and experience.

32. The Director of UNIDO's System of Consultations Division started his remarks by stating that UNIDO was well accustomed to the traditional and proverbial hospitality of Pakistani people and authorities who had in the past contributed substantially towards the fulfillment of the organization's mandate by a close involvement in its activities. He expressed his conviction that by the time the workshop was over, all participants would take home with them the same sense of appreciation and generosity shown by the National Fertilizer Corporation of Pakistan as hosts on the previous occasions

33. With respect to the subject matter of the workshop he pointed out that all recent investigations point unmistakably to the urgent need of developing the fertilizer sector if policy targets set for agriculture were to be met. In Asia tremendous success had already been achieved in this area particularly in countries such as Pakistan, India, Indonesia, China, etc., but in Africa, which was again confronted with a major food crisis, the necessity for industrial action in the sector remained acute.

34. In the developing countries, as a whole, in spite of recent achievements, fertilizer supply problems remained a strategic bottleneck in incremental yield increase. Effective usages of imported fertilizers was detrimentally affected by numerous problems of quality, delivery, distribution, agronomic inadequacies, etc. He identified as one of the major impediments to the establishment of manufacturing units in developing

countries the rapidly rising construction and equipment costs of imported technology. Therefore a main issue before the workshop was to examine technological alternatives susceptible of offering cost and other advantages. He then briefly introduced the objectives and activities of UNIDO's System of Consultations Division, stating that it had already generated many innovations particularly with respect to integrated sectoral development, contractual arrangements and technological alternatives like mini-fertilizer and mini-hydro plants. In the context of model contracts he paid special homage to the crucial role played in the conceptualization and elaboration by National Fertilizer Corporation of Pakistan.

B. Closure of the Workshop

35. In his closing address, H.E. Mr. Tarique Mustafa, Secretary to the Government of Pakistan, Ministry of Production who had presided over the adoption of the final conclusions and recommendations of the workshop, stated that the quality of these were a clear evidence of the thoroughness of the deliberations of the workshop. He also expressed his conviction that, as the workshop had demonstrated, only an agricultural policy encompassing all the components of agricultural development would enable the definition of an appropriate fertilizer strategy in developing countries particularly in those of Africa. Those countries often had a need of support and assistance from the international fertilizer fraternity and intergovernmental agencies such as UNIDO in their programmes and projects for the production and use of fertilizers. He again recalled the rapid demographic growth in developing countries which necessitated a major increase in agricultural productivity which in turn could only come about by wider and effective use of agrochemicals.

36. The Chairman of NFC addressing the closing session of the workshop thanked all participants for their valuable contributions to the excellent results of the meeting which was clearly manifested in a series of concrete and far-reaching recommendations. He particularly welcomed the fact that the workshop had enabled the identification of a number of co-operation possibilities between those attending. In this context concrete measures were already being taken in response to requests voiced by some national representatives. He therefore welcomed the convening of these fora since, these apart from achieving their set objectives also served as an informal framework for those responsible for the fertilizer industry to discuss their problems and seek co-operation for their solution.

37. Finally, the Director of UNIDO's System of Consultations Division joined previous speaker in commending the nature and quality of the recommendations reached by the workshop. He stated that not only were they concrete and implementable and susceptible of making a real contribution to the solution of the constraints identified, but their addressees clearly spelled-out. Reciting them briefly he outlined those, whose implementation would be the responsibility of UNIDO and undertook to do his utmost to reflect them in the work programme of activities in coming months. He also praised the excellent arrangements made by NFC for the convening of the workshop and the exceptional hospitality shown by authorities and the people of Pakistan. He was very encouraged by the spirit of co-operation and good-will demonstrated by the all participants during the formal sessions of the workshop but particularly at informal contacts between them and cited the examples of co-operation in technical assistance which was initiated during the week's deliberations.

38. On behalf of all the foreign participants to the workshop, Mr. A. Benmansour, the Tunisian representative expressed his thanks to both UNIDO and

NFC on having taken the initiative in organizing the meeting and having ensured that it was efficiently conducted. The themes treated during the deliberations represented real issues of concern to those responsible for the fertilizer industry in the developing countries. New insights have been gained as a consequence of the discussion and possible solutions delineated. He valued particularly the bilateral and multilateral contacts made possible by the presence of a wide spectrum of experts including many technology suppliers. He expressed his conviction that those initial contacts would prove very useful in establishing inter-industry and commercial relationship. He also reiterated his offer of co-hosting the next UNIDO Expert Group Meeting on fertilizer process technologies in his country. He concluded by expressing his gratitude to the Government and authorities of Pakistan for having acted as such cordial hosts and for having accorded the participants such generous hospitality.

AGENDA AND WORK PROGRAMME

Monday, 29 April 1991

- 09:00 - 10:00 Registration
- 10:00 - 11:15 Inaugural session
- 11:45 - 13:00 Presentation and discussion of UNIDO's background documents
setting the theme for the Workshop
- 14:30 - 17:00 Presentation and discussion of technical papers by
International and regional organizations and specialized
companies

Tuesday, 30 April 1991

- 09:00 - 11:00 Presentation and discussion of technical papers by
specialized companies
- 11:30 - 13:00 Presentation and discussion of country papers
- 14:30 - 17:30 Presentation and discussions of country papers (continued)

Wednesday, 1 May 1991

09:00 - 19:00 Two options available to participants for technical visits:

1. Pakarab Urea, NP & CAN Plants. Multan and
NFC Technical Training Centre. Multan
2. Lyallpur Chemicals and Fertilizers SSP Plant, Jaranwala
and Fertilizer Research and Development Institute.
Faisalabad

Thursday, 2 May 1991

09:00 - 12:00 Discussion of issues:

- Process technology
- Equipment manufacture
- Consultancy services
- Construction and operational experience

15:00 - 16:00 Concluding session

Presentation of Conclusions and Recommendations of the
Workshop

16:00 - 17:00 Concluding addresses

Friday, 3 May 1991

10:00 - 11:00 Adoption of the report of the Workshop

The rest of the day is earmarked for informal contacts between the participants with a view to examining the possibilities of co-operation on technical assistance, transfer of technology and investment promotion.

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Production of multinutrient fertilizers with special focus on the
nitrophosphate route
- Mr. Z. Aziz (UNIDO Consultant). NFC - National Fertilizer Corporation. Pakistan
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plants
- Messrs. M.I. Bajwa, Z. Aziz, M. Rashid, Anwar-ul-Haq, R. Hussain and
R. Rehmann, NFC, Pakistan
Agronomic evaluation of phospal as phosphatic fertilizer
- Messrs. K. Saeed, M.S. Chughtai and M.D. Mohammed, NFC. Pakistan
Engineering procurement and construction of a 300 TPD phosphate
fertilizer plant

- Messrs. Tahir Saleem, I.T. Twyford and Tila Mohammad, NFDC - National Fertilizer Development Centre, Pakistan
Policy issues in expansion of the fertilizer industry
- Messrs. S.A. Khan and M. Mahmood, NFC Technical Training Centre (Pvt.) Ltd., Pakistan
Simulators to stimulate fertilizer technology development
- Mr. M.H. Chaudhry, PERAC - State Petroleum Refining and Petrochemical Corporation Ltd., Pakistan
Fertilizer industry, past performance and future prospects
- Mr. Aftab Ahmad, Aftec Pvt. Ltd., Pakistan
Biofertilizer - Experience in Pakistan
- Mr. Ahmed Shah Nawaz, Chemical Consultants Pakistan (Pvt.) Ltd., Pakistan
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Indigenous manufacturing of fertilizer plant & equipment
- Messrs. Muhammad Nawaz Malik and Syed Iqrar Hussain Shah, Central Cotton Research Institute, Pakistan
Efficiency of nitrogen fertilizer applied via fertigation and side-dressing methods in cotton
- Mr. W.M. Butt, Technology Management International Pvt. Ltd., Pakistan
Fertilizer industry development - problems and prospects
- Messrs. I. Ahmad and F.H. Shah, PCSIR Laboratories Complex, Pakistan
Accumulation of nitrates and nitrites in foods of plant origin
- Mr. R.M.U. Suleman, (Ronco Consulting Corp., Washington), USAID, Pakistan
Fertilizer Marketing in Pakistan: Some lessons from recent Bangladesh experience
- Mr. K.N. Jayasuria, Ceylon Fertilizer Corporation, Sri Lanka
Fertilizer consumption in Sri Lanka
- Mr. Salah Abdalla Elamin, Ministry of Industry, Sudan
Situation of Fertilizer Industry in Sudan
- Mr. L. Mariani, Ammonia Casale S.A., Switzerland
Advanced retrofitting technology for large ammonia and urea plants
- Mr. Prakarn Virakul, Ministry of Agriculture and Co-operatives, Thailand
Fertilizer situation in Thailand
- Mr. A. Benmansour, SIAPE - Société Industrielle d'Acide Phosphorique et d'Engrais, Tunisia
Fertilizer development technology in Tunisia
- Mr. Dave Ivell, Hydro Agri International Licensing, United Kingdom of Great Britain
Granular triple superphosphate technology

Mr. D.G. Hooper. Nalfloc Ltd., United Kingdom of Great Britain
Philosophy and latest developments for water inhibitors in the
fertilizer industry

Mr. J.K. Dunleavy. Dytech Corporation Ltd., United Kingdom of Great Britain
Improved performance in steam reformers

Mr. Ampah K. Johnson. IFDC - International Fertilizer Development Centre -
Africa, Togo
Opportunities to develop West African Agrominerals

SUMMARIES OF THE PAPERS PRESENTED

Technological options for the construction of fertilizer plants, mini-plants

by Mr. A.L. Davister. UNIDO Consultant. Belgium

The purpose of this meeting is to determine under what circumstances the establishment of fertilizer mini-plants may contribute to the development of agriculture in the developing countries. That being so, cases will be sought where these conditions apply or where their existence can be encouraged, and then efforts will be made to promote the establishment of a number of mini-plants.

Economically speaking, the establishment of fertilizer mini-plants will favour agricultural development in places where such installations are capable of producing fertilizer cheaper than is at present possible. But, as can be seen in this paper the unviervalization of the fertilizer trade, based on mega-plants close to large raw materials sources, has brought about a downward levelling of fertilizer prices, at least in respect of standardized fertilizers having undergone a first or second processing stage.

The establishment of mini-plants can therefore be contemplated only in places sufficiently remote from the world-trade routes, in this instance deep-sea ports, with the result that the ancillary costs (made up of unloading, storage, maintenance, transport, re-storage, distribution and credit costs) represent a significant proportion with regard to the price of the fertilizer, delivered free port.

An here again, in such cases, it is necessary to define what fertilizers are to be produced.

If raw materials are available for the production of nitrogenous or potash fertilizer, the complexity of the chemical and/or physical processes involved demands a minimum scale which exceeds that of mini-plants. It is thus necessary to have access to adequate material and human resources and to a sufficiently large market, which normally goes beyond local dimensions and reaches those of at least a regional market.

If on the other hand phosphate resources are available, it is enough to supply under adequate conditions the acid required for solubilization of the phosphate in order to derive fertilizer products which are simple and adaptable to local market capacities.

It is thus in the field of phosphates that a start could be made on the construction of fertilizer mini-plants offering the greatest chance of success.

This is favoured by the following circumstances:

- Many countries, particularly in Africa, have phosphate resources of more or less sufficient quality;
- The acidulation methods - whether total or partial - are simple; they can take the form of batch or continuous processes;

- The technologies involved adapt themselves well to simple plant making maximum use of local materials and manpower;
- The level of sophistication of these plants can be rudimentary, thus putting them within reach of the operators.

That is therefore the framework within which a search should be made for situations favourable to the establishment of fertilizer mini-plants and their construction encouraged.

Naturally, it can be maintained that circumstances or factors other than economic conditions come into play, such as for example:

- Strategic considerations
- Foreign exchange policy

However, these factors should be treated with care, because whenever making allowance for them increases the price for fertilizers, it hold up agricultural development to a corresponding degree.

Furthermore, whereas such a price increase may possibly be accepted by the country where the plant is located, this does not mean that it can be imposed on other countries.

The result would be the need to stay on the domestic market only, if not an engagement in export operations at prices lower than cost is envisaged.

That is why feasibility studies for the establishment of mini-plants should in all cases be economically competitive.

Burundi's fertilizers policy

by Mr. Emmanuel Kamenyero, Department of Mines, Ministry of Energy and Mines, Burundi

Like in most developing countries, Burundi's economy is mainly based on agriculture, on which it depends for nearly 90% of its GNP.

The exchange of goods between Burundi and its neighbourly countries is mainly done across the Tanganyika Lake and by roads. A third transportation means is growing more and more, that is the air freight from the international Bujumbura airport, which now accomodates heavy carriers like B 737 and DC 10.

In the sixties, Burundi's population essentially consisted of cattle-breeding farmers who relied upon their cattle to improve their lands. Confronted today with land shortage, they tend to abandon traditional cattle-breeding for modern methods in order to keep more land under cultivation. The population of which over 90% is rural, lives on food-producing agriculture. Till today, the national economy depends on one single export product: coffee, which represents 60% of the general national product and 90% of foreign exchange earnings

On the other hand, degradation of soils is aggravating further limiting agricultural production, whereas the primary objective of the Burundi Government consists in a rapid increase in agricultural products in order to achieve self-sufficiency in food production.

Another factor which is not less important and contributes to the diminution of agricultural production is the high-rate population growth. In 1982, Burundi's population was indeed estimated at 4.3 million inhabitants, that is an average rate of 163 inhabitants per km². when calculated after the number of inhabitants per km² of cultivated lands, the population rate shoots up to 256 inhabitants/km² and reaches 389 inh./km² on the high plateaus. At the present yearly increase rate, population growth per km² of cultivated lands will pass from 256 inh./km² in 1982 to 435 inh./km² by the year 2000. This means that if the country should keep today's level of self-sufficiency in food, its agricultural production per km² of cultivated lands should have risen by an average of 70% in 2000.

Considering this information, the only way to increase agricultural production remains the use of organic and/or in-organic fertilizers in order to increase the food-crops yield, which has been declining in recent years due to degradation of the quality of cultivated land. At the same time, importation of fertilizers necessitates an outflow of foreign exchange, which the country is lacking, and transportation costs yet aggravate the situation of land-locked Burundi.

Exploitation of the phosphates of Matongo in Burundi with a view to produce fertilizers could remedy the situation if a judicious study, based on reliable industrial experience, could be conducted.

Phosphate compound fertilizer in China (Brief introduction)

by Mr. Chen Honguang, Vice President, Nanjing Chemical Industry Company, China

This paper represents the situation of phosphate fertilizers in China and discusses the strategies for chemical fertilizer technology and application.

According to China's condition, following measures have been taken for developing the phosphate fertilizer industry in China: developing large, medium and small-scale fertilizer plants simultaneously and exploiting high concentration phosphate fertilizer and driving scientific application of fertilizer. For using of special fertilizer effectively, three stages have been gone through that is from the single to the compound fertilizer; from common-used compound to the special fertilizer and from the special compound to the multi-functional compound fertilizer.

Strategy of developing China's chemical fertilizer industry

by Mr. Du Shiquan, Chengdu Chemical Engineering Corporation, China

It is no doubt that the chemical fertilizer industry is a major pillar in the development of agriculture: Past 40 years, China has achieved remarkable success in this field by following the simultaneous policy of establishing large, medium and small-scale plants and as a result, China becomes one of the countries in the world who have achieved rapid growth in production.

In 1949, there were two ammonium sulphate units only in China with total annual capacity of 26,000 tons, but nowadays there are already more than 1,800 plants in different scales with 20 and more kinds of products, 40% of ammonium bicarbonate, 30% of urea and 30% of single and double superphosphate, ammonium chloride, ammonium nitrate, ammonium sulphate, DAP and potassium chloride, potassium sulphate, etc. The annual total capacity has reached 90 million tons.

In spite of rapid growth of fertilizer production, the market demands are also increasing rapidly and market demands still exceed supply because of its large population and decreasing of cultivated land along with the fast development of industry and transportation. So it is necessary and quite important to take measures to raise yield production by utilization of more fertilizers. To solve short supply problem, China not only still imports a large quantity of fertilizer every year but also gives many preferential policies to the chemical fertilizer plants specially to small-size plant in order to ensure the uninterrupted growth of fertilizer industry.

Production of Superphosphates with Batch Process in Kemira

by Mr. Taisto Koivumäki, Development Manager, Kemira Oy, Finland

The following is a short description of the superphosphate process of Harjavalla, the plant of which was in operation 1949-1988.

With this process it was possible to produce SSP, TSP, mixtures of these and "Kotka Superphosphate" now known as PARP. Raw materials were phosphate rock, sulphuric and phosphoric acid. Rock was ground in the production of SSP and Kotka superphosphate, sulphuric acid was diluted and mixed with ground rock in a vertical mixer. Hardening happened in a dens equipped with a central core. Fumes from the reactor and dens were taken to scrubber and to the exhaust pipe. After hardening still hot superphosphate was excavated to the conveyor beneath the den to be transported to storage piles for curing.

When producing TSP the process was the same as with SSP except sulphuric acids, which was replaced by phosphoric acid.

In a production at Kotka superphosphate addition of extra rock was made after the dens. Curing time was shorter, free acid concentration lower and P₂O₅ total higher than with normal SSP.

After curing time granulation was done in a typical granulation drum process.

The type of phosphate rock had great influence to the production and to the solubilities of products, however both magmatic and sediment rocks could be used. Impurities and influence to process.

Production capacity for SSP was 1200 t/day. Production could be done in 1-shift or 3-shift operation. The degree of automation was low, operators were able to do many maintenance works by themselves, hence maintenance costs were low. Also the total energy consumption was low. From energy costs as well as investment costs quick a big part was due to phosphate grinding and gas scrubbing. Process is suitable due to its flexibility, low investment and operation cost and low need of educated personnel to many countries to be considered as a mini plant.

Humifert - A new plant fertilization concept

by Mr. S. Thillard, Commercial Manager, SOFRECO - Société Française de Réalisation, d'Etudes & de Conseil, Paris, France

Humifert process consists in attacking a blend of phosphate rock and organic matter with NO_x gases. NO_x gases are obtained through combustion of ammonia. Organic matter can be peat, rice balls, baggasse, peanut shells, etc.

The advantages of the process are the following:

- The final product contains N and P (respectively about 5% and 15% for a 28% P₂O₅ phosphate rock), as well as organic material, it is both a chemical and an organic fertilizer.
- The technology has been developed to build mini fertilizer plants (100 t/day). Investment costs are low (no separation of Ammonium Nitrate, no fabrication of nitric acid).
- Low grade phosphate rock can be used.

Investigations have demonstrated that:

- NO_x gases form, through reaction with organic matters, organic acids which contribute to the solubilization of phosphate;
- Organic molecules "trap" cations (Ca, Al, Mg, Fe), which then are no longer available to participate to the retrogradation of the assimilable P₂O₅ into non assimilable P₂O₅. Assimilability of Humifert is very high.
- The produced has a strong phytofortimulant effect.

These last two characteristics allow to decrease the quantities of N and P to be brought to the soil.

Situation of Fertilizer Industry in Indonesia

by Mr. Sutijono Ontorikso, Directorate General for Basic Chemical Industry, Ministry of Industry, Indonesia

Indonesia has launched an economic development by series Five Year Development Programme called PELITA. Fertilizer use is one of the key points of the successful national programme.

The fertilizers use in Indonesia commonly are single fertilizers, compound fertilizers, natural fertilizer and mixed fertilizer. Those fertilizers are Urea, TSP, Ammonium Sulphate, Potassium Chloride and small amount of Calcium Nitrate and Potassium Sulphate. Urea, TSP and Ammonium Sulphate has been produced locally, while the rest are still imported.

All of the fertilizer companies are owned by the Government except Asean Aceh Fertilizer belongs to Asean Industrial Project.

Different raw materials used by fertilizer industry are the following:

1. Natural Gas as a main raw material for urea which is deposited in scatter location.
2. Phosphate rock deposit is available with various of P₂O₅ contents in between 10% to 28% found in East Java and other scatter areas.
3. Potassium is not yet available and some geologic zones are being investigated for economical exploration deposits.
4. Deposit of sulphur is available in several regions with low quantity, low quality containing sulphur between 20% to 50%.

5. Deposits of lime and dolomit are available: the majority is found in Java and Madura Islands.

The priority of fertilizer production is for domestic consumption.

Export of urea is regulated by the Government with consideration to domestic supply. Beside urea, ammonia excess is also exported regularly.

Current Situation of Fertilizer Industry in Iran

by Mr. B. Zokai, Planning Director, National Petrochemical Company, Iran

The total land area of Iran comprises of approximately 165 million hectares, 52% of which is hilly, non-arable land and desert stretches. The country is mainly composed of a large triangular plateau set between two great depressions, i.e., the Persian Gulf to the South and the Caspian Sea to the North.

Iran's population is 55 million and people living in rural areas constitutes about fifty percent of the total population.

A variety of food and commercial crops is grown in the country. Principal cereals are wheat, barley and rice. The staple crop is wheat. Current annual wheat production is 6.8 million tons which with an average annual growth rate of 7% will increase to 8.3 million tons by 1994. Major cash crops are sugarbeet and cotton. Beans and peas, important food items, are grown in scattered areas. Alfalfa and clover are the major fodder and forage crops and the principal vegetable crops are potatoes and onion. Among the perennial crops apple, citrus, grapes, pistachio and in the southern regions dates are important.

The fertilizer industry in Iran is managed and operated by the National Petrochemical Company (NPC), a wholly-owned subsidiary of the Ministry of Petroleum which has the responsibility of petrochemical industry implementation plans as well.

Substantial oil and gas reserves tend to make the dynamic investment in and the development of the petrochemical and fertilizer sectors the most compelling prospects in Iran. In fact the country benefits from one of the world's largest reserves of liquid and gaseous hydrocarbons. The proven crude oil reserves stand at 92.9 bn barrels, which is 10.4% of the world's total and 16.5% of those contained in the Persian Gulf region. Statistics are even more impressive on natural gas. Iran's proven natural gas reserves are estimated at 14.0 trillion cubic meters amounting to 12.5% of the world's total.

During the next five years, plans being implemented for the expansion of fertilizer and petrochemical industries in Iran call for a total investment of 6 to 7 bn dollars, which is bound to expand the country's production capability in fertilizers and petrochemicals on a large scale.

The existing fertilizer capacity is concentrated in the following two centers of production:

- Shiraz Petrochemical Complex, which also produces an array of chemical products and intermediates, is located on the outskirts of Shiraz. The installed annual capacity at this complex includes 433,000 metric tons of ammonia, 545,000 metric tons of urea, 254,000 metric tons of ammonium nitrate and 20,000 metric tons of diammonium phosphate.

- Razi Chemical Complex, constructed on the north-western coast of the Persian Gulf, has the installed annual capacity of 660,000 metric tons of ammonia, 744,000 metric tons of urea, 248,000 metric tons P_2O_5 phosphoric acid and 230,000 metric tons of diammonium phosphate. The sulphur and sulphuric acid annual production capacity of this complex stands at 460,000 metric tons and 1.06 million metric tons, respectively.

Operational problems encountered and improvements made at Shiraz Fertilizer Complex

by Mr. S.M. Mirsaedi, National Petrochemical Company, Iran

During operation of the plants at Shiraz Fertilizer Complex, operational problems were faced which hampered the normal production. Improvements were made by local engineers and experts in dealing such problems which resulted in approaching the desired level of production.

The presentation reviews specifically some of the problems encountered at Shiraz Complex, the measures adopted and implemented, the results obtained and improvements made.

Some of the operational problems encountered in 2nd train of Shiraz Fertilizer Complex, which used to hamper production are presented in following sections, which also covers the measures of debottlenecking as adopted by local engineers and the results obtained.

Foaming of the benfield solution & the erosion in the benfield streams. The absorbers and the strippers were designed to work with ceramic packings. Benfield solution partially dissolved ceramics creating silica and fine suspended solid which brought about the following problems.

- i) Fine suspended solid created foaming, increased the pressure drop in the tower and some benfield solution was lost as carry over from CO₂ vent.
- ii) Particles of silica created erosion on the impellers and casing of pumps throughout the benfield circulation streams.

Erosion in the secondary reformer had caused many shutdowns of ammonia plant in the past years. It was found that inadequate design in the stream of air and gas distribution caused vortex around the internal zone of distribution. By slight modification and placing steel ring at the zone, erosion was avoided.

In these equipments, during operation, any small change in pressure, because of weak catalyst support, resulted in catalyst being carried away by the discharge streams, creating various problems throughout the system. During past years these problems caused about 80 days ammonia production lost.

The problem was overcome by using a stronger catalyst support.

Boiler feedwater before entering the boilers are preheated in direct fired heaters. This preheater failure in the past has caused two month ammonia plant shut-down. The situation was about 80% improved by using a better tube material and changing the direction of water entering preheater.

Gas discharged from primary reformer passes through transfer line and enters the secondary reformer. The skin temperature especially at the bends on the transferline become excessive. To control the temperature several fans are switched on to blow air on the transfer lines.

ACES Process technology for urea production

by Mr. H. Uchino, Manager, Licensing & Patents Department, Toyo Engineering Corporation, Japan

The ACES Process is the most energy efficient urea process for urea synthesis among the commercially operated urea process plants at present.

Toyo Engineering Corporation (TEC) established the ACES Process in 1983 as a result of almost 3 years pilot plant operations.

As of today, two industrial plant using the ACES Process are in operation in Korea and Spain. The third plant is under preparation for commissioning in Bangladesh. Another 3 plants are under construction for completion within 1993 in Indonesia.

The ACES Process features highly economical urea production not only for large scale urea plants but also for mini scale urea plants with the following concept.

- High one-pass conversion in the reactor
- Efficient separation of unconverted materials
- Maintenance free operation.

To meet recent demands, TEC has been proceeding "Transfer of Technology" to the clients and to the local engineering firms for their benefits through the project execution.

Production of Multinutrient fertilizers with special focus on the nitrophosphate route

by Mr. O. Andreassen, Licensing and Project Development Department, Norsk Hydro Agri A.S., Norway

The use of multinutrient or complex fertilizers is receiving increased attention throughout the world due to inherent advantages such as: easy application, balanced crop nutrition, even distribution of nutrients and high fertilizer efficiency.

The production of complex fertilizer via the true nitrophosphate, or Odda process, uses only nitric acid for the "dissolution" of phosphate rock. The process has advantages in many areas, such as phosphate rock flexibility, raw material efficiency and energy efficiency. Increasing interest is also seen in the process as it can meet the increasingly strict environmental requirements and in particular as a process without by-product gypsum disposal problems.

Being a process independent of sulphur, the production cost of the nitrophosphate products is today considerably lower than for alternative products based on sulphur as raw material. In a sulphur market which will continue to be tight in the years ahead, the nitrophosphate process will obviously gain even more interest.

An assessment on utilization of Pakistani phosphate rock

by Mr. Z. Aziz, UNIDO Consultant, General Manager, National Fertilizer Corporation, Pakistan

In view of the high cost of engineering, equipment and materials and its impact on the profitability of fertilizer plants, it has become imperative that the developing countries should promote their own resources like consultancy, engineering, equipment and machinery manufacture, project management, procurement, plant start-up, operation, etc.

A serious effort is necessary to compile and consolidate data and pertinent information related to the capabilities of all developed and developing countries so that useful information is available for mutual co-operation.

The first part of this paper highlights Pakistan capabilities in these areas.

This paper also provides a list of Asian Countries as Annex I, Statistics on Fertilizer production in Asia as Annex II and a list of Asian firms which provide process know-how, plant and equipment or consultancy services as Annex III.

The author considers that these annexes could make a useful reference for further study in this field.

Experience of Pakistan on marketing strategy and small scale fertilizer plants

by Mr. Z. Aziz, UNIDO Consultant, General Manager, National Fertilizer Corporation, Pakistan

Increasing food production is one of the basic economic priorities of most of the countries, especially the developing countries. Fertilizer being one of the most important input for increasing food production.

Pakistan has made a phenomenal growth in fertilizer use. Started with only 1000 tonnes of nitrogen in 1952-53 the total fertilizer offtake has reached a level of about 1.89 million nutrient tonnes in 1989-90. This trend in fertilizer usage underlines the importance and the role played by fertilizer in Pakistan's agriculture. Of the total consumption of 1.890 million tonnes of NPK in 1989-90 was N, 20% P₂O₅ and 2% K₂O, giving a ratio of 1:0.31:0.04 among N, P and K.

At present there are nine fertilizer plants in the country, with a combined capacity of 1,092,000 tonnes of N and 102,000 tonnes of P₂O₅, meeting roughly 93% of total nitrogen and 26% of total phosphate requirements. All potash is supplied from imports.

Whether the supply of fertilizers will be obtained from building of adequate number of fertilizer plants or by direct importation is mainly a policy decision by any Government.

For many of the developing countries, which possess raw materials for all three (N:P:K) types of macro nutrients, it is sometimes thought that it might be more economical to import fertilizer products instead of converting the raw materials into products internally.

In this paper, an attempt is made to highlight all hidden socio-economic factors which should be evaluated for a decision towards establishing a fertilizer production unit in a specific area.

Agronomic Evaluation of Phospal as Phosphatic Fertilizer

by Messrs M.I. Bajwa, Z. Aziz, M. Rashid, Anwal-ul-Haq, R. Hussain, F. Rehmam, National Fertilizer Corporation, Pakistan

Seventeen field trials to evaluate phospal as phosphatic fertilizer were conducted on rice, wheat, cotton, maize and sugarcane over a 3 year period at six sites representing diverse soil types and agro-ecology. Phospal was compared with standard single superphosphate (SSP) fertilizer for immediate, cumulative and residual effect in recommended and graded doses. The averaged results showed that phospal was equally efficient agronomically as SSP for rice, cotton, maize and sugarcane but less so for wheat. Phospal and SSP, however, appear to have identical cumulative and residual effect at comparable doses.

Blending of phospal with urea and calcium ammonium nitrate by pan granulation revealed that blends widely varying in N:P ratio, physical and chemical characteristics, could be prepared. However, those prepared with urea had the most desirable features. Agronomically urea phospal fertilizer would be superior to urea alone by acting as slow-release fertilizer.

Engineering procurement and construction of 300 MTPD phosphate fertilizer plant

by Messrs. K. Saeed, M.S. Chughtai, M.D. Mohammed, National Fertilizer Corporation, Pakistan

It is basically the history of a successfully implemented small phosphatic fertilizer project.

Cost-wise it 80% local including Engineering, consultancy and construction.

Project information:

- Major raw materials - local phosphate rock
- Containing 28% P₂O₅ & high silica
- Local sulphur from Dakhni
- Cost - Rs. 244 million spent in 1989
- Employment - 360 direct employees

The objective of the presentation is to share the experience gained during implementation and operation of a small fertilizer production unit and to highlight potential of indigenous, engineering, manufacturing in respect of equipment used in the industry.

The execution strategy of the project is maximizing indigenous inputs in engineering, procurement, fabrication, construction.

The National Fertilizer Corporation appointed a local engineering contractor to serve as the main engineering contractor with a foreign sub-contractor to supplement the local engineering contractors resources and know-how where necessary.

Policy issues in expansion of the fertilizer industry in Pakistan

by Messrs. T. Saleem, I.T. Twyford and T. Mohammad, National Fertilizer Development Centre, Planning and Development Division, Government of Pakistan (FAO assisted project GCPF/PAK/075/NET through Trust Funds from the Government of Netherlands)

Fertilizer use in Pakistan took off in the mid-sixties with the nitroductioin of semi-dwarf cereal varieties. Subsequently, phenomenal growth took place with the result that today fertilizer nutrient consumption is about 1.9 m tonnes (nitrogen 1.468 m, phosphate 0.382 m, potash 0.040 m tonnes). In future to meet population growth, nutrient use will have to increase to nearly three times present levels.

For the 10 years ending 1989-90, the annual growth rate was 6.0 percent. However, the rate for phosphate use has slackened, which is a matter of considerable concern. Urea and DAP are the major fertilizers, however agronomically, NP (nitrophosphate) and SSP may be superior to DAP and CAN as AS superior to Urea (in view of the sulphur content of SSP and AS and more volatilization loss of nitrogen from urea, vompared with other nitrogen fertilizers).

Existing fertilizer capacity is 1.2 m nutrient tonnes; 1.1 m tonnes N and 0.1 m tonnes phosphate. However, to meet demand, 0.6 m tonnes nutrients (over 1 m product tonnes) are imported annually. Long-term (2000) demand is estimated at 2 m tonnes N, 0.8 m tonnes P₂O₅ and 0.2 m tonnes K₂O. Thus the shortfall is about 0.8 m tonnes N and 0.7 m tonnes P₂O₅; all potash is imported. Capacity is planned to expand by 0.6 m tonnes N and 0.15 m tonnes P₂O₅. Policy and agronomic considerations would make it advisable to develop NP/NPK fertilizers, rather than urea above, or there will be increasing problems of imbalance and inefficient use of nutrients and a surplus in nitrogen capacity.

As far as environmental pollution is concerned, there is no evidence that fertilizers have led to soil fertility or other degradation. On the country, more fertilizer means higher crop yields and soil fertility enhancement. Further, the fertilizers used, or likely to be used, do not contain any appreciate injurious substances. However, organic nutrition must not be forgotten. In addition to farmyard and biological resources, is much scope for processing town and slaughterhouse wastes, as well as for a great increase in sludges from bio-gas production.

Policy decisions on fertilizer development must be based on long-term agricultural suitability as well as financial attractiveness. Granular urea should be considered as well as prills. A consultant's report has shown that in 1989 Pakistan conditions, a new large ammonia/urea plant (1726 tonnes urea per day), is more economical than a smaller one (790 tonnes per day), with 8% lower production cost. further phosphate (or N&P) development will have to use imported rock or acid, as local resources are meagre. To produce 23:23:0, the cheapest route is via locally produced TSP and urea. Three other routes result in higher costs. Government will have to consider the adequacy of current incentives for phosphate development. Bulk blending appears to offer much scope the processing being cheap and very flexible, with automatic balanced fertilizing and micro-nutrients can be added as appropriate. Marketing specific blends for particular crops is advocated.

However, much the fertilizer industry develops, it will have to depend on imports of raw materials. Efficient port handling and transport must be

included in future planning. Factory location should be co-ordinated with import flows.

Simulators to stimulate fertilizer technology development

by Messrs. S.A. Khan and M. Mahmood, NFC Technical Training Centre (Pvt) Ltd., Pakistan

Simulators is today's most crucial training need especially when it comes to large process plant as such fertilizer plants. Today's management depends on a foolproof way of importing training. Workbook methods are outdated since they rely heavily on students' honesty whereas simulators by comparison track each student through his training and formal testing. An operator is no longer at the mercy of the lecture delivered by the instructor. Simulators allow him to undertake the training as often as he needs to do so to achieve an acceptable standard.

It is equally beneficial for management personnel who can become aware of possibilities in plant operation which in their normal daily plant life they probably would have missed. Using a process simulator for the last part of their training gives operators confidence which is embedded in them for years to come.

Fertilizer industry, past performance and future prospects

by Mr. M.H. Chaudhry, Chairman, PERAC - State Petroleum Refining & Petrochemical Corporation Ltd., Pakistan

The annual growth rate from 1952-53 to 1960-61 was 53.9% while it was 24.6% during 1960-61 to 1970-71 and 14.2% during the decade ending 1980-81. The growth rate declined to 7% during 1982-87 and 3% during 1987-89 period.

Annual growth rate in case of Pakistan during 1970-89 has been as follows: nitrogenous fertilizer 8.3%, phosphatic fertilizer 13.6%, potassium fertilizer 18.5%.

There are four major producers of fertilizers in Pakistan, namely: NFC, Fauji Fertilizers, Exxon & Dawood Hercules. Total installed capacity is 1216 thousand nutrient tonnes - 650 tonnes in the Public Sector and 542 nutrient tonnes in the private sector of the total installed capacity, 1091 thousand nutrient tonnes is on nitrogenous fertilizer and 102 thousand n/tonnes is of phosphate fertilizer. The indigenous fertilizer production during 1970-89 increased at an annual growth rate of 11.5%.

The factors that influence the demand for fertilizers are future approach to cropping, new croppings, soil fertility of land, price structure, etc.

Nitrogen and phosphorus being the major deficiencies in the soil, it is necessary to maintain an appropriate balance between nitrogen and other nutrients in the soil.

Policy measures may have to be evolved so that fertilizer efficiency and crop productivity are not adversely affected by international price fluctuations.

Fertilizer demand by the year 2006 has been estimated to increase at an

annual growth rate of about 3%. NFC's estimates envisage a growth rate of 4% for the same period.

Biofertilizer - Experience in Pakistan

by Mr. A. Ahmed, Aftec Pvt. Ltd., Pakistan

Biofertilizer is an organic bacterial fertilizer, supplying the soil with rich human containing growth substances (vitamins, auxins, etc.) and spores of bacteria specially selected for their value to agriculture: ligninolytics, cellulolytics, pectinolytics, nitrogen fixers, etc.

Soil is closely related to three factors: physical (humus), chemical (N, P, K are major elements) and biological (worm, insector, fungus, bacteria, etc.).

Biofertilizer does not conflict with chemical fertilizers. In fact it supports chemical fertilizer. There must be a combination of mineral and organic fertilizers, not only for fertility but also for efficient soil conservations.

Biofertilizer was by a Private Sector Organization introduced into Pakistan about three years ago in Micro organism ferment was imported from Europe and was mixed in Pakistan with sugar industry waste product known as filter cake or press mill. After fermentation for about six weeks under moist conditions, biofertilizer is ready for use.

Experiments and field trials were carried out through courtesy of Ayub Agricultural Research Institute, Faisalabad, Punjab. These experiments were spread over three stages : laboratory study, pot culture study; field condition trials; and farmer field trials. The result of these trials are reproduced below:

Laboratory Study:

- Acetylene Reduction Activity indicated AZOTOBACTER cell up to 225 per grams were present.
- Total bacterial counts in the product were tested 1550 million per gram.

Pot Culture Study:

These experiments were carried out to assess the manning value of biofertilizer under controlled conditions. The experiments were conducted with maize and rice crops in earthen glazed pots each having 18 kg of sandy - clayee - from soil. The pot culture study culture study indicated that biomass yield when using biofertilizer with mineral fertilizer showed an increase of 22.43% in case of maize and 5.18% for rice over mineral fertilizer alone as control.

Field Condition Trials:

They were undertaken with the assistance of crop specialists/in charge of Punjab Government Agricultural Farms/ Agricultural Research Stations. Results are as follows:

<u>Crop</u>	<u>Average increase in yield with MF+MF over MF</u>
Cotton	20.44%
Potatoe	32.73%
Rice	34.45%
Maize	28.61%

Farmer Field Trials:

A large number of trials were carried out at farmers fields and results are summarized below:

<u>Crop</u>	<u>Average increase in yield with MF+MF over MF</u>
Cotton	21.96%
Potatoe	15.13%
Sugarcane	25.19%
Wheat	23.80%

PAKISTAN

Consultancy services and developing countries

by Mr. A. Shah Nawaz, Managing Director, Chemical Consultants Pakistan Ltd., Pakistan

Developing Countries have had to pay high charges towards Consulting and Engineering Services as part of fertilizer projects. This paper looks at two aspects of reducing these costs:

- developing an indigenous consultancy service.
- reducing the cost of consultancy services by using south-south facilities.

Before looking at these aspects it is of importance to consider the type of consultancy services needed for fertilizer projects. These are:

(a) Initial market study. As an initial examination of the viability of fertilizer projects an initial market study for requirement of nutrient tons of N, P and K fertilizers are required. These are generally available as consumption on a national basis in country studies or in international publications (FAO Fertilizer Review) and can easily be used as a basis for a first study on whether a minimum economic size of plants of 300 tons/day, not only P₂O₅ plants but also nitrogen plants of a minimum economic size can be built in most countries.

(b) Thereafter an initial study of raw materials is necessary and the choice of a raw material which can be considered can be pin-pointed. In the case of nitrogenous fertilizers at one time natural gas, naphtha and coal were all considered to be economical but, today, the main concentration is on natural gas as a source of raw material - indigenous generally, but in a few cases imported.

(c) The next stage is to prepare a detailed feasibility for the project. Apart from the capital costs and the economic viability of the project, the

correct site for the project should also be undertaken. This study should include a detailed market study with forecasts for at least 10 years and should break up marketing zones where competitive plants exist.

Indigenous manufacturing of fertilizer plants at HMC - Heavy Mechanical Complex (Pvt) Ltd

by Messrs S.N. Hassan and Z. Ahmed. General Managers. Heavy Mechanical Complex (Pvt.) Ltd., Ministry of Production, Pakistan

To ensure repeated healthy crops, the importance of maintaining adequate soil-nutrient levels by appropriate fertilizer additions is necessary. Traditional low-analysis materials such as manure and other animal or vegetable wastes, are usually in limited supply, and have to be supplemented or replaced by high-analysis chemical fertilizers formulated to specific soil and crop needs. There is hardly any alternative to chemical fertilizers as a way of meeting current world food needs.

Consumption of fertilizers in Pakistan has virtually gone three fold since 1976 (rising from 0.631 tons to around 2 million nutrient tons). Nevertheless, the per hectare consumption of fertilizer in Pakistan is still one of the lowest in the world. It is therefore imperative that availability of fertilizers be increased further for boosting agricultural production. One of the limitations, is our continued dependence on import of plants and machinery for fertilizer plants. HMC has made some contribution in developing, locally such machinery. It is now planning to enhance this activity according to the national needs.

Typically, 50% of the cost of a chemical sector project is made up of hardware. 50% of this figure is usually consumed by the cost of vessels, columns, heat exchangers, and around 15% by control instruments, electrical equipment, dryers, filters and miscellaneous fabricated equipment. A fertilizer plant like most of the other chemical process plants comprises machinery and equipment as listed below:

- pressure vessels
- heat exchanger
- reactors
- absorption towers
- regeneration towers
- converters
- furnaces
- power equipment
- conveying equipment
- rotary equipment (air and gas compressors and pumps)
- piping
- electrical equipment
- controls
- dryers (both drum and vacuum type)
- scrubbers
- cyclones
- separators.

Fertilizer plants are capital intensive and are required to be highly energy efficient, well balanced and with precise process controls. Fertilizer plant and equipment are highly engineering intensive and require good designing, manufacturing capabilities, and experience in the field of process

plant supply. A variety of construction materials, manufacturing skills and quality assurance facilities are required to produce such equipment.

Efficiency of nitrogen fertilizer applied via fertigation and side-dressing methods in cotton

by Messrs. M.N. Malik and S.I. Hussain Shah, Central Cotton Research Institute, Pakistan

Nitrogen is a major nutrient limiting cotton production in Pakistan. Farmers apply 125-200 kg N per ha to harvest good yield. Nitrogen is applied by side-dressing method and via irrigation water (fertigation). No research has been done on the relative efficiency of these two methods and choice depends more on convenience rather than efficient utilization. Experiments were therefore carried out at Cotton Research Institute, Multan to measure the relative efficiency of two application methods.

Data presented show that seed cotton yield increased with each treatment of nitrogen. Maximum increase in yield occurred at the level of 200 kg N/ha. Fertigation method of nitrogen fertilizer seemed inferior to side-dressing method. Nitrogen sources caused little differences in yield.

Accumulation of nitrates and nitrites in foods of plant origin

by Messrs. I. Ahmad and F.H. Shah, PCSIR Laboratories Complex, Pakistan

Nitrate accumulation in plants is a natural phenomenon resulting from uptake of nitrate ion in excess of its reduction and subsequent assimilation. Accumulation of nitrate is dependent on the genetic make up of the plant, on nitrate supplying power of the soil and the environmental conditions under which the plant is propagated. Nitrate accumulation in plants had been observed for many years, but interest in nitrate accumulation has intensified since mid-1950's with increased use of nitrogen fertilizers. In recent years, high nitrogen fertilization of plants had been a common agricultural practice. Consequently many plants accumulate nitrate in excess of their needs.

In addition to deaths of animals, as a result of the ingestion of forages containing nitrates, there are reports of cyanosis in infants (blue babies) which occurred after consuming food to which water contaminated with nitrates was added. The incidence of methemoglobinemia, in infants, was reported to be due to ingestion of foods containing large amounts of nitrates. Nitrates and nitrites combine with haemoglobin in blood thus impairing oxygen carrying capacity of haemoglobin.

Fertilizer Industry Development - Problems and Prospects

by Mr. W.M. Butt, Technology Management International (Pvt.) Ltd., Pakistan

The production of nitrogenous and phosphatic fertilizer plants in Pakistan has been described and future projects for the manufacture of Chemical Fertilizers at present at various stages of development have been reviewed.

Estimates of maximum fertilizer nutrient requirements have been made and it is concluded that there is still untapped market potential of 67.4% for nitrogenous, 72.6% for phosphatic, and 97.3% for Potassic fertilizers. Estimates for the future demand of various fertilizers has also been made and it is shown that the demand in Pakistan for nitrogenous fertilizer will rise to about 2.36 million nutrient tons and for phosphatic fertilizers to 593,000 nutrient tons by the year 2000.

The cost of the production of urea has been calculated for grass roots as well as urea expansion projects. It is shown that the cost of investment constitutes about 45 percent of the total cost of production of urea. It is concluded that a grass roots project is not feasible unless the Government assists the prospective investor in assembling a financial package at realistic interest rates. This factor has hampered the development of the investors is to look for second hand plants but reliability of such plants is questionable because of lack of experience worldwide in relocating large scale plants.

Fertilizer Marketing in Pakistan: Some Lessons from Recent Bangladesh Experience

by Mr. R.M.U. Suleman (Senior Consultant, Ronco Consulting Corporation, Washington, D.C.), USAID, Pakistan

Fertilizer is one of the most important components of improved agricultural technology and it is widely believed that in a modern crop production system, as much as a third to a half of the increased crop output per unit of land is attributable to fertilizer use. The agronomic aspects of fertilizer use are fairly well-known and quite efficiently propagated. The same cannot, however, be claimed about the marketing aspects of a commodity or product as extensively used as fertilizer. This is as true of the pricing and market promotion as of the distribution aspect of fertilizer marketing. Involving millions of users, the potential for adding on unnecessary costs of inefficient distribution are great and proper price announcement policy is also quite important for suitably moderating these costs.

Proper dissemination of fertilizer price information is quite as important as the announcement of administered prices. This has relevance for nitrogenous fertilizers at present, but will be equally true of other fertilizers in years to come. For an arbitrary assortment of fertilizer products, mainly nitrogenous, the only current source of price information is the Monthly Statistical Bulletin of the Federal Bureau of Statistics. There is no wholesale market for fertilizer products in Pakistan, but the Bureau's fertilizer classification under whole-sale prices of related commodities includes - 1) Ammonium Solphate, 2) Ammonium Nitrate, 3) Urea, and 4) Super Phosphate. Ignoring the errors of description, it is interesting to note that Karachi, the only center selected for reporting is now the least relevant for the products concerned and the prices reported are generally at variance with the Pakistan averages published in specialized international journals.

In the beginning, maximum retail price was fixed for each type of fertilizer by the Federal Government and was uniform throughout the country. Sale at prices higher than the fixed retail prices is still a cognizable offence. During slack periods the retail prices often drop below the price ceiling, while during periods of shortages there are instances of overcharging. From 4 May 1986 the prices of nitrogenous (N) fertilizer were deregulated. Similar deregulation is planned for straight phosphatic

fertilizers and compounds from October 1991 and for straight potassic fertilizers and compounds from October 1995. Even in respect of N fertilizer, price determination is oligopolistic rather than competitive, with public sector and para-statal manufacturers playing the role of price leaders. Of the two private sector manufacturers one maintains explicit and the other implicit relationship with the oligopolistic price setting. Further complication arises due to occasionally imported urea also being distributed largely through domestic manufacturers. When marginal supplies are provided by imports, the price of imported urea, if it is higher than that of the domestic manufacturers' consensus, becomes the price setter and provides super profits to domestic N manufacturers farmers. Unlike Bangladesh, most of the private sector retail trade in Pakistan has always been in the hands of the Arhtis. The business orientation of these retailers is such that they normally rely on quick turn-over for profitability since there are several seasonal investment options open to them.

Fertilizer consumption in Sri Lanka

by Mr. K.N. Jayasuria, Marketing Manager, Ceylon Fertilizer Corporation, Sri Lanka

Sri Lanka with a total area of 65,527 m² and a population of 16.4 million is essentially an agricultural country. The use of chemical fertilizers in Sri Lanka dates back to the early 1930's and has been increasing steadily during the last 27 years. The increase in fertilizer amounted to 79% in product terms and 169% in nutrient terms between 1962 to 1989. The total fertilizer consumed by different crop sectors amounted to 523,000 MT (Product term).

The main fertilizer ingredients used in Sri Lanka are urea, sulphate of ammonia, triple super phosphate, rock phosphate, rock phosphate muriate of potash, kieserite and dolomite.

Being a non fertilizer producing country, Sri Lanka has to solely depend on imports for its total fertilizer requirements. However, an extensive deposit of apalite, located in North Central part of the country is believed to have over 40 million tons of rock phosphate reserves, sufficient to meet local demand for several generations. This phosphate is presently used in just ground form in plantation crop sector and its annual supply amounting to approximately 25,000 MT. In addition to rock phosphate, dolomitic lime stone deposits that are found in central parts of the Island supply the dolomite requirements of the country. This ingredient is mainly used as a soil rehabilitating agent in plantation crops. The annual consumption of dolomite is around 15,000 MT. This country has been manufacturing urea between 1981 and 1986. Since then the 310,000 ton capacity naphtha based urea plant has been ideling as it was found to be commercially non viable.

Situation of fertilizer industry in Sudan

by Mr. Salah Abdalla Elamin, Chief Chemist, Ministry of Industry, Sudan

Irrigated cotton production accounts for the greater part of Sudan's total production (Gezira Scheme the largest irrigated scheme).

The production has grown at an average rate of about 4.5%/year over the last 40 years, as a result of expansion of the area under irrigation which has

exceeded 2 millions feddans. The annual production is about 900.000 tons of cotton seed and 500.000 tons/year cotton lint. The volume of production of cereals has increased slowly over the years. The production of Sarghum is 2.0 million tons, production of millet is 500.000 tons and wheat production increased to about 900.000 tons.

Among the oil seeds, production of cotton seed and ground-nuts production is 400.000 tons and sesame 600.000 tons.

Cotton accounted for about 50% of the total exports of Sudan with about 400.000 tons. Oil seeds and related products accounted for nearly 25% and Gum Arabic export for another 9%.

In order to meet the demand for petroleum products a petroleum refinery was erected in Port Sudan by Royal Dutch Shell Company with a capacity of 1 million tons (using imported crude). This refinery supplies the only one plant for fertilizer manufacturing (Sudan-Ren) with naphtha. The plant working with a capacity of 90.000 tons/year of ammonia nitrate, 50.000 tons of ammonia and 70.000 tons/year of nitric acid. The consumption of fertilizers nitrogen, phosphates and potash is continuously increasing from 50.000 tons, 5.000 tons, 1.000 tons respectively in the year 1970 up to 200.000 tons, 70.000 tons and 30.000 tons respectively in the year 1985. The preference for the use of nitrogenous fertilizers is likely to continue during the next few years, since the development of a fertilizer industry in Sudan is to be limited to the production of nitrogen fertilizers.

Another problem that the great majority of developing countries is short of skilled manpower for extension and/or funds to employ adequate number of personnel and to provide them with necessary back-up services. Trade-offs between manpower and funds may be feasible, for example, in the provision of extra transport and more audio-visual aids where manpower is short. Extension to perform, and adequate recurrent funds where necessary. As a result of foreign exchange and/or recurrent funds constraints in recent years, a number of countries have not provided adequate travel funds for supervisory extension staff, subject matter specialists or field workers. As a result, extension work has suffered.

Another problem that the recycling of crop residues, farm manure and the biological fixation of nitrogen, supplemented by mineral fertilizer, where there is little land and adequate amounts of organic manure and labour to transport and spread it are not available, nutrient requirements for intensive crop production must be largely met by mineral fertilizers. Taking account of nutrient reserves in the soil by means of periodic testing.

Adequate fertilization can also serve to reduce moisture stress. Application rates need be related to reasonable expectations of yields, largely determined by the availability of water, choice of seed variety and general standards of crop husbandry. To ensure optional benefits from every unit of plant nutrient applied, high standard of crop husbandry are essential.

Losses in fertilizer efficiency and reduced yields of up to 50%, occur because of inefficient control of factors such as weed infestation, time of sowing, choice of variety, insect attacks and wrong and imbalanced nutrient application of major nutrients, nitrogen, phosphate and potash (N, P₂O₅, and K₂O) plus secondary and micronutrients is extremely important. In large areas under irrigation for instance, the predominant use of nitrogen alone over long periods now needs to be corrected by the incorporation of phosphates and potash. In upland crops any imbalance is quickly revealed by a reduction of potential yields.

Advanced retrofitting technology for large ammonia and urea plants

by L. Mariani, Ammonia Casale S.A., Switzerland

When starting to look at a revamping project, in principle a multiplicity of options is available to the designer.

However, the very nature of revamp work for large ammonia and urea production plants requires keen attention and experience, as compared to a new plant design: conditions can arise that cannot be foreseen, requiring special expertise to develop sound solutions.

The paper describes typical "case retrofitting projects" implemented by Casale and Process Management Enterprises giving the criteria used for the selection of the steps adopted to improve capacity and/or energy efficiency in large ammonia and urea plants.

Problems encountered and results obtained are reviewed.

Fertilizer Situation in Thailand

by Mr. Prakarn Virakul, Senior Agricultural Economist, Ministry of Agriculture and Co-operatives, Thailand

The use of fertilizers in Thailand is made possible through imports. The domestic consumption demand for fertilizer boosted the amount of imports by 13% per annum. At present the quantity imported is around 2.6 million tons. Fertilizer marketing and distribution come from two major channels, private sector and government agencies. The government agencies have the share of one third to the total consumption. Since 1981, the natural gas reserves have been developed, the government is, on the way, scrutinizing the possibility to establish fertilizer complex to produce urea, DAP, MAP. This policy will help Thailand to meet the real fertilizer demand in the future.

Fertilizer development technology in Tunisia or Forty years of phosphoric acid production by wet process

by Mr. A. Benmansour, SIAPE - Société Industrielle d'Acide Phosphorique et d'Engrais, Tunisia

The development of the phosphate industry in Tunisia can be quoted as an ideal example of a technology transfer and assimilation of this technology, since Tunisia is presently one of the greatest exporters of phosphate products like: phosphate rock, merchant grade acid, superphosphoric acid and various fertilizer products (TSP, DAP, NPK).

After mastering these technologies, SIAPE has been able to intervene outside of Tunisia.

Such information has been effected in various forms:

- promotion of the country's phosphate rock sale,
- sales of fertilizers process engineering,
- revamping of fertilizer plant revamping.

Granular triple superphosphate technology

by Mr. D. Ivell. Hydro Agri International Licensing. Levington Research Station. United Kingdom of Great Britain

Hydro Fertilizers through their predecessors Fisons Fertilizers have been associated continuously with superphosphate production since the start-up of the first fully integrated fertilizer factory in the world in 1854. The company has always been at the forefront of technical development and pioneered many significant improvements. At the same time much operational and maintenance experience has been accumulated. Hydro Fertilizers experience, know-how, licensed technology, and process design for Granular Triple Superphosphate is made available through Hydro Agri International (HAI).

There are two principle processes for production of Granular Triple Superphosphate (GTSP), these are normally called the Den Route and Slurry Route. Hydro Fertilizers have operational experience of both and Hydro Agri International Licensing offers licensed processes for both.

This process description should be read in conjunction with the process flowsheet.

Liquid ammonia and phosphoric acid are fed to the reactor. A small amount of sulphuric acid is usually required to control the product analysis and this is also fed to the reactor. The reactor is of the draught tube type. Ammonia is fed to the base of the central tube, phosphoric acid to the outer annulus. The resulting ammonium phosphate solution produced in the reactor is sprayed into the granulator. The pressure in the reactor is controlled at 1 kg/cm²g but the release of reaction steam. Reaction steam is scrubbed with weak phosphoric acid in the ammonia scrubber to remove the majority of the ammonia carried over from the reactor. The ammonia scrubber is a co-current void tower with a high liquor spray density. The airstream drawn through the granulator also contains ammonia which is recovered in the ammonia scrubber. The exhaust from the ammonia scrubber is fed via a fan to the gas scrubber. Drier air containing dust and ammonia is also cleaned with weak phosphoric acid in the gas scrubber which operates counter-currently. The scrubber liquors are returned to the reactor.

The ammonium phosphate solution is sprayed through a system of spray nozzles onto a bed of recirculating fines in the rotary granulator. Ammonia is added to achieve the required product analysis. Filler is added if necessary. The granulated material then falls directly into the rotary drier. Here the material is contacted with a hot airstream to reduce the moisture content of the solids for good storage properties. Drier air is heated by a direct fired gas or oil burner. From the drier the material is elevated to the screening section. These screens are double deck machines. Undersized material is separated on the lower deck for recycling to the granulator via the fines hopper which is located directly beneath the screens. Oversized material is separated on the upper deck and crushed before passing to the fines hopper.

The flowrate of product to storage can be regulated and excess product fed either to the crushers or direct to the fines hopper to maintain the recycle rate as required. Recycled material is metered back from the fines hopper to the granulator at a constant rate so that granulation is maintained at the optimum at all times.

The product stream is cooled in a simple fluidized bed cooler to a temperature satisfactory for product storage and bagging. The dust in the air stream from the cooler is recovered in a bag filter.

To provide a clean working environment dust extraction points are fitted at various transfer points. All the points are connected to a centralized bag filter where the dust is removed from the airstream.

Philosophy and latest development for water inhibitors in the fertilizer industry

by Mr. D.G. Hooper, Technical Development Manager, Nalfloc Limited, United Kingdom of Great Britain

Increasing technical and environmental pressures are being exerted on chemical suppliers who are investing in research and development to provide safer and more effective answers to the problems of water systems and this paper briefly reviews some old, new and future technologies with particular reference to the fertilizer industry.

It gives an overview of the use and need for inhibitors in water systems used in the fertilizer industry with particular emphasis on their environmental impact.

It makes the point that the control of the application of inhibitors is as important as the initial choice of the agents themselves. This is considered both in terms of their efficacy in the industrial situation, as well as their effect on the environment.

It suggests that "environmentally acceptable" does not have to mean "more expensive". New programmes use inherently less toxic agent and good control reduces over-use and waste which are major contributors to costs and pollution.

It concludes that there is no short cut or panacea answer to the problems of water systems but that there are technological solutions to them. Some are here now and proven while others are coming. All are more environmentally acceptable.

Improved performance in steam reformers

by Mr. J.K. Dunleavy, Dvtech Corporation Ltd., United Kingdom of Great Britain

Existing ammonia plants have a number of options to increase plant capacity and decrease energy consumption. This paper discusses two options that are readily available:

1. New Reformer Metallurgy.
2. New Reforming Catalysts.

The section of the appropriate metallurgy and catalysts are cost-effective and can provide significant improvements over existing materials.

Opportunities to develop West African Agrominerals

by Mr. A.K. Johnson, Geologist, IFDC - Africa, Lomé, Togo

In sub-saharan countries, agriculture which is the economic development spearhead occupies more than 80% of the population. All realistic forecasts predict that without the use of fertilizers, Africa will be faced with widespread starvation. Only intensive agriculture and fertilizer promotion supported by adequate agriculture policies which takes account of the real farmer's purchasing power might lead to food security in sub-saharan countries.

Population growth rates outpace the growth in food production. Slow pace in food production is the result of:

- soil fertility, nutrient depletion and degradation.
- poor availability and high costs of fertilizer which farmers often cannot afford.
- weak agricultural development strategies and associated resources constraints.