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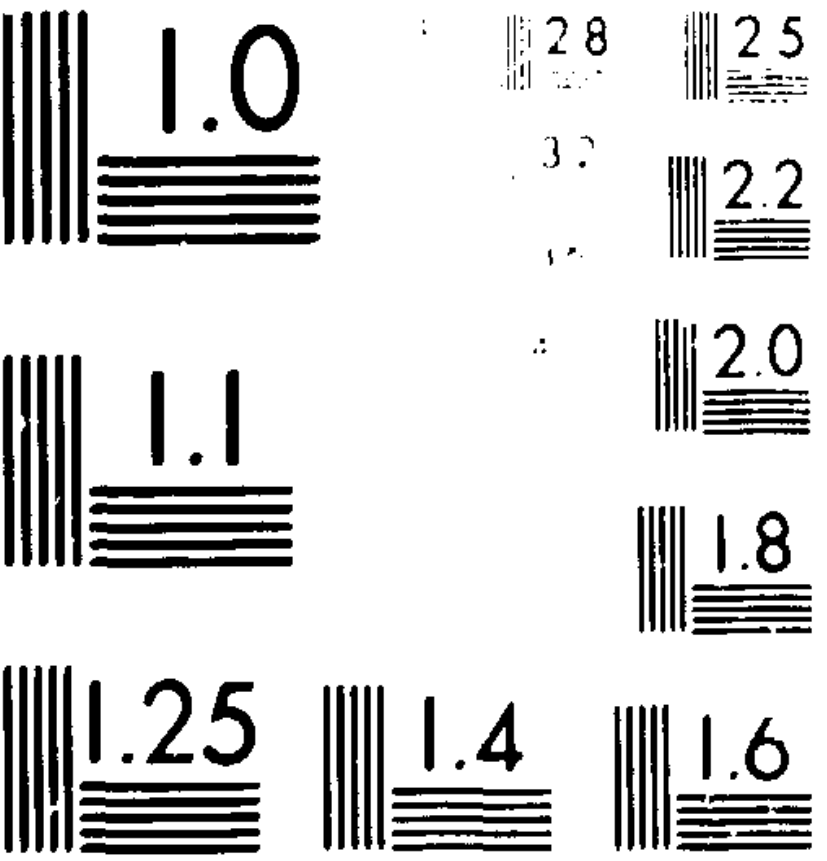

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Seminar on Mini Fertilizer Plants

Lahore, Pakistan, 15 - 20 November 1982

REPORT * (Seminar on mini fertilizer plants).

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ANNEXURES

INTRODUCTION

1. UNIDO in co-operation with the National Fertilizer Corporation of Pakistan Limited convened a technical Seminar on Mini Fertilizer Plants in response to a recommendation of the Third Consultation on the Fertilizer Industry convened at Sao Paulo, Brazil, from 29 September to 2 October 1980.

2. The topics for consideration recommended by the Third Consultation were as follows:

(a) The identification of developing countries where the construction of mini fertilizer plants might be desirable;

(b) The identification of available technologies and plant engineering designs that could be used for building mini fertilizer plants in developing countries;

(c) The development of new energy-efficient technologies and engineering designs for model mini fertilizer plants;

(d) Recommendations for co-operation between developed and developing countries as well as among developing countries in promoting mini fertilizer plants;

(e) The potential role of UNIDO in promoting mini fertilizer plants in developing countries.

3. To implement the recommendation, UNIDO was and is undertaking the following activities:

(a) A Technical Conference on Ammonia Fertilizer Technology was convened at Beijing, People's Republic of China, from 13 to 28 March 1982. A review was made of advances in ammonia technology and the Chinese technologies for small and medium-sized plants producing nitrogenous fertilizers.

(b) The convening of the present technical Seminar on Mini Fertilizer Plants at Lahore, Pakistan, to discuss in-depth with the interested parties the full issue of mini fertilizer plants.

(c) An on-going techno-economic study on the products and plant sizes recommended by the Seminar on Mini Fertilizer Plants, to be presented to the Fourth Consultation on the Fertilizer Industry.

4. The Seminar was attended by 65 participants from 28 countries and 2 international organizations.

I. ORGANIZATION OF THE SEMINAR

5. The Seminar on Mini Fertilizer Plants organized by UNIDO in co-operation with the National Fertilizer Corporation of Pakistan was convened at Lahore, Pakistan, from 15 to 20 November 1982.

6. The Seminar was opened by Lt.Gen. Saeed Qadir, Minister for Production, Railways and National Logistics, Government of Pakistan who emphasized its importance for national planning in developing countries where decisions are to be taken on the type and size of fertilizer plants and where the Government would welcome the recommendations of meetings such as the present one.

7. Mr. Riyaz Bokhari, Chairman of the National Fertilizer Corporation of Pakistan was elected Chairman and Mr. S.R. Panfil, UNIDO as Vice Chairman of the Seminar.

8. The Seminar adopted the following Agenda:

(a) The concept of mini fertilizer plants

(b) The experience of developing countries in establishing mini fertilizer plants

(c) Ammonia plants with capacities of 40-60 mtd, 90-100 mtd and 200-300 mtd.

(d) Mini plants for nitrogenous fertilizers

(e) Mini plants for phosphatic fertilizers

(f) Mini plants for potassic fertilizers

(g) NPK fertilizers

(h) Recommendations for future work to be undertaken by UNIDO on mini fertilizer plants

The details of the Agenda and Work Programme are given in Annex A.

9. The proceedings of the Seminar are going to be published by the National Fertilizer Corporation of Pakistan. The list of participants and the list of documents to be included in the proceedings are given in Annexes B and C respectively.

II. THE ROLE OF MINI FERTILIZER PLANTS

10. Discussions at the Seminar indicated that mini fertilizer plants were particularly advantageous in situations were:

(a) There were limited markets and/or restricted foreign exchange resources.

(b) There were limited or dispersed raw materials with nearby farming areas.

(c) There were high transportation costs both within a country and from the nearest ports to farming areas or to land-locked countries.

(d) It was important to decentralise industry to promote regional development.

(e) Countries at an early stage of technological development could make a sounder beginning in the fertilizer industry. It was pointed out that in countries such as Brazil, China, India, Mexico, Pakistan, etc. where the industry was well developed, the beginnings were made with mini fertilizer plants.

(f) Where limitation of resources made the development of large fertilizer complexes difficult and expensive.

11. Participants stated that mini plants were not justified where the prime consideration was the conversion of unutilized raw material to fertilizers for export. However, with the relative shrinking of export markets it was rapidly becoming more difficult to build large plants in countries with limited domestic markets and hope to export the surplus, unless this was undertaken in countries with advantageously priced raw materials.

12. Among the advantages of mini plants which were emphasized at the Seminar were the following:

(a) Mini plants allow the selection of plant sizes to meet only the requirements of domestic markets thus eliminating the need for exports from so-called optimum-sized plants.

(b) To enable the use of local raw materials and to assure fertilizer supply to farmers when required by them.

(c) To facilitate the transport and distribution of fertilizers using the existing infrastructure.

(d) By using smaller but proven equipment, not only can trouble-free operation be achieved in a shorter period but technological developments can be integrated into the plant after they have been proven elsewhere.

(e) Mini plants provide greater flexibility and adaptability to local conditions.

13. Farmers generally face four main constraints in increasing their fertilizer use: lack of knowledge in the use of fertilizers, untimely delivery of fertilizers, expensive farm-gate costs, and restrictions on the availability of the right type of fertilizers due to foreign exchange limitations.

Mini plants help in solving their problems by:

(a) Supporting agricultural extension programmes for the farmer.

(b) Delivering fertilizers in accordance with agronomic requirements.

(c) Enabling the Government to better spread the economic effects of raw materials, fertilizer and agricultural produce prices and costs over a longer period because the apportioning of those economic effects are fully under its influence and control.

(d) Reducing or eliminating the bulk of fertilizer imports at an earlier opportunity, thus freeing scarce foreign exchange resources for other prioritary uses without having to wait for a long time until the domestic market and/or risky export markets may justify the establishing of a large fertilizer plant.

14. In appraising the returns of mini fertilizer plants, it is important to consider some of their hidden advantages against large fertilizer complexes. Among these are:

(a) The smaller number and qualifications of the required personnel;

(b) The reduced problems of plant maintenance;

(c) The lower degree of infrastructural requirements;

(d) The socio-economic impact of using local resources and capabilities;

(e) Reduction in the quantity of spare parts and numbers of critical equipment, which would require long periods for replacement if damaged;

(f) The possibility of easier technological change when new developments take place;

(g) By training local personnel it helps to reduce the technological gap of developing countries. The tendency for large fertilizer plants is to continue to use foreign manpower for many years;

(h) Shorter construction period and earlier returns on investment;

(i) Easier and faster to finance due to the smaller investment required;

(j) Earlier reduction of fertilizer imports and savings in foreign exchange;

(k) Less financial exposure to inflationary pressures due to the earlier completion of the project.

15. The Seminar ascertained that proper consideration should be given to the establishing of mini fertilizer plants. However, questions were raised about the potential for grouping the demand of some countries to build large fertilizer plants. The Seminar noted that the experience of the last years has shown that within regional groupings, country expectations tend to prevail over technically sounder solutions and hence, the need to cater for the requirements of individual countries through smaller sized fertilizer plants.

16. Discussions were held on the economic comparison between mini fertilizer plants and large fertilizer plants. It was, however, emphasized that this comparison should not only be made along a standard economic appraisal restricted to battery limit costs but should also include:

(a) All infrastructural costs related to both the raw materials supply and fertilizer distribution to farmers, particularly the secondary warehousing network required for large plants. It is

the farm-gate price which is important;

(b) The higher on-stream factor of mini plants (generally about 10% higher than for large plants) should also be taken into account;

(c) The additional and/or strengthened transport infrastructure required to move the major quantities of fertilizers from large plants should also be appraised.

III. THE EXPERIENCE OF DEVELOPING COUNTRIES

17. Country papers were presented by Brazil, China, Indonesia, Kenya, Malawi, Malaysia, Mauritius, Mexico, Nigeria, Pakistan, Peru, Tanzania, Turkey and Zambia, by the Arab countries and the Central American countries.

18. The Seminar noted with interest that within the developing countries which have built large plants, there are some countries such as China and Mexico where mini fertilizer plants are operating along with the large plants. Thus, mini plants in China account for 45% of the 10 million tons/year nitrogen capacity and in Mexico for 48% of the 4.5 million tons/year total nitrogen capacity.

19. It was noticed that developing countries often have similar problems. For instance, in Mexico and Pakistan common problems in transporting fertilizer by rail resulted in difficulties for large plants installed in the gas fields. Participants pointed out the necessity for secondary warehousing at strategic points when the production of large plants is considered. It was thus felt important that when comparing mini fertilizer plants to large plants, the farm-gate price and the total investment costs including secondary warehousing should be considered as bases for comparison.

20. Some developing countries reported equipment difficulties with small skid-mounted fertilizer plants in the past and, therefore, they recommended the use of proven technologies. Other participants emphasized that the difficulties were with certain equipment rather than with the process and concurred that equipment should be proven.

21. The Seminar noted that mini fertilizer plants in several countries had less critical equipment and were able to run uninterruptedly for a longer period than is usual in large plants. This factor coupled with the faster construction time for mini plants resulted in early production of fertilizers and savings in foreign exchange.

22. The Seminar noted that some countries have had negative experiences in developing their fertilizer industry from large plants. For instance, in an African country the project for a large plant requiring substantial exports has already been going on for 5 years and as yet remains unimplemented, but its domestic fertilizer needs are still met by imports. In another Asian country, a large naphta-based plant contingent upon exports was installed but has had to be shut down a while later. The high cost and long gestation period of large fertilizer plants would often result in project delays and higher investment and production costs.

IV. AMMONIA PLANTS

23. The Seminar discussed investment cost comparisons for mini and large ammonia plants. One participant stated that in the past, for given capacity increases an investment cost escalation factor of 0.7 had been applicable. Other participants indicated that this logarithmic relation between plant capacity and investment cost is not applicable to mini and large ammonia plants, for the concept of design from one to another is quite different. However, it was felt that mini ammonia plants for developing countries could be made simpler than large plants (requiring high energy recovery and higher investment in equipment).

For instance, in Pakistan two new ammonia-urea plants were constructed in 1982, a simpler plant of 170-200 mtd ammonia costing US$ 62 million and a sophisticated 1,000 mtd ammonia costing US$ 320 million.

24. Mini ammonia plants can be designed and built under two main concepts: minimum investment cost (and higher energy consumption) and minimum energy cost (and higher investment in equipment). Some participants emphasized that reliable technology and proven equipment resulting in high plant availability is the most important factor for mini plants. Other participants stressed the need for modern good technology instead of technological reliability, albeit energy inefficient, alone.

25. The Seminar felt that there was scope for designing mini ammonia plants in order to lower investment costs, with only marginal effects in the consumption of energy as feedstock and power.

26. The Seminar reviewed ammonia plants in three different plant capacities: 40-60 tons/day, 90-100 tons/day and 200-300 tons/day.

27. A paper was presented on the small Chinese ammonia plants producing ammonium bicarbonate as fertilizer. The low cost of the 40-60 tons/day plant (about US$ 7 million) was appreciated but some reservations were expressed on the use of ammonium bicarbonate as fertilizer. It was felt that UNIDO,

jointly with FAO, would sponsor tests on soils outside China to examine both the storage loss and the agronomic effectiveness of this fertilizer against other nitrogenous fertilizers.

28. Several papers were given on the small skid-mounted ammonia plant, and although the cost of manufacture from such plants was relatively more expensive, the ease of installation was emphasized. However, in some countries such as Kenya and Pakistan, major difficulties were found in endeavouring to operate these plants stemming more from equipment failure than from process difficulties.

29. A draft basic engineering design for a 100 mtd ammonia plant based on coke or heavy fuel oil was presented. The Seminar felt that although the design uses reliable technology, the flowsheet contains quite expensive steps which were considered unnecessarily in addition to the high cost of both raw materials. A more streamlined and modern flowsheet based upon natural gas and coal would make this plant more economically viable.

A participant stressed that mini ammonia plants can start competing with large plants when the ammonia is converted into straight liquid products instead of the solid products large plants must produce.

30. Several papers were presented on the 200-300 tons/day ammonia plant. It was found that technology had been developed for plants currently available in which the energy consumption is claimed to be as low as 7.6 to 8.4 million Kcals/ton of ammonia. This compares very favourably with modern large scale ammonia plants where operating plants brought on-stream in 1982 use 8.5 to 9.0 million Kcals/to of ammonia, while the next generation of large scale ammonia plants would operate at only 7.0 to 7.5 million Kcals/ton of ammonia.

31. The reduction in feedstock consumption for mini ammonia plants in the 200-300 tons/day range has not come from new processes but from improvements in existing technology and the use of lower pressures. Thus the use of such

energy-efficient mini ammonia plants does not justify the risk of unproven equipment.

32. In view of the above changes in both costs and efficiency of the new mini ammonia plants between 200 to 300 tons/day, UNIDO was requested to prepare an appraisal of technologies and other information available for consideration by the Fourth Consultation on the Fertilizer Industry

In carrying out the appraisal, UNIDO should request the Licensors of the new process designs to prepare a critique of their respective processes in order to prepare a technical guide on the processes and licenses available.

V. NITROGENOUS FERTILIZERS

33. Papers presented at the Seminar on the conversion of ammonia to nitrogenous fertilizers showed that the production cost does not vary much for different plant sizes when based on an equivalent ammonia price. This situation highligths that variable costs have become dominant over fixed costs in the total production cost of nitrogenous fertilizers, thus making mini plants relatively competitive with large plants.

34. It was therefore felt, that for countries with limited domestic markets a case could be made for mini plants based upon imported ammonia if no feedstocks are available in the country.

35. While it appeared likely that under the conditions mentioned above mini nitrogenous fertilizer plants were fairly competitive, UNIDO was requested to collect data on the relative production costs of mini plants for ammonium sulphate, ammonium nitrate and calcium ammonia nitrate, urea and also ammonium bicarbonate based upon purchased ammonia and within a mini ammonia-ammonium bicarbonate integrated plant.

VI. PHOSPHATIC FERTILIZERS

36. The single superphosphate plant is considered a mini plant and several of its advantages were emphasized. The process can use rocks which other processes cannot, and the gypsum remaining in the fertilizer is an advantage in saline soils. Moreover, the manufacture of SSP plants is relatively simple and can be undertaken in a number of developing countries. These factors can often offset its lower phosphate content (17% P_2O_5) and mini SSP plants can even be set up all over a large country, as has been successfully demonstrated in China.

37. In areas where acidic soils exist, the production of semi-accidulated phosphate rock was considered to be useful, particularly where refractory phosphatic rocks have to be used as raw material.

38. In a paper presented to the Seminar, a comparison was made on the production cost from a large (1000 tons/day) plant established in a phosphate rock producing country and exporting the fertilizer (US$ 40 per ton freight) as against a mini (100 tons/day) plant put up in a different location and importing phosphate rock (US$ 25 per ton freight). The results showed that mini phosphate plants under these conditions are fairly competitive with large plants as follows:

	Ex-plant price (US$/ton)	
	1000 tons/day centralised location	100 tons/day dispersed location
Diammonium Phosphate (DAP)	281.3	289.4
Triple Superphosphate (TSP)	212.5	210.6
Ammonium Sulphate-Phosphate (ASP)	207.6	188.2

39. It would appear, therefore, that phosphatic fertilizer production costs are marginally sensitive to plant sizes between 100-1000 tons/day P_2O_5 as long as raw material prices are similar.

40. In the production of diammonium phosphate or other NP compound fertilizers such as nitrophosphates, the requirement of ammonia can govern plant sizes. Thus a 1000 tons/day DAP plant requires a 225 tons/day ammonia plant, which is in fact a mini plant.

41. From the foregoing analysis on phospate and nitrogenous plants, it is seen that mini plants are economically comparable with large plants provided that raw material prices and particularly ammonia prices are equivalent. Thus, in designing a mini plant complex, the main point of appraisal is the price of the produced ammonia. It was, therefore, recommended to UNIDO that emphasis should be placed upon assisting to develop a satisfactory and economical mini ammonia plant.

VII. POTASSIC FERTILIZERS

42. The Seminar noted that substantial reserves of potash salts had now been identified in a number of developing countries. Important deposits have been identified in Africa, Asia and Latin America. Of these, the deposits in Chile, China and Jordan are being exploited. There are advanced plans to exploit the reserves in Brazil, the Congo, Mexico, Thailand and Tunisia, and to increase production in China.

43. Most of the current potash projects call for large scale production. However, a paper presented to the Seminar showed that even small potash plants can be economical where a reserve of potash salts as brine or solid is available.

44. The Seminar felt that more attention should be given to the recovery of potash from biomass, particularly from the waste solution of alcohol distilleries containing 1-2% K_2O, for several developing countries in Latin America and Asia are producing or considering to produce ethanol as motor fuel.

VIII. NPK FERTILIZERS

45. A paper presented to the Seminar showed that 100 tons/day NPK granulation plants are fairly economical when compared with 1000 tons/day granulation plants, thus suggesting the possibility of installing mini NPK plants in farming areas.

46. Another paper presented a concept for a standard granulation plant that was simple and easy to operate and which could be manufactured in the developing countries. Some participants felt that sufficient information existed to design such plants in developing countries, and recommended UNIDO to make an appraisal of available technologies.

47. Several participants pointed out that currently many countries make too many different NPK formulations when but a few were truly needed. For instance, in India one of the largest NPK producers had now reduced its large range of products to only 2 NPK formulations without affecting the market. However, other participants felt that the market should indicate the number of formulations needed to meet domestic requirements.

48. It was noted that granulation costs on average between US$ 10 to US$ 12 per ton, and hence a suggestion was made that granulation plants should preferably be installed either when there was a strong demand for NPK products or when a chemical reaction (e.g. reaction of ammonia and phosphoric acid) is accompanied in the granulation process with the addition of the remaining materials. Modern granulation plants tend to produce NPK mixtures along with the production of MAP, DAP or similar fertilizers.

49. In the case of urea-based formulations, there are minor difficulties in blending it with MAP or DAP. But on NPK formulations many operational difficulties arise, particularly in dry areas for urea becomes unstable, increases heat emission when added water and creates dusting problems. Non-urea based formulations are better suited for trouble free operations. On-going research at institutions such as the TVA is improving the granulation of urea to facilitate its utilization in formulations and minimize its loss as dust.

50. A shift towards physical bulk blending of granulated standard fertilizers is taking place in several developing countries, for agronomic and economic considerations favours the use of granules which increases the efficiency of nutrient intake by crops and giving about 10-15% increases in crop yield over the yield obtained by using the same nutrients in other physical form.

51. The current trend in some developed countries is for standard granulated fertilizers to be further bulk blended with other materials at the request of farmers in units established near agricultural centres. It becomes a marketing concept. It was felt that in the long run such centres would also develop in developing countries and help achieve a more balanced fertilization of crops.

52. A process for NPK formulation using phosphate rock, nitric acid and potash materials was presented. However, the phosphate formed appears to be in the form of dicalcium phosphate. The production cost is claimed to be lower than with other NPK processes.

IX. CONCLUSIONS AND RECOMMENDATIONS

1. The Seminar recommended that UNIDO should examine the domestic fertilizer requirements of developing countries from the agronomic, economic and social conditions prevailing and to classify the countries into those which would require mini fertilizer plants either in the near future or within 10 years. The countries should also be classified, where possible, on the type of fertilizers required.

2. The Seminar recommended that UNIDO should collect and provide estimates of the cost of such plants and the finances which will be required for such purposes.

3. The Seminar recommended that in evaluating mini fertilizer plants, and particularly when comparing them with large plants, UNIDO should not only consider the battery limits costs of manufacture but should also consider other relevant factors such as the availability of raw materials, the shorter construction period, the smaller infrastructure required, the possibility of longer on-stream days per annum and the local availability and training of personnel. In addition, the transport costs and difficulties of movement of raw materials and fertilizers should also be examined, and the costs of fertilizers should be compared on a farm delivered price.

4. The Seminar noted that developing countries which now have an advanced fertilizer industry commenced with mini plants and in several of them mini plants still have a substantial share of their total capacity. The Seminar recommended that countries which are establishing plants for the first time should duly consider the possibilities of commencing production with mini fertilizer plants in order to be better prepared for the absorption of technology for further development.

5. The Seminar recommended that UNIDO should prepare a guide to mini fertilizer plants in order to enable planning and other organisations in developing countries to consider mini plants as a possible alternative for the development of the fertilizer industry.

Ammonia

6. The Seminar recommended that since ammonia is the base of all nitrogenous fertilizers and of NP fertilizers, UNIDO should carefully examine all available technologies for the production of ammonia. The Seminar suggested that UNIDO should confine its attention to plants of 100 tons/day and up to 250 tons/day as mini plants. In comparing technologies, both minimum-investment and minimum-energy evaluations should be considered.

7. The Seminar noted that acceptable modern technology was available for plants of 200-250 tons/day of ammonia, but technology for smaller plants (100 tons/day) may need further development. The Seminar recommended that UNIDO should study the newer designs of the latter size of plant and take appropriate action if found inadequate.

8. The Seminar suggested that the ammonia plants considered should be based upon natural gas, coal and residual fuel oil as feedstocks. The use of electrolytic hydrogen as a feedstock should also be studied.

Nitrogenous fertilizers

9. The Seminar recommended that UNIDO should consider the production of urea, ammonium sulphate, ammonium nitrate, calcium ammonium nitrate and ammonium bicarbonate for techno-economic appraisal and for comparison with large plants. The plant sizes to be considered should match the ammonia plant sizes given in 6 above, except for ammonium bicarbonate which should be based upon integration with a 60 tons/day ammonia plant.

10. The Seminar considered that sufficient technological developments had taken place on mini plants for nitrogenous fertilizers to make such plants economical for establishment in developing countries. No new process technology would be required for this purpose.

11. The Seminar recommended that UNIDO should study the storage and utilization of ammonium bicarbonate on soils outside China, as the product was a low cost fertilizer which had only been tried in China so far.

Phosphate fertilizers

12. The Seminar recommended that UNIDO consider the following phosphatic mini plants for a techno-economic appraisal:

(a) Single superphosphate plants (300 tons/day)

(b) Triple superphosphate plants (100 tons/day)

(c) MAP and DAP plants (100 tons/day and 200 tons/day)

(d) Nitrophosphate plants (200 tons/day, 60% water soluble)

(e) Phosphoric acid plants to match the requirements of (b) and (c) above

13. The Seminar considered that there was no particular need for any additional process design studies for phosphates, as economic processes were currently available for such plants.

14. The Seminar recommended that countries which had statutory regulations covering the strength of fertilizers should modify them in such a way that the strength stated on the bag should be sufficient.

Potash fertilizers

15. The Seminar recommended that UNIDO study the techno-economic production of potash from sylvinite and carnallite in plants with a capacity of 50 tons/day. Processes for such plants were currently available but should be compared.

16. The Seminar suggested that UNIDO study the extraction of potash from biomass and other industrial by-products. The plant sizes to be considered should be flexible and based upon the availability of raw materials.

NPK granulations

17. The Seminar recommended that UNIDO should make a techno-economic study of NPK granulation plants with a capacity of 100 tons/day. Several processes are available for this purpose and the Seminar recommended that no new processes need to be considered.

ANNEX A

SEMINAR ON MINI FERTILIZER PLANTS

AGENDA AND WORK PROGRAMME

Time	Monday
8.30- 9.30	Registration of participants
9.30-10.00	Opening of the Seminar
10.00-10.15	Coffee break
10.15-12.30	Introduction to mini-fertilizer plants (i) concepts (ii) definition of mini-fertilizer plants (iii) plant sizes
12.30-14.00	Lunch
	Nitrogenous fertilizers The experience of developing countries (a) Production (b) Raw materials (c) Economic results (d) Complementary/ competitiveness with larger plants
14.00-16.00	Experiences of Asia and Africa
16.00-16.15	Coffee break
16.15-18.15	Experiences of Latin America and the developed countries

Time	Tuesday
9.00-11.00	Potential markets (i) current markets suitable for mini-plants: products, countries, quantity (ii) logistics
11.00-11.15	Coffee break
	Production technologies (a) Products (b) Available technologies (c) Available equipment (d) Feedstocks: natural gas, fuel oil, coal/coke (e) Techno-economic appraisal
	A. Production in 50/60 mtd ammonia plants
11.15-13.00	(i) Ammonium bicarbonate and aqua ammonia: Chinese technology (ii) other fertilizers
13.00-14.00	Lunch
	B. Production in 100 mtd ammonia plants
14.30-16.30	(i) Package ammonia plant (ii) Ammonia conversion in 170 mtd urea plant
16.30-16.45	Coffee break
16.45-1830	(iii) Integrated ammonia-urea plant (iv) ammonium nitrate (v) other fertilizers

Time	Wednesday
	C. Production in 200 mtd ammonia plants
9.00-11.00	(i) Chinese technology for ammonia plants (ii) developed country technology for ammonia plants
11.00-11.15	Coffee break
11.15-13.00	(iii) ammonia conversion in 340 mtd urea plant (iv) other fertilizers
	D. Current research and development
13.00-14.30	Lunch
	Technology developments
14.30-16.30	(i) Preliminary basic design for a 100 mtd ammonia plant
16.30-16.45	Coffee break
16.45-18.30	(ii) Potential for using available technologies: improvements recommended (iii) need for new plant design: improvements in equipment

SEMINAR ON MINI FERTILIZER PLANTS

AGENDA AND WORK PROGRAMME

Time	Thursday	Friday	Time	Saturday
	Phosphate fertilizers			Potash and compound fertilizers
	The experience of developing countries (a) Production (b) Raw materials: phosphate rock and sulfur (c) Economic results (d) Complementary/Competitiveness with larger plants		9.00-11.00	Potash review (i) utilization of small material deposits. (ii) available processes.
9.00-11.00	Experiences of Asia, Africa and Latin America	Plant visit to NFC's Hazara Urea plant at Haripur Hazara	11.00-11.15	Coffee break
11.00-11.15	Coffee break		11.15-13.00	Compound fertilizers (N/P/K) Available technology for 200 mtd plant
11.15-13.00	Potential markets		13.00-14.30	Lunch
13.00-14.30	Lunch		14.30-17.30	Conclusions and recommendations (i) The need for mini-plants. (ii) Recommended products for mini-plant production. (iii) Criteria for selecting mini-plants. (iv) Recommended new plant designs (products/processes) (v) Future actions
	Production technologies (a) Products (b) Available technologies (c) Available equipment (d) Techno-economic appraisal		17.30-18.00	Coffee break
14.30-16.30	(i) Single superphosphate plants (SSP) up to 100 mtd. (ii) Granulation of SSP (iii) 200 mtd ammonium phosphates/ triple superphosphate plants		18.00-18.30	Closing of Seminar
16.30-16.45	Coffee break			
16.45-18.30	(iv) 50/100 mtd phosphoric acid plant (100% P_2O_5) (v) other fertilizers			
	Technology developments (i) Potential for using available technologies: improvements recommended (ii) Need for new plant design			

ANNEX B

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ANNEX C

LIST OF DOCUMENTS

AUSTRIA	Report to the Seminar on Mini Fertilizer Plants (by G. Krug)
BELGIUM	The case for small-scale fertilizer units in developing countries (by M.E. Banfield) Skid-mounted ammonia/urea plants (by M.E. Banfield)
BRAZIL	Market study of mini fertilizer plants for developing countries (by Shu Lin Peng) Acting of Petrofertil in Brazilian Fertilizer Market (by C.P. Correa Accioly)
CHINA	Experience in construction of small and medium sized fertilizer plants in China (by Li Qing-chun and Sun Wei-ming)
EGYPT	New technology for Helwan fertilizer plant extension and its cost estimation (by M. El Nashar)
FEDERAL REPUBLIC OF GERMANY	UHDE's approach to the design of low-cost mini ammonia plants with high operational reliability and favourable consumption figures (by P. Kalthoff)
FRANCE	Mini NPK fertilizer plants The Reasons of rentability of such plants (by C. Bracone)

GUATEMALA	The market possibilities for mini fertilizer plants in the Central American common market (by Rafael Ponciano Asturias)
HUNGARY	Small-scale AN fertilizer production (by G.D. Honti)
INDIA	Model basic engineering design for a 100 mtpd ammonia plant (by Paul Pothen and M. Krishnamurthy) Mini fertilizer plants (SSP, NPK and granulation units) (by K.S. Sarma)
INDONESIA	Mini fertilizer plants as a catalyst for developing a large modern industry: Indonesia/PUSRI experience (by Sri Martati Muhammad)
ITALY	Relevance of FAO fertilizer programme activities on the creation of markets for products from mini fertilizer plants (by J. de la Vega and M. Aspiras) Small ammonia plants: considerations on their optimization (by E. Comandini) Modularization and mini fertilizer plants (by F. Saviano)
JAPAN	TEC/MTC's new urea process: "Advanced process for cost and energy saving" and its applicability to mini plants (by S. Saito) Nissan phosphoric acid process in mini fertilizer plants (by N. Yamanaka)

KENYA	Experiences in constructing mini fertilizer plants (by J.S. Mburu)
KUWAIT	Market possibilities for mini fertilizer plants in the Arab Region (by M.Y. Abu-Khader)
MALAWI	Malawi position paper for presentation at the Seminar on Mini Fertilizer Plants (by F. Msiska)
MALAYSIA	Construction, operation and marketing of fertilizer plants in Malaysia (by S.S. Sidhu)
MAURITIUS	The Mauritius Chemical and Fertilizer Industry Plant (by E. H. Ng Kwing King)
MEXCIO	Mexico's experiences in the operation of mini fertilizer plants, market characteristics and future prospects (by S. Alejandro Velez Marquez)
NETHERLANDS	A new concept for ammonia production (by J.J. Westenbrink, K.S. Raghuraman and J.F. Nomden)
NIGERIA	Mini fertilizer plants within agro-engineering micro-systems; projections for Nigeria (by H.K.E. Wilson-Iteke)
PAKISTAN	Development of Fertilizer Industry in Pakistan and a case study of its mini fertilizer plants (by Riyaz H. Bokhari)
	Evaluation of different fertilizer products for large versus small production units in Pakistan (by M.C. Bhutto)
	Experience of operating a mini ammonia plant at Multan (by Zahur Ahmad Khan)

PAKISTAN	Manufacture of ammonium sulphate from gypsum at low capacities (by A. Shah Nawaz)
	A small-scale plant design for extraction of potash from carnallite (by A. Shah Nawaz)
	Pakistan: Market possibilities for mini-phosphatic fertilizer plants (by R.M.U. Suleman)
PERU	The operation of mini fertilizer plants in Peru (by Bartolomé Rios Berninzon)
SPAIN	Mini ammonium nitrate and superphosphate plants (by Luis M. Marzo)
TANZANIA	Tanzania Fertilizer Company Limited - Seminar on Mini Fertilizer Plants (by O.L. Mollel)
TURKEY	Present situation and production experience of AZOT Sanayii T.A.S. (by M. Erkan and M. Yarimagan)
UNITED KINGDOM	Scaling down of high efficiency plants (by F.C. Brown)
	A universal granulation plant - a standard design concept (by J.P. Hill)
	Small versus large ammonia/urea plants and the effect of variation of input and output parameters on the relative economics (by A.E. McNamara)
UNITED STATES	Development of technology applicable to small fertilizer plants: IFDC and TVA studies (by Travis P. Hignett and Owen W. Livingston)
	Small ammonia plants for developing countries (by Gerald W. Alves and Jerry D. Martin)

ZAMBIA — Production of fertilizers in Zambia
(by I.M. Liayo)

UNIDO — The situation of the potash industry in the developing countries
(by Fernando C. Angulo)