OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

D04645

C.66/1
Vol. 8

UNITED NATIONS

Department of Economic and Social Affairs

Centre for Industrial Development and
Bureau of Technical Assistance Operations

Original: English

Inter-Regional Seminar on the Production of Fertilizers

FERT/CONF.1/REPORT

Kiev, Ukrainian SSR
24 August - 11 September 1965

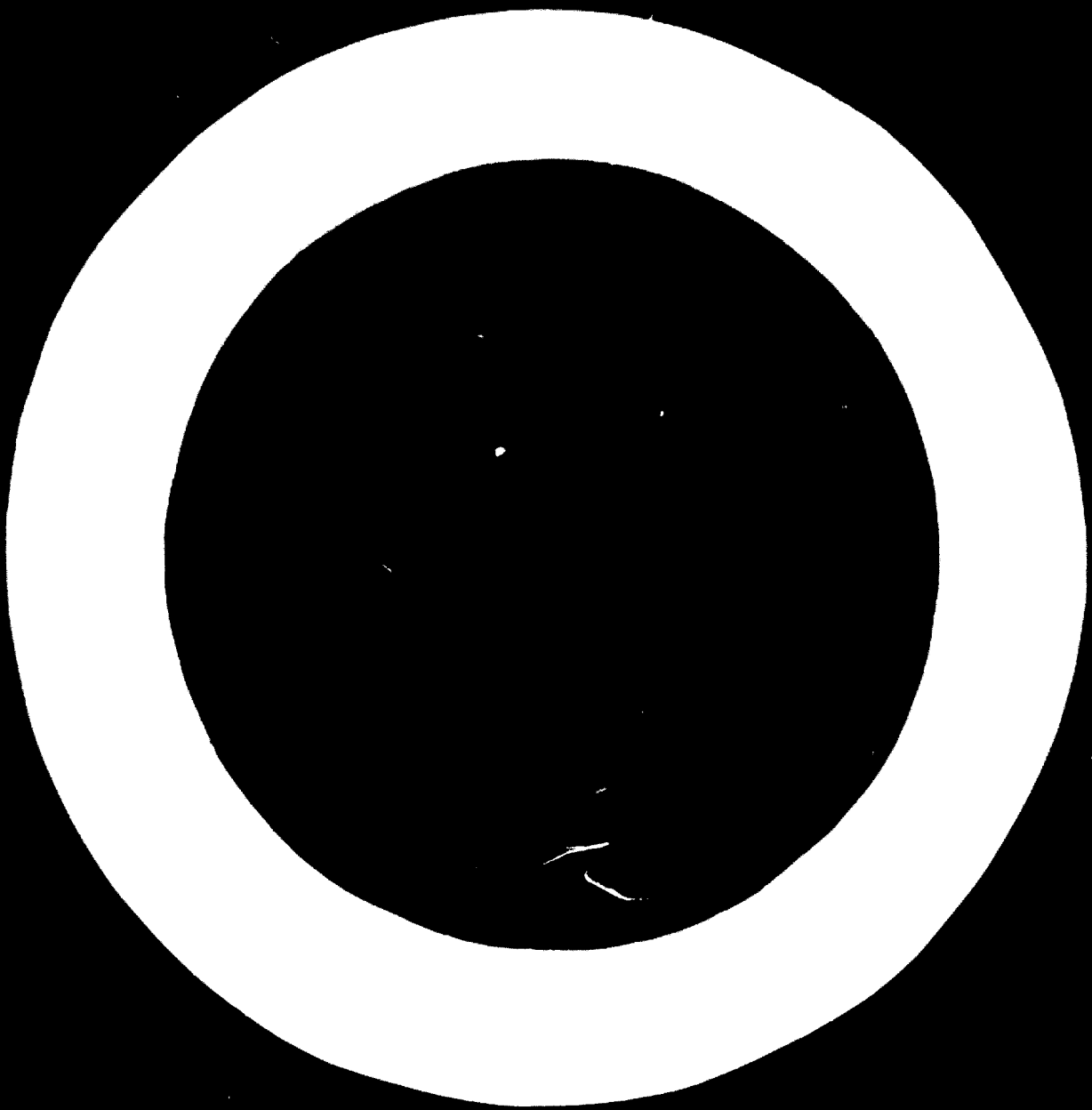
REPORT

On the Proceedings and Recommendations of the Inter-Regional Seminar On The Production of Fertilizers

Held at Kiev, Ukrainian S.S.R. from 24 August to 11 September 1965

This Report was adopted by the Seminar at its concluding session on 11 September 1965.

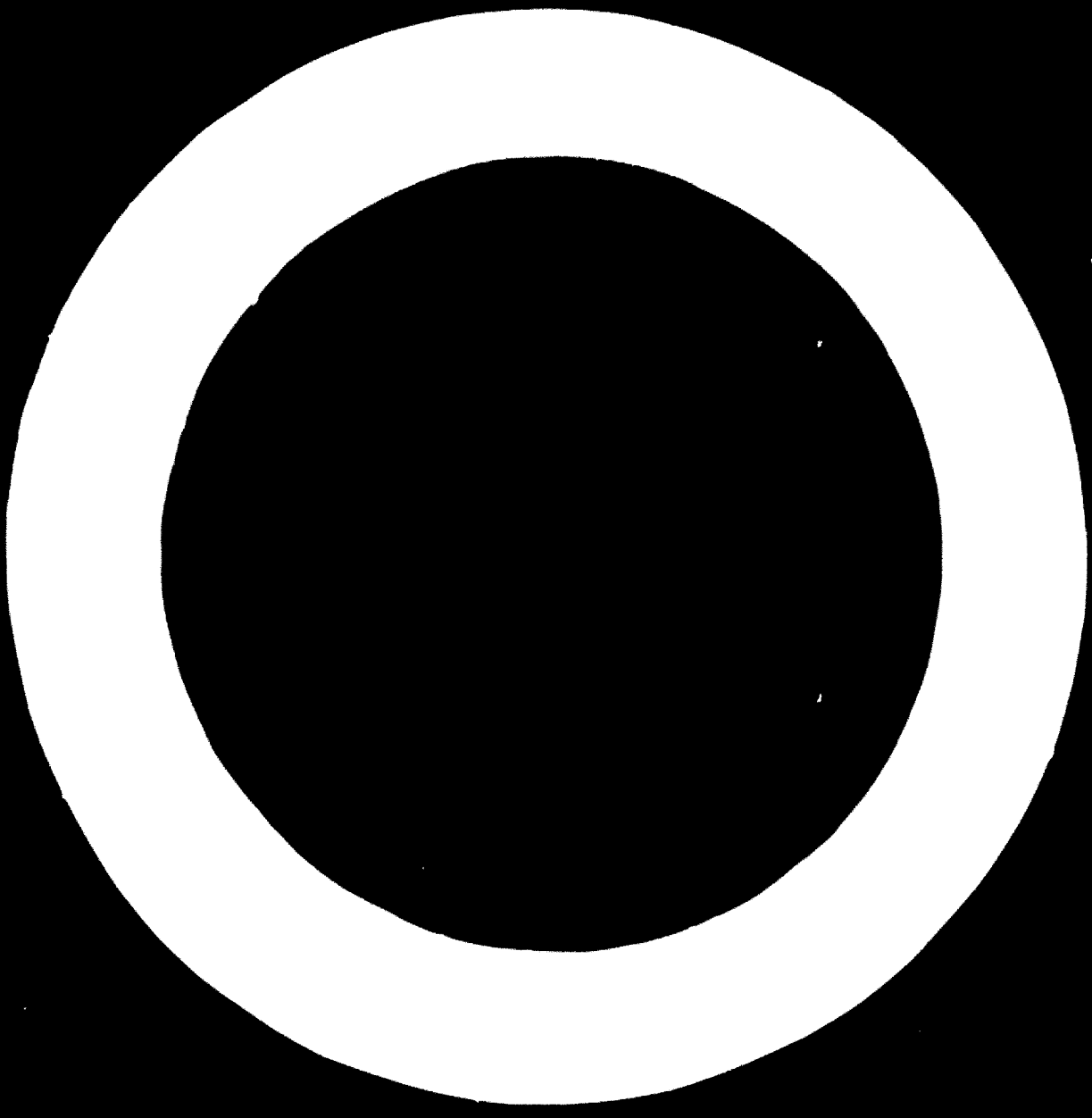
65-14427



CONTENTS

CONTENTS (cont'd.)

APPENDICES



INTRODUCTION

1. The Inter-Regional Seminar on the Production of Fertilizers was organized by the United Nations in co operation with the Government of the Ukrainian SSR, which acted as host country. The Seminar was held in Kiev, the capital of the Ukrainian SSR from 24 August to 11 September 1965.

2. Mr. P. A. Rozenko, Deputy Chairman of the Council of Ministers of the Ukrainian SSR represented the Ukrainian Government, and the United Nations was represented by Mr. N. K. Grigoriev, Director, Technological Division, and Mr. M. C. Verghese, Inter-Regional Adviser, Centre for Industrial Development. Mr. M. A. Shumayev represented the USSR State Committee for External Economic Relations.

3. Mr. V. Pelykh of the Ukrainian SSR was co-Director and Mr. M. C. Verghese was the Technical Director of the Seminar.

4. There were 2) participants from 17 developing countries and 15 from the Ukrainian SSR and the USSR, 10 United Nations experts and 7 United Nations industry lecturers. Also, there were 3 participants from FAO and one from each of 3 regional economic commissions: ECA, ECAFE and ECLA.

The geographical distribution of participants was as follows:

Region	No. Countries	No. Participants
Africa	4	6
Asia	3	5
Middle East	4	7
Latin America	5	8
Europe (USSR, Ukrainian SSR, Rumania)	3	18

The complete list of participants is given in Appendix I.

5. English, French, Spanish and Russian were the official working languages of the Seminar, and the linguistic distribution of participants was:

English 38
French 2
Spanish 9
Russian 18

Some of the participants were fluent in many languages and operated in more than one of the official languages.

6. The inaugural session was opened by Mr. N K. Grigoriev, who extended warm thanks to the Ukrainian Government for inviting the Seminar to meet in Kiev. Mr. P. A Rozenko, Deputy Chairman of the Council of Ministers of the Ukrainian SSR, presented a message of welcome from his Government and proposed to proceed to the election of the Chairman of the Seminar. The delegates elected Mr. Rozenko Chairman. Mr. M. C. Verghese read a message from Dr. Victor Hoo, Commissioner for Technical Assistance of the United Nations on behalf of the Secretary-General. Mr. Grigoriev read a message from Mr. I. H. Abdel-Rahman, Commissioner for the Centre for Industrial Development. Mr. Shumayev made a statement welcoming the participants on behalf of the Government of the USSR.

The Chairman proposed the adoption of the agenda which was accepted unanimously.

Mr. Rozenko informed the participants of the Seminar that because of his other pressing obligations he would be unable to act during the entire Seminar as Chairman and Mr. Grigoriev accepted the working chairmanship.

7. The Committee to draw up the proceedings of the Seminar consisted of the following members:

Mr. V. Pelykh	Ukrainian SSR
Mr. A. S. Bayram	Turkey
Mr. V N. Kasturirangan	India
Mr. E. Ojurongbe	Nigeria
Mr. G. Gaytan Cardenas	Mexico
Mr. E. Forero Fonseca	Colombia
Mr. Alemeyahu Maknonnen	ECA
Mr. R. Petitpas	ECLA
Mr. Tin Nyunt	ECAFE
Mr. F. W. Parker	United Nations Expert
Mr. M. Taha Zaki	United Nations Expert
Mr. R. Ewell	United Nations Expert
Mr. S. Kimura	United Nations Expert
Mr. D. J. Borgars	United Nations Expert
Mr. A. P. Oele	United Nations Expert
Mr. S. K. Mukherjee	United Nations Expert
Mr. D. N. Daruvalla	United Nations Expert
Mr. R. S. Ray	United Nations Expert
Mr. O. Ruhl	United Nations Expert
Mr. M. C. Verghese	United Nations

8. The Seminar at its concluding session on the 11th of September welcomed Mr. I. H. Abdel-Rahman, Commissioner of the Centre for Industrial Development of the United Nations. He addressed the participants and once again thanked the authorities of the Ukrainian SSR for organizing and conducting the Seminar. He explained the present and future programmes of work of the Centre for Industrial Development.

After some discussions, the Seminar unanimously adopted the present report and the recommendations and conclusions reached.

Mr. P. A. Rozenko addressed the concluding session. Participants from four developing countries and Mr. M. A. Shumayev on behalf of the USSR expressed appreciation of the proceedings of the Seminar. The Seminar came to a close with a statement from Mr. N. K. Grigoriev expressing heartfelt thanks for the efforts of the host country in making the Seminar an outstanding success. He praised the work of all participants, the representatives of the Economic Commission and the Food and Agriculture Organization, the interpreters, the translators and all other officers of the Seminar, as well as United Nations experts and United Nations industry lecturers.

I. WORLD PRODUCTION, CONSUMPTION AND INTERNATIONAL TRADE IN FERTILIZERS

9. Production and consumption World production and consumption of fertilizers have increased rapidly in the last 20 years, particularly during the last 10 years. This is shown by the following data on consumption (in million tonnes):

	Nitrogen	P_2O_5	K_2O	Total
1945/1946	2.0	3.[illegible]	2.1	7.5
1954/1955	6.3	7.9	6.3	20.5
1963/1964	15.3	12.9	10.8	39.0

The 1963/1964 data include estimates for Mainland China, North Korea and North Viet Nam. Production of fertilizer has increased approximately at the same rates, totalling about 40 million tonnes in 1963/1964.

The largest producing and consuming areas are Western Europe, Eastern Europe, USSR and the United States/Canada. These areas all produce surpluses of fertilizers which are exported. The fertilizer-deficit areas are Asia, Africa, and Latin America. Japan and Oceania are approximately balanced in total plant nutrients.

These facts are illustrated by the following data for 1963/1964 (in million tonnes of total plant nutrients):

	Production	Consumption	Surplus (Deficit)
Western Europe	13.8	12.1	1.7
Eastern Europe	4.1	3.8	0.3
USSR	5.2*	4.2*	1.0*
USA/Canada	11.0	10.1	0.9
Japan	1.8	1.8	-
Asia (except Japan)	1.8	3.8	(2.0)
Africa	0.5	0.8	(0.3)
Latin America	0 7	1.2	(0.5)
Oceania	1.1	1.2	(0.1)
Total	40 0	39.0	1.0

However, in nitrogen alone the picture is somewhat different. Japan is a large exporter of nitrogen but a large importer of potash, and these two exchanges approximately balance. Likewise Eastern Europe imports nitrogen and phosphate fertilizer, but East Germany (G.D.R) is a large exporter of potash, giving an over-all surplus in total nutrients.

Particular note was taken of the rapid increase in fertilizer production and consumption in the USSR during the past few years. Since 1962 fertilizer production has been increasing at rates of 20 - 30 per cent per year. If present growth rates continue it seems likely that the USSR and the United States production will be about the same in 1970 at around 18 million tonnes each.

10. International trade Total inter-regional exports and imports of nitrogen are about 2 million tonnes per year with a value of approximately $400 million. The largest exporters of nitrogen in order of size are

---

* Includes ground phosphorite

Japan, West Germany, Italy, USSR and Norway. The largest importers of nitrogen are in order of size Mainland China, India, Spain, Republic of Korea and Denmark. Among the countries represented at the Seminar, Japan and Rumania indicated their intention of expanding their nitrogen industry for export. Chile will continue to be the major exporter of sodium nitrate.

Inter-regional exports and imports of phosphate fertilizer are much less than nitrogen amounting to about 700,000 tonnes of P_2O_5 per year with a value of approximately $100 million. The largest exporters are the United States, Western Europe and the USSR, and the largest importing regions are Asia, Latin America and Eastern Europe.

Potash is produced largely by the United States, West Germany (F.R.G.), East Germany (G.D.R.), France and the USSR and is exported by these countries to most of the other countries in the world. Canada is growing very rapidly as an exporter of potash and seems likely to become the largest exporter in a few years. Israel is a small but growing exporter of potash.

11. Relative growth rates and N-P-K ratios

Nitrogen production and consumption is growing much faster than phosphates or potash fertilizer. In the 9-year period 1954/1955 to 1963/1964, nitrogen increased at an average rate of 8.9 per cent while phosphate and potash both increased at rates of 5.5 per cent per year.

Therefore the worldwide $N/P_2O_5/K_2O$ ratio increased from 1/1.16/0.96 in 1954/1955 to 1/0.87/0.73 in 1963/1964. If present trends continue the ratio in 1974/1975 will be 1/0.61/0.53.

12. Projections of future fertilizer production/consumption

Several papers presented projections of the production and consumption of fertilizer in 1969/1970 and 1974/1975. If the growth trends cited in the last paragraph continue, future production and consumption would be as follows (in million tonnes):

	1969/1970	1974/1975
Nitrogen	23.0	36.0
P_2O_5	17.0	22.0
K_2O	14.5	19.0
Total	54.5	77.0

Projections made using other more sophisticated methods gave figures very close to these.

13. Consumption per person and per hectare

There are extremely wide variations in the consumption of fertilizers per person and per hectare in the various regions and countries of the world. The following data illustrate the vast difference in consumption of fertilizer by the developed areas and the developing areas (for 1962/1963):

	Total nutrients, kg./yr.	
	Kg. per person	Kg. per hectare
Oceania	56	28
USA/Canada	45	40
Western Europe	36	117
Eastern Europe	29	61
Japan	18	275
USSR	20*	20*
Latin America	5.0	11
Africa	2.9	3
Asia (except Japan)	1.8	5
Average	14	25

The low consumption of fertilisers per person and per hectare in Asia, Africa and Latin America is clearly correlated with the low nutritional level and the slow rate of agricultural and economic development in these continents.

* Includes ground phosphorite

II. PRODUCTION AND CONSUMPTION OF FERTILIZERS IN THE ECAFE, ECA AND ECLA REGIONS AND IN OTHER COUNTRIES REPRESENTED AT THE SEMINAR

14. Papers were presented from ECAFE, ECA and ECLA on the current status and future plans for development of production and consumption of fertilizers.

The ECAFE region, despite plans and efforts for domestic production will continue to import fertilizers for the foreseeable future. It was noted that ammonium nitrate production is planned only in Australia and Afghanistan because the rest of the region is primarily rice-paddy growing and nitrate fertilizers are not suitable for irrigated rice-paddy cultivation.

In the ECA region both consumption and production are small. Governments are expected to play an active role in developing the extensive use of fertilizers. Where raw materials, fuel and electric power are available a number of fertilizer projects have been proposed. These would enlarge production and consumption and promote economic co-operation within the region.

The demand for fertilizer consumption in the ECLA region is expected to be stimulated by intensifying technological research and application and by improved marketing and transport facilities. Larger production than at present is possible in view of the quantities of raw materials now available. Studies have been started to determine the siting of proposed fertilizer factories.

15. With regard to developing countries building fertilizer plants the Seminar considered that each case has to be decided on its merits. The desirability of a regional approach in building fertilizer projects was emphasized in order to take advantage of modern technology and large size plants.

16. Considerable concern was expressed by developing countries regarding sulphur and phosphate rock availability and it was concluded that exploration for deposit of these raw materials should be accelerated in developing countries.

17. Papers were presented from Ceylon, India and Japan from ECAFE region; Nigeria from ECA region; Argentina, Colombia, Chile, Mexico and Peru from ECLA region. Papers were also presented from Israel, Rumania, Turkey, USSR and the Ukrainian SSR.

18. ECAFE Region

Ceylon The imports for 1965 are estimated to be 38,000 tonnes N as ammonium sulphate, 2,800 tonnes N as urea, 70,000 tonnes of phosphate rock 6,000 tonnes of muriate of potash and 24,000 tonnes of other fertilizers. A fertilizer project to manufacture 59,000 tonnes N as urea and ammonium sulphate is being considered.

India The production in 1963/1964 was 219,000 tonnes N and 108,000 tonnes P_2O_5. Projects currently under construction and plants already approved will increase the total capacity to 2.2 million tonnes N and nearly 1.0 million tonnes P_2O_5 by 1970/1971. Naphtha will be used in the new plants to produce ammonia and the fertilizers would be predominantly urea and ammonium phosphate. In 1963/1964, fertilizers distributed in India contained 442,000 tonnes of N, 121,000 tonnes of P_2O_5 and 52,000 tonnes of K_2O.

Japan The production of N in 1963 was 1.3 million tonnes while that of P_2O_5 was 558,000 tonnes. The estimated production in 1967 is 2.4 million tonnes of N. New ammonia plants are proposed with a minimum capacity of 500 tonnes per day in a single stream. The proportion of ammonium sulphate in the total production is declining while the proportions

of urea and ammonium phosphate are increasing. In 1965, multinutrient fertilizers accounted for 55 per cent of the total consumption of nitrogen fertilizers. The Japanese fertilizer industry is characterized by its large percentage of export. Almost half its production of nitrogen fertilizers is exported. In 1967 it is estimated that exports would total about 1.7 million tonnes of nitrogen.

19. ECA Region

Nigeria There is no fertilizer manufactured at present although natural gas is available in large quantities. Efforts are being made to popularize the use of fertilizers among the farmers in order that consumption will reach a level sufficient to sustain a fertilizer plant of economic size. In this connection the FAO (Freedom from Hunger Campaign) Fertilizer Scheme has been of great help. Consumption in 1964 was 16,300 tonnes of materials in all types of fertilizers.

20. ECLA Region

Argentina The production in 1965 is estimated to be about 4,000 tonnes of N as by-product ammonium sulphate. Plans are being prepared for the building of two ammonia plants of 100,000 tonnes and 55,000 tonnes annual production capacities. These will use natural gas. The consumption in 1963/1964 was 22,000 tonnes of N, 6,700 tonnes of P_2O_5 and 5,000 tonnes of K_2O.

Chile In 1963, the production of nitrogenous fertilizers was all natural Chilean nitrate equivalent to 170,000 tonnes of N. The consumption in 1963 was 27,300 tonnes of N, 77,000 tonnes of P_2O_5 and 12,000 tonnes of K_2O. The nitrogen consumption was about 14 per cent of the production, the balance being exported. In the future, production of natural nitrates will not be increased. Plans are on hand to manufacture ammonia, urea and ammonium nitrate from natural gas. Phosphate

will also be produced as triple superphosphate at the rate of 50,000 tonnes per year and fused calcium-phosphate at 12,000 tonnes per year.

Colombia There are two ammonia plants in operation. In 1964 production was 33,450 tonnes of N, and 5,700 tonnes of P_2O_5. The consumption in 1964 was 32,000 tonnes of N, 50,000 tonnes of P_2O_5 and 29,200 tonnes of K_2O Plans are under way to increase production of nitrogenous fertilizers not only for domestic needs but also to offer the surplus to the regional market.

Mexico The production in 1964 was 99,700 tonnes of N, and 63,600 tonnes of P_2O_5. Consumption in that year was 240,000 tonnes of N, 68,000 tonnes of P_2O_5 and 24,400 tonnes of K_2O. It is estimated that by 1970 the production will reach 550,000 tonnes of N and 116,900 tonnes of P_2O_5 while the consumption would increase to 645,000 tonnes of N, 164,900 tonnes of P_2O_5 and 43,600 tonnes of K_2O

Peru The production in 1965 is estimated to be 62,400 tonnes of N, 36,400 tonnes of P_2O_5 and 4,400 tonnes of K_2O while the consumption is estimated to be 191,000 tonnes of N, 110,000 tonnes of P_2O_5 and 50,000 tonnes of K_2O. Peru's requirements are augmented by the use of natural fertilizers namely guano, while plans have been made to produce 50,000 tonnes of N and 200,000 tonnes of complex fertilizers.

21. Other country papers

Israel Israel produces all its domestic fertilizer needs which in 1963/1964 were 22,400 tonnes of N, 11,000 tonnes of P_2O_5 and 2,600 tonnes of K_2O. Consumption in 1969/1970 is estimated to be 25,000 tonnes of N, 12,500 tonnes of P_2O_5 and 4,000 tonnes of K_2O. While a small quantity of urea is imported for aerial application, Israel exported 210,000 tonnes

of phosphate rock and 280,000 tonnes of potash in addition to 2,000 tonnes of P_2O_5 and 5,000 tonnes of K_2O in processed fertilizers. The estimated exports in 1969/1970 are 900 000 tonnes each of phosphate rock and potash, and 200,000 tonnes of P_2O_5 and 100,000 tonnes of K_2O in processed fertilizers.

Rumania The production of fertilizers in 1965 is estimated to be 197,000 tonnes of N and 132,000 tonnes of P_2O_5. The production planned to 1970 is 1.05 million tonnes of N and 275,000 tonnes of P_2O_5. The nitrogen fertilizer industry is based mainly on the use of natural gas as raw material.

Turkey The production of fertilizers in 1964 amounted to 32,000 tonnes of N and 28,400 tonnes of P_2O_5 and consumption was 54,200 tonnes of N and 47 700 tonnes of P_2O_5. By 1969 production is expected to increase to 112,400 tonnes N. and 90,000 tonnes of P_2O_5 by the addition of two new plants. Estimated consumption in 1969 is 136,500 tonnes of N, 139,000 tonnes of P_2O_5 and 22,500 tonnes of K_2O.

USSR The USSR has been the second largest producer of fertilizer since 1963 when the USSR first surpassed West Germany. The USSR fertilizer production grew at rates of 5 - 10 per cent per year during the period 1950-1960, but since 1960 it has been growing at an increasingly rapid pace, in fact increasing to a rate of 25 - 30 per cent in the 1963/1965 period. Present plans call for an increase from 7.8 million tonnes of plant nutrients in 1965 to 19.0 million tonnes in 1970. This would correspond to an average annual increase of 20 per cent per year. About 10 per cent of the USSR production of fertilizer is in the form of ground phosphate rock (phosphorite). The USSR is the only country which uses ground phosphorite in large quantities since on several soils in

USSR ground phosphorite gives almost the same increase in yield as water-soluble P_2O_5.

There were 15 synthetic nitrogen plants operating in 1964 in the USSR which produced 2.1 million tonnes of fertilizer nitrogen in 1964 and ten are under construction. The principal nitrogen fertilizers produced in the USSR are ammonium nitrate, ammonium sulphate and urea. The changing pattern of production is shown by these data (in per cent):

	1958	1964	1970 (plan)
Ammonium nitrate	74.4	64.0	44.4
Ammonium sulphate	21.7	12.9	10.2
Urea	1.0	13.5	28.6
Liquid fertilizer	0.2	6.7	7.6
Compound fertilizer	-	1.5	7.3
Others	2.7	1.4	1.7

Ammonium sulphate is produced entirely from ammonia recovered from coke oven gas or as by-product of caprolactam production. Liquid fertilizers, principally anhydrous ammonia and aqua ammonia, are developing rapidly. Mixed fertilizers of all types are only 1 - 2 per cent of production.

Until 1960 the principal raw material for production of nitrogen fertilizer was coal but the industry is now shifting rapidly to natural gas. Coke-oven gas will continue to be important; however, no liquid feedstocks, such as naphtha, are used.

In 1964 phosphate fertilizer production was 1.4 million tonnes P_2O_5 with an additional 0.65 million tonnes P_2O_5 in ground phosphorite.

The principal phosphate fertilizer produced is single superphosphate, but double superphosphate and compound fertilizer are becoming more important. The changing pattern of production is shown by these data (in per cent):

	1958	1965	1970 (plan)
Single superphosphate	96.6	86.5	39.0
Double superphosphate	—	6.1	36.0
Compound fertilizer	—	2.5	20.0
Phosphate slags	3.4	2.7	1.0
Others	—	2.2	4.0

Compound fertilizers will be principally ammonium phosphates.

Potash fertilizers produced in 1964 totalled 1.9 million tonnes K_2O. The principal potash fertilizer is potassium chloride (40 per cent) and the remainder is made up of various mixed salts, silvinite, kainite and a small amount of potassium sulphate.

Ukrainian SSR The pattern of production of fertilizer in the Ukrainian SSR is similar to that of the USSR. In fact, the Ukrainian SSR is one of the main centres of the USSR fertilizer industry. The Ukrainian SSR in 1958 produced 27 per cent of all fertilizers in the USSR and according to plans this will increase to over 30 per cent by 1970.

III. TECHNOLOGY OF PRODUCTION OF AMMONIA

22. Ammonia is the principal starting material in the production of nitrogen fertilizers. The technology and economics of ammonia plant design and operation were reviewed in detail with special reference to recently developed processes and to the basic process steps.

Developments of the past five years in the technology of ammonia production from natural gas or petroleum naphtha have given a new dimension in size. Very large single-stream plants, with great potential for reduced unit cost, are now a reality and should be considered for situations where the market is large enough.

The principal changes in technology of the past five years can be summarized as follows:

a) High pressure steam reforming of both natural gas and light naphtha at outlet pressures up to 32 atmospheres (absolute) coupled with catalytic partial oxidation of the remaining methane with air in a secondary reformer. Still higher pressures are being planned.

b) Improved gas purification processes and catalysts during the last four years, particularly reforming catalyst, for use with naphtha feed. The low temperature shift catalyst is operated without inter-stage carbon dioxide removal. This catalyst has been in successful commercial use for more than two and one-half years.

c) Use of high capacity centrifugal compressors for synthesis gas compression up to 200 atmospheres.

d) Methanation (conversion of carbon oxides into methane) at pressures of 20 - 30 atmospheres to carbon oxide contents of less than 5 PPM in the synthesis gas.

e) More efficient carbon dioxide removal systems at the higher process pressure levels are now operating.

f) Complete redesign of the heat recovery and steam generation systems. This has led to the development of plants with steam drives for all major uses requiring little or no external source of power or steam.

g) Large scale, low cost, ammonia transport in bulk and lower-cost auto-refrigerated storage techniques.

23. Large single stream ammonia plants are now being built with 550 to 900 tonnes per day capacity and 1,350 tonnes per day plants are being evaluated. The use of centrifugal synthesis gas compressors is considered economic only when plant capacities in single stream are more than 550 tonnes of ammonia per day. Smaller plants would continue to use reciprocating synthesis gas compressors.

24. Closer zone-temperature control in the new high pressure reformer furnaces, improved alloy steels, and use of high heat flux densities to the tubes at high temperature levels have been significant developments. Even more severe operating conditions can be anticipated as new alloys are developed.

25. Economic calculations show that a 550 tonnes per day plant with centrifugal compressors operated at about 360 tonnes per day rate will produce ammonia at roughly the same cost as a conventional 360 tonnes per day plant operating at full capacity. From the point of view of investment costs, a 550 tonnes per day plant utilizing the centrifugal compressor concept would cost about the same as a 400 tonnes per day conventional ammonia plant with reciprocating compressors.

26. The new development in large ocean-going ammonia tankers and high capacity atmospheric pressure ammonia storage may help in making low-cost ammonia available for developing countries. Examples of costs for sea transport of ammonia in a 9,000 tonnes tanker vary from $4.50 for 1,700 miles to $22.00 for 9,000 miles and depend on specific contract terms.

27. Four single stream units with a capacity of more than 550 tonnes of ammonia per day are now in operation (American Oil - Texas, USA; W.R. Grace - Trinidad; Monsanto - Luling, Louisiana, USA; ICI - Severnside, England). At least 25 new single stream plants with the same or larger capacities are under construction.

28. In the USSR the application of steam reforming under pressure is in an early stage of development. Reformer tubes made of centrifugally cast high-nickel alloy will be used.

29. Several of the new ammonia plants now being built in the USSR will undergo a design change to utilize pressure steam reforming to replace catalytic partial oxidation of natural gas with oxygen.

IV. TECHNOLOGY OF PRODUCTION OF NITROGEN FERTILIZERS

30. There have been significant technical improvements in the production of nitric acid. As in ammonia production, increased size is a major factor in reducing costs. Larger, single stream plants are being built utilizing the new technology with emphasis on an optimum utility balance. A plant for production of 630 tonnes of nitric acid (100 per cent basis) per day in one stream is being built.

In the high pressure (up to 8 atmospheres) process for ammonia oxidation to nitrogen oxides over a platinum-rhodium catalyst, ammonia efficiency is lower and catalyst losses are comparatively high, but special techniques are available to reduce this loss appreciably.

Urea

31. Papers were presented on the development of the urea industry. Urea processes have improved greatly during the past decade and more particularly during the last two years. The product qualities are now excellent allowing world-wide shipping, handling and storage without noticeable deterioration. Urea with low biuret content is now available to suit requirements. The various processes have been proved in plants up to 300 tonnes per day capacity and new single stream plants of 500 to 1,000 tonnes per day capacity are under construction. Single stream plants of 1,350 tonnes per day are under consideration. Efficient heat interchange techniques are being utilized to obtain higher thermal efficiencies and to reduce steam consumption.

The upper limit for biuret content in urea for fertilizer use in Japan is officially set at 2.5 per cent; however, in actual trade practice the biuret usually is between 0.5 and 1.5 per cent. Experimental work in the USA showed no significant difference in the use

of urea fertiliser on crops with biuret varying from 0.3 to 1.5 per cent (no bad effect up to 2.5 per cent).

A recent development in Japan is the use of nearly pure titanium metal liners of about 3 mm thickness in urea reactors. With the current lower titanium metal prices in Japan, these new reactors are approximately equal in cost to those previously made with stainless steel liners of 10 to 13 mm thickness.

The discussion on urea technology indicated that there may be no economic advantage in increasing urea synthesis pressure above 200 atmospheres. The choice of the correct urea process, i.e. (1) once through, (2) partial recycle, or (3) total recycle, will depend on the need in each specific case and no general recommendation could be made.

New urea processes were briefly discussed one process utilizing hot gas recycle and large centrifugal compressors called "Thermo-Urea Process" has been patented, the other, a medium pressure urea synthesis (150 atmospheres pressure) with first stage dissociation of carbamate at synthesis pressure and CO_2 and NH_3 recycled to the reactor, and only the carbamate solution from second stage dissociation at 4 atmospheres being recycled to the reactor, has been developed. It is in pilot plant stage in Holland and a commercial unit is being built. This process looks favourable for producing urea with lower operating costs.

Utilization of by-product gypsum for production of ammonium sulphate

32. In India, utilization of by-product gypsum (from wet process phosphoric acid production) has been developed and is in commercial operation for manufacturing high quality ammonium sulphate.

The by-product from this process, calcium carbonate, can be utilized in the manufacture of cement which is also important in a developing country and it is being utilized for this purpose.

Ammonium chloride fertilizer - use of dual-process

33. The use of ammonium chloride as a fertilizer for paddy has been successfully practiced in Japan and India. The prospects of adopting a dual soda-ash (sodium carbonate) - ammonium chloride process in this connection merits consideration.

34. In comparing the cost for distribution and application of fertilizer solutions with the cost for the evaporation, granulation and distribution of solid fertilizer it was concluded that each case should be considered on its merits. The application of liquid anhydrous ammonia by injection in the soil is the most economic way of utilization of nitrogen fertilizers in liquid form. Multicomponent solutions are, generally speaking, no cheaper in distribution and application than the solid compound fertilizers. In-between are the nitrogen solutions, containing ammonia, ammonium carbonate and urea, which have some promise for future successful application.

V. TECHNOLOGY OF PRODUCTION OF PHOSPHATE FERTILIZERS

35. The process economics for the production of wet process phosphoric acid up to 54 per cent P_2O_5 was discussed. It was noted that large plants with capacities up to 550 tonnes per day P_2O_5 are being built.

36. Production of electrothermal phosphorus for phosphoric acid production (furnace acid) might be considered for locations where large quantities of cheap hydroelectric power are available, and sulphur costs are either high or sulphur is not available.

37. Development in Israel of a hydrochloric acid process utilizing solvent extraction for the production of relatively clear phosphoric acid evoked much interest.

38. Processes for the concentration of phosphoric acid to superphosphoric (polyphosphoric) acid up to 72 - 85 per cent P_2O_5 have now been developed and production capacity in the USA of superphosphoric acid has already reached 1,000 - 1,200 tonnes P_2O_5 per day. Plans for the installation of a number of new plants are now in an advanced stage. The higher concentration super-phosphoric acid is relatively non-corrosive and could be shipped in ordinary mild steel tanks. Rubber-lined ocean-going tankers are being considered for overseas shipment of 54 to 64 per cent (P_2O_5) phosphoric acid and higher.

39. Great emphasis was laid on production of concentrated superphosphates for which the technology is well established.

40. Phosphorite meal (ground phosphorite rock) is extensively used

in the USSR for acid soils. Such phosphorite meal, however, is different from ground apatite. The phosphorite structure is such that it breaks up in acid soils making phosphates available for plant nutrition whereas the crystal structure of apatite cannot be disintegrated even in highly acidic soils and even when finely ground.

VI. TECHNOLOGY OF PRODUCTION OF POTASH FERTILIZERS

41. High-grade potassium chloride up to 61.5 per cent K_2O is now being successfully produced.

42. New development in Israel on the production of potassium nitrate (14-0-44) with potassium chloride and nitric acid in the presence of a solvent at normal temperature and pressure is of significant importance.

43. Two other developments were also reported for production of high analysis potassium metaphosphate and potassium magnesium phosphate.

44. Solution mining of potash has been developed recently and facilities are now in operation in Canada.

VII. TECHNOLOGY OF PRODUCTION OF COMPLEX AND MIXED FERTILIZERS

45. A review of the technology of the production of complex nitrophosphate fertilizers and of the production of mixed fertilizers from solid mono- and di-nutrient component fertilizers lead to questions on the relative economics of these alternative process routes. When producing for a large area with a high consumption, the large scale production of compound granulated fertilizers is more economical. However, there is scope for smaller fertilizer mixing plants for the introduction of multinutrient fertilizers in developing areas.

46. For the production of diammonium phosphate the use of wet process acid may be more economical in most locations than acid from elemental phosphorus depending on many factors. India plans to expand its diammonium phosphate production as an intermediate for production of high analysis granular fertilizers of N:P:K ratio of 1-1-0, 1-1-1 etc., from its present 150,000 tonnes capacity to 900,000 tonnes per year in 1971.

47. Concentrated N-P fertilizers can be produced by mixing and granulating diammonium phosphate with either urea or ammonium nitrate. The mixture could contain 25 per cent of nitrogen and 25 per cent of P_2O_5 or even higher.

48. Generally speaking ammonium phosphates and ammonium polyphosphates are suitable for practically all soils and crops.

49. Nitrophosphates generally have 30 - 50 per cent of the phosphates in water soluble form (although there are nitrophosphates where the water-soluble P_2O_5 is nil) and 40 - 50 per cent of the

nitrogen in the nitrate (NO_3) form. As nitrate nitrogen is unsuitable for paddy, and a large degree of water-soluble phosphates is either essential for many soils or crops, or at least desirable, the nitrophosphates would have only restricted application. Any decision to manufacture nitrophosphates must, therefore, be taken only on the basis of reliable agronomic data for the soils and crops for which the nitrophosphate fertilizer is intended to be used. Generally speaking, however, nitrophosphates containing at least 50 per cent water-soluble P_2O_5 are suitable, except for paddy rice.

50. The investment cost for the production of nitrophosphates would be generally higher than ammonium phosphates. The operating costs would depend on the particular conditions of the cost of ammonia, the cost and availability of sulphur, etc.

51. Successful granulation leading to a non-caking product is still an art. As a new technique for granulation, air prilling has found widespread application in continuous processes and pan granulation can now be applied for small batches of products. Production of suitable granules with low moisture content, proper bagging and rapid despatch is still a better way to prevent caking than coating with inert water repellent material unless otherwise warranted.

VIII. RAW MATERIALS AND INTERMEDIATES FOR FERTILIZER PRODUCTION

52. In the production of nitrogenous fertilizers the pattern of raw materials utilization has changed over from solid fuels to the gaseous and liquid forms such as natural gas, naphtha, and heavy oils. In locations where bulk low cost electrical energy is available this electrolytic hydrogen for ammonia synthesis may be favourably considered.

The trend in the industry is large scale production of liquid ammonia and its transport in tankers as an intermediate for the manufacture of solid fertilizers.

53. Raw materials for phosphatic fertilizers are phosphate rock and sulphur for the wet process. It is estimated that by 1970 consumption requirements of phosphate rock will be of the order of 80 million tonnes per year whilst rock production will be in the order of 80 - 90 million tonnes. Shortages of sulphur and consequent increases in its prices may prove to be the limiting factor in the manufacture of phosphatic fertilizers.

54. Efforts must be made to increase the production of sulphur in all possible ways. Simultaneously studies should be made to explore other processes using nitric acid and hydrochloric acid.

55. Elemental phosphorus and furnace type phosphoric acid could constitute another source for production of P_2O_5 where low cost electrical power and plentiful and suitable rock phosphate are available.

56. There is a current trend to lower transport costs by shipping phosphoric acid (50 - 70 per cent P_2O_5) in large quantities instead of phosphate rock and sulphur.

IX. PLANNING LOCATION, ORGANIZATION AND ECONOMICS OF FERTILIZER PRODUCTION

57. The creation and development of the fertilizer industry is all the more important in developing countries since in reality fertilizer means food and therefore it is an economical and political necessity. Furthermore, it is a direct and valuable contribution to the solution of the world food problem.

58. The creation and development of this industry in developing countries involves a great economic effort on the part of these countries necessitating mobilisation of their capital resources to meet the heavy financial demands involved. The important role of public enterprise operating under the principle of "production to satisfy needs" and backed by total planning is essential to carry out this task.

59. It is evident that developing countries are seriously handicapped by the lack of capital, at progressive rates and conditions, to augment their efforts in the development of the fertilizer industry. The rate of development of this industry in developing countries is consequently very slow.

60. The planning and organisation for the creation and development of a fertilizer industry must be based on techno-economic studies and evaluations of present and future local requirements of fertilizers as well as the natural resources available for the development of the industry. It is also advisable to take into consideration the regional requirements with a view to establishing modern large units technically of fertilizer production.

61. Developing countries are usually faced with the serious problem

of lack of trained efficient labour in sufficient numbers to meet the requirements of industrial development. This problem unless properly handled could be a serious limiting factor in this objective. Therefore, it is to be strongly recommended that developing countries should undertake, in line and in time with technical and economic plans for the development of the industry, parallel plans for the creation of the required working force of technicians and operators of the different skills for the construction, operation and maintenance of the fertilizer plants.

62. It is acknowledged that, at the start, the primary activities of developing countries in this industry are in the field of [illegible]-duction and maintenance . However, for the progressive development of the fertilizer industry in these countries it is necessary to stress the importance of research and development work both in the field of equipment and processes as well as in the directions of types, quality, and form of product and applications best suited to attain economic results.

63. The choice of the location of the industry is of special importance since it implies the creation of new economic activity which in turn involves interrelations with other economic activities and generates new social activities and problems. Therefore the choice of the location must be made on the basis of careful, scientific studies covering the availability of natural resources, transportation, communication, general services, availabilities of efficient trained labour, social and cultural services, locational effects of other existing economic activities and in certain cases, political conditions. The criteria vary from one country to another according to the conditions in each country.

64. In reviewing the relative merits of local production versus im-

portation of fertilizers, the possibility of regional co-operation in planning fertiliser factories was recognized. The encouragement of such co-operation is mainly the task of the Regional Economic Commissions of the United Nations.

65. The economics and organizational aspects of the planning of large fertiliser projects in the USSR were discussed with particular reference to the latest developments and rapidly changing technology in this field.

A. IMPLEMENTATION, MAINTENANCE AND SAFETY IN CHEMICAL PLANTS

66. To meet the expanding world demand for fertilizers at reduced costs, the fertilizer industry had to increase both in magnitude, in scope and in efficiency.

67. This increase in operating efficiency and technique has been obtained by the extensive use of automatic control instruments and systems, which enable plants to operate at or near maximum efficiency continuously. In certain cases automatic control made possible commercial operation of processes which would have been impracticable on manual operator control.

68. Developments in the field of computers indicate that in the future higher efficiencies may be obtained by complete computer control of the plant.

69. The necessity for well-organized maintenance work is fully acknowledged with emphasis on preventive maintenance. In the Ukrainian SSR a distinction is made between ordinary preventive maintenance, overhaul and basic repair work. Labour expenditures of these different types of maintenance are estimated to be 5 - 10 per cent, 30 - 50 per cent and 40 - 65 per cent respectively of the total maintenance value.

70. The prevailing regulations and methods of implementation for safe plant operation and maintenance and other working conditions for chemical plants were discussed with special reference to the fertilizer [illegible] and the USSR. It is acknowledged that [illegible] regulations lead to considerable reduction [illegible] from accidents.

XI. MANUFACTURE OF FERTILIZER PLANT EQUIPMENT

71. The need for developing countries to start the design, engineering, fabrication and construction of their own fertilizer plants was recognized.

72. India's experience in the construction of the Rourkela nitric acid and nitrolimestone plants (120,000 tonnes N/year), and other superphosphate/sulphuric acid plants was taken as a case history for the maximum utilization of locally produced equipment, machinery and other services.

73. Similar efforts are recommended to other developing countries in order to enable them to achieve self-sufficiency in the development of their fertilizer industry.

XII. TRAINING OF FERTILIZER PLANT PERSONNEL

74. In the USSR and the Ukrainian S.S.R considerable emphasis is given to the higher educational training and continuing education of workers employed in the chemical industry. Usually they join the industry after finishing secondary education at the age of seventeen. Education in the USSR is free of charge at all levels.

75. Developing and improving the professional skill of personnel employed in the chemical industry is accomplished through higher schools, technical schools and at various training centres catering to different levels of employees. For employees who do not have special technical or higher education this is accomplished by using both individual and group training methods.

76. These courses may be full time study and training, part time release or evening correspondence study and may last from a few months to one year. Higher school training lasts for five to six years. The student enjoying part time release is paid an appropriate wage during the period of examination and working on his diploma papers, or given a compensatory paid holiday, depending upon the type of study undertaken. At all levels the student is examined at the end of his course and provided his work is satisfactory is awarded the appropriate state qualifications.

77. Re-training and refresher courses can continue through the whole of an employee's life at regular five-year intervals.

78. Considerable use is made of the actual operating personnel, engineers, foremen, operators, etc., in training the students in the training centres and on the shop floor.

XIII. [illegible]

79. In developing countries the demand for fertilizers is large, considering their present low [illegible] consumption and their need to use more fertilizers to increase agricultural productivity to promote general economic growth. The actual demand for fertilizers in each country has however, to be assessed taking into account the current agricultural practices, the crop response to fertiliser application, the economics of fertiliser use, etc.

80. The use of fertilisers has been started by farmers in most developing countries only recently. In these countries a product such as fertiliser is not likely to gain general acceptance by merely making the product available to the farmer. An organised educational and marketing programme becomes essential in this context.

81. The marketing programme should aim at making available the right type of fertiliser, at the right time and in a place convenient to be reached by the farmers. Besides attempting purely marketing tasks, the programme should devote its attention to the problem of consumer acceptance and to convincing farmers of the benefits of fertiliser usage.

82. An organized marketing system should therefore include the following:

(a) It should establish a decentralized storage and distribution system. The network should extend to the village level so that no farmer need [illegible] to obtain his fertilizer requirements;

(b) [illegible] farmers either through trade

channels or through independent agencies like co-operative societies or farm banks. Though the manufacturer may not directly provide credit to the farmer he should be able to extend credit to the dealers who could in turn pass it on to the farmers.

(c) An organized and efficient agronomic service unit as part of the selling and servicing organisation is a necessary part of the programme. This agronomic service should be comprehensive and include soil testing facilities, advice on fertilizer application, selection of seeds, use of pesticides, etc.;

(d) Farmer education programmes using all mass communication media techniques such as fertilizer festivals or fairs, exhibitions, films, etc., are essential to the success of the entire marketing programme. In farmer education programmes, field demonstrations are successful means of convincing farmers of the profitability of fertilizer application. Similarly mobile audio visual units could also be used effectively in village level programmes.

83. In planning for new fertilizer factories it is considered necessary before starting production to organize a development programme aimed at preparing the market to take the new product when the factory comes on stream.

84. It can be truly said that in developing countries producing fertiliser is perhaps less of a problem than marketing.

XIV. FERTILIZER AND AGRICULTURE

85. Agricultural production in many countries, particularly the developing countries must increase by a minimum of 4 - 5 per cent per year to keep pace with a population growth of 2 - 3 per cent per year and to ensure a rising standard of living.

86. The use of fertilizers in the developing countries is low and must increase rapidly if agricultural production in these countries is to keep pace with the increase in population and standard of living.

87. Crop production can be increased both by extending the cultivated area and by increasing crop yields per hectare of land cultivated. Extension of the cultivated area may not be possible and is generally a longer-term process involving greater capital investment than the use of fertilizers to increase yields on existing arable land. Increased crop production can be most rapidly achieved by the increased use of fertilizers and the choice of the right crop varieties for the area concerned. Increased use of fertilizers can be particularly important where water shortage limits crop output as the amount of water used per ton of crop is significantly less when fertilizers are used than when they are not used.

88. In order to get farmers to increase the crop production by the use of fertilizers, the cost of the fertilizers in relation to the value of the extra crops it produces must be such as to give an overall economic return which is attractive to the farmer. It is noted that in Japan where fertilizer prices to farmers are low and prices of farm products are high, the level of fertilizer consumption and average crop yields are among the highest in the world. On the other hand, in many of the developing countries both these factors are un-

favourable and fertilizer consumption and crop yields are low.

89. In this connection the practice in use in Taiwan, whereby a fixed barter ratio between the value of paddy rice and fertilizer is established each season, may be of interest to developing countries in promoting the use of fertilizer by their farmers. This has the advantage of eliminating for the farmer the uncertainties of market prices by equating the use of fertilizers with their agronomic response.

90. In developing countries, fertilizers have been very effective in increasing crop yields in areas where the soil fertility is low, either inherently or as a result of many years of cropping. Therefore, there is need for much more fertilizer response data obtained from trials and demonstrations carried out in research stations and on farmers' fields in developing countries. These data are needed to provide information on the essential role of fertilizers and to guide governments in formulating policy and targets for fertilizer use in achieving the necessary increases in agricultural production to provide for their rapidly expanding populations.

91. In order to persuade the farmer to use fertilizers, or more fertilizers, an effective Agricultural Research Service must be set up in developing countries to include, among its main functions the determination of the right types of plant strains to be developed in each area, the best type of fertilizer to use for each crop and the most economic amount of fertilizer to apply for each crop in each area.

The essential agricultural services required to encourage and support fertilizer usage in developing countries are:

(a) Research and experimentation, including pilot farm schemes;

(b) Information and education services to the farmers;

(c) The use of co-operatives or similar schemes to provide distribution services and credit facilities;

(d) Stable and economic prices for farm products;

(e) Marketing service including a programme of farmer education and agronomy advisory service organized by the manufacturing units of other agencies;

(f) Some form of crop insurance to cover the risk of crop failures.

92. These services can be provided by organizations such as:

(a) Government departments, particularly a ministry of agriculture, agricultural research stations, and extension services;

(b) Commodity and marketing boards;

(c) Co-operative societies and farmers' associations;

(d) Agricultural banks;

(e) Fertilizer producers and distributors;

(f) Agencies of multilateral and bilateral aid organizations.

93. The FAO Freedom From Hunger Campaign Fertilizer Programme is assisting many developing countries in their fertilizer research and development programmes by providing expert advisers, by putting down large numbers of trials and demonstrations of farmers' fields, and by conducting pilot schemes for fertilizer distribution, marketing and credit in a number of countries. The trials and demonstrations overcome the inadequate information on fertilizer dressings needed by particular crops under various environmental conditions, and show farmers the effectiveness of fertilizers in raising their crop yields and incomes. They also influence the effectiveness of extension services in providing information about fertilizers to cultivators and assisting them in applying fertilizers correctly. The pilot schemes, on the

basis of practical experience, develop distribution, marketing and credit systems suited to the needs of the farmers of developing countries.

94. If fertilizer supply and use are to expand as quickly as necessary to help in providing the rapidly increasing food needs of developing countries, the efforts of the United Nations and its specialized agencies, of governments and of industry must be expanded and intensified as soon as possible in this direction.

XV. UNITED NATIONS FERTILIZER MANUAL

95. Twelve key chapters of the United Nations Fertilizer Manual in draft form were presented and discussed. The aim of the Manual is to adapt and transfer modern fertilizer technology for use in developing countries as a guide to planning bodies, industrial corporations and individuals concerned with fertilizer development.

96. The rest of the Manual in ten chapters was used as background papers to supplement the information given in the papers presented at the Seminar. The participants showed keen interest in the Manual. It was suggested that specific comments, suggestions for changes and improvements should be communicated to the United Nations, Centre for Industrial Development for the attention of Mr. M.C. Verghese.

AVI. [illegible] ACTIVITIES NOT IN INDUSTRIAL DEVELOPMENT

97. In 1967 the [illegible] established a Centre for Industrial Development within the Department of Economic and Social Affairs. The aim of the Centre is to promote a better understanding of the nature and requirements of industrial development and to assist governments [illegible] to accelerate their economic growth by [illegible]

98. The programme of work of the Centre is carried out in three main divisions:

(a) Planning, programming and industrial policies;

(b) Industrial [illegible] institutions for support and promotion of industry;

(c) Bureau of Co-ordination for technical assistance and Special Fund projects.

99. The work of the Centre is carried out by

(a) Research;

(b) Seminars and other international meetings;

(c) Advisory services to Governments;

(d) Management and [illegible] programmes;

(e) Support of field operations in developing countries by several United Nations programmes such as industrial research institutes, techno-economic surveys, standardization, etc.;

(f) Preparation of [illegible] manuals.

100. The Centre has [illegible] to for promoting the development of the chemical industry [illegible] by the fertilizer industry. The

Centre is being expanded and it is expected that by 1967 the gap between required action and means of implementation will be reduced by additional resources and technical manpower.

101. The Economic Commission for Asia and the Far East established a Regional Industries Promotion and Planning Centre on 1 January 1965 to promote industrial development in the region with particular emphasis on the establishment of joint industries on a regional basis.

XVII. PLANT VISITS

102. Lisichansk Chemical Combinat. The programme of the Seminar included a tour to three different industrial plants in the Ukraine.

Installations for the production of oxygen, ammonia, nitric acid, ammonium nitrate and urea were visited at the Lisichansk Chemical Combinat. This visit took two days. At this plant, production, which earlier was based on coke, has now been completely changed over to natural gas. The total production is 1.5 million tonnes of nitrogen fertilizers (on basis of 20.5 per cent N) per year. This is 1% per cent of the 1964 output of the USSR in nitrogen fertilizers. The visit was concluded by an open and thorough discussion on the essential techno-economic data and the different process routes. The ammonia production amounts to 1,000 - 1,200 tonnes per day in 8 - 10 ammonia converters of different sizes and is based on atmospheric catalytic partial oxidation of natural gas followed by CO-conversion, removal of CO_2 partly by water scrubbing, partly by MEA scrubbing, and thereafter removal of traces of CO by copper liquor scrubbing. The synthesis is at 320 atm. pressure. One thousand tonnes per day of ammonium nitrate and 700 tonnes per day of urea are produced. A total of 50,000 tonnes of ammonium sulphate is also produced as a by-product of caprolactam production.*

The sale price (ex-works) of the fertilizers is as given below (in rubles per tonne):

	Sales Price
-Ammonia anhydrous	95.7
-Ammonium nitrate (34.2 per cent N)	48.9
-Ammonium sulphate	35.0
-Urea	105.0

* The annual sales turnover of fertilizers is about 90 million rubles and profits average 20 - 21 per cent of sales value.

The application of liquid anhydrous ammonia and of ammonia solution with ammonium bicarbonate is being studied experimentally with promising results.

103. Chemical Combinat at Sumy. In Sumy, a plant for the production of phosphate fertilizer and phosphatic cattle feed was visited. This visit took one day. The participants saw installations for the production of sulphuric acid, simple superphosphate and thermally defluorinated phosphate rock for cattle feed purposes. The production capacity of this installation was 55,000 tonnes of defluorinated phosphate per year containing about 38 per cent P_2O_5 and 0.2 per cent F (the fluorine content of the feed apatite is 3 per cent F). The fuel consumption is about 700 M^3 of natural gas per ton of feed, and by-product steam (about 4 tonnes per tonne of product) is also generated. The plant capacity for superphosphate is 820,000 tonnes per year on the basis of a 20 per cent P_2O_5 content.

A rapid expansion programme is now being undertaken to produce triple superphosphate. The annual sales turnover is about 37 million rubles, and profits average about 14 per cent of sales.

Chemical plant and machinery manufacturing works at Sumy. A one-day visit to the M.B. Frunze Works for the manufacture of chemical equipment and machinery at Sumy was also undertaken. This shop is one of the three biggest in the USSR for production of this type of equipment. A complete and up-to-date series of large boxer-type high pressure piston compressors (2,000 - 5,000 KW) and modern balanced opposed type, form an important part of the production programme. Medium-pressure vessels up to 40 atmospheres including columns, towers, heat exchangers, etc., are being manufactured in well-equipped shops, besides fabrication of stainless steel equipment

for chemical and food industries. The annual production is about 5 - 10,000 tonnes of stainless steel equipment, 20 - 22,000 tonnes of carbon steel (vessels up to 40 atmospheres) and 20 - 25,000 tonnes of cast iron components. About 40 - 50 high pressure reciprocating compressors of sizes varying from 2,000 - 5,000 kW are also produced annually. This plant also makes basket-type centrifuges.

The total number of employees is over 10,000 and these put in about 27 million working hours per year. The annual sales turnover is 27 million rubles.

104. Welfare facilities

The participants were considerably impressed by the welfare facilities for workers at all the plants. At Lisichansk, for example, a modern township has been built. With a population of 78,700 mostly workers of the combinat, this town provides 21 schools ranging from kindergarten through technical schools, and it was noted that 40 per cent of the population attend some kind of school. Provisions for medical treatment are extensive, with a total of 1,200 medical department staff and a 640-bed hospital. Elaborate facilities have also been built to enable workers to participate in sports activities.

XVIII. CONCLUSIONS AND RECOMMENDATIONS

105. The Seminar concluded that the trends in fertilizer production and consumption indicate:

(1) fertilizer deficits in the developing countries will increase further while exportable fertilizer surpluses in certain individual developed countries may become even larger,

(2) fertilizer consumption in the developing countries during the next five to ten years will probably be inadequate to meet agricultural and food production needs, whereas in the developed countries increased fertilizer consumption may result in even greater agricultural production. The Seminar therefore

RECOMMENDS:

That the United Nations and its specialized agencies, member governments and the world fertilizer industry should consider steps to correct the increasingly large imbalance in both production and consumption of fertilizers between the two groups of countries.

106. The Seminar concluded that there is an imperative need for developing countries to establish their own fertilizer industries to satisfy their own needs and to complement regional requirements. The Seminar further noted that despite the revolutionary developments in the technology of production of low cost fertilizers, the principal limiting factor for establishing this industry is lack of capital available to developing countries to augment their own resources for the import of necessary machinery, equipment and know-how. The Seminar therefore

RECOMMENDS:

That urgent steps be taken by the United Nations, the Centre for Industrial Development and other specialized United Nations agencies and international financial institutions to evolve a "New Framework" for making capital available on liberal terms to meet the special needs of financing fertilizer projects in developing countries more with a view to satisfy "needs" than with a view on "returns" on capital invested.

107. The Seminar concluded: (1) that most of the countries of Asia, Africa and Latin America will be net importers of fertilizers for the foreseeable future; and (2) that fertilizers are in irregular supply and subject to rising prices. The Seminar also concluded that studies to develop regional co-operation would stimulate bilateral and multilateral financial aid for specific projects and that new large fertilizer production projects may be necessary in certain areas to overcome the existing world imbalance in fertilizer production. The Seminar therefore

RECOMMENDS:

That the Centre for Industrial Development and the Economic Commissions of the United Nations should organize and conduct studies for the establishment of large fertilizer production projects in areas of the developing countries where abundant natural gas and other raw materials are available.

108. The Seminar, noting the anxiety regarding the acute shortage and increasing prices of sulphur

RECOMMENDS:

That the Centre for Industrial Development of the United Nations should undertake techno-economic studies on the production of water-

soluble phosphates by methods which do not require elemental sulphur, such as (1) the use of hydrochloric acid or nitric acid, (2) the production of electrothermal phosphorus, (3) utilization of gypsum and pyrites as substitutes for sulphur.

109. The Seminar noted several differences in the basis of reporting fertilizer statistics by member countries leading to some inconsistencies in the data published by the Food and Agriculture Organization. The Seminar therefore

RECOMMENDS:

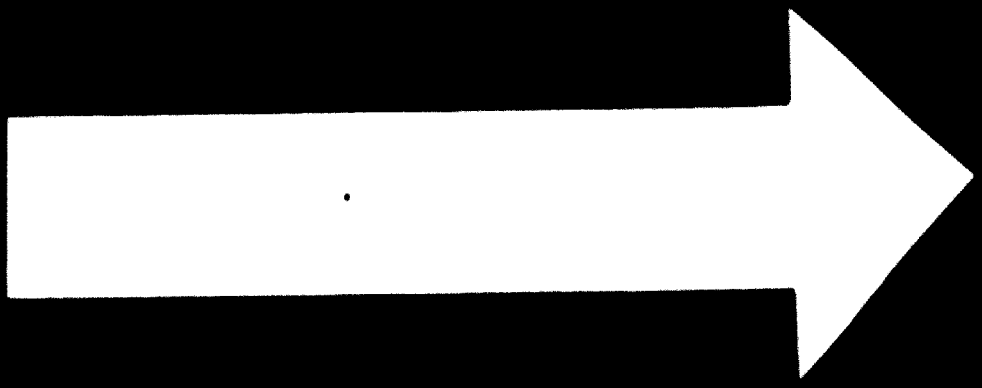
That (1) data on the production, consumption and international trade of fertilizers should be reported on a standard basis in terms of N, P_2O_5 and K_2O, (2) ground phosphate rock should be reported separately from chemical fertilizers, (3) non-fertilizer use of N, P_2O_5 and K_2O should be excluded from the statistics, (4) the Food and Agriculture Organization should investigate the possibility of reporting fertilizer statistics on a calendar year basis.

110. The Seminar, noting the almost complete absence of data on fertilizer consumption by crops in various countries and the usefulness of such data if it were available

RECOMMENDS:

That the Food and Agriculture Organization should take steps to collect and publish data on the consumption of fertilizer by crops and that all member countries should co-operate to supply relevant data.

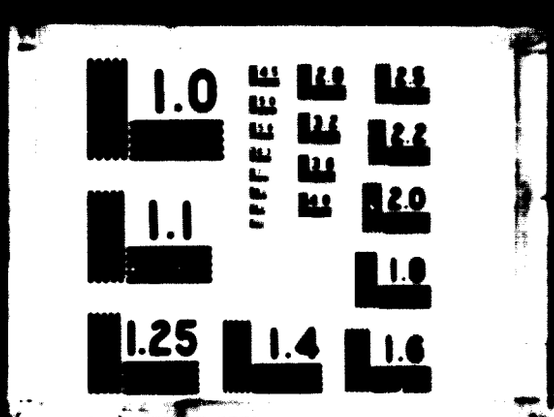
111. The Seminar noted that a shortage of adequately trained personnel exists in several developing countries in the fields of the technology of fertilizer production, plant maintenance and marketing of



29.3.74

2 OF 2

04645



fertilizers. The Seminar therefore

RECOMMENDS:

That the United Nations and its specialized agencies urgently promote group training programmes in the above fields for appropriate personnel from developing countries.

112. The Seminar, noting the continuing shortage of fertilizers in many areas of the world and the growing importance of adequate fertilizer usage for increasing food production

RECOMMENDS:

That the United Nations should hold a world conference on fertilizers in the two weeks before the proposed International Symposium on Industrial Development to be held in 1967. Such a conference should embrace technology, world trade, the use of fertilizers in agriculture, and the financing of fertilizer production facilities, and should involve the Centre for Industrial Development, the Food and Agriculture Organization, the World Bank and other United Nations agencies.

113. The Seminar fully endorsed the view that a "modus operandi" should be established for continuity of the excellent work and contacts initiated and established during this Seminar. The Seminar therefore

RECOMMENDS:

That the Centre for Industrial Development should take steps:

(1) to appoint eminently suitable country correspondents to report to the Centre on plans and developments in the fertilizer

industry in their respective countries or areas;

(2) to constitute an "ad-hoc" panel of experts for consultations as and when necessary on the Centre's present and future work programmes to ensure that these be most effectively implemented in developing countries;

(3) to issue a periodic circular letter summarizing world trends in technology, production and prices of raw materials and other related subjects, thus to aid developing countries in assessing current information on these matters.

114. The participants were of the opinion that the papers presented at the Seminar would form a very valuable reference document for the future and therefore the Seminar

RECOMMENDS:

That the Centre for Industrial Development of the United Nations should take steps to print and distribute the papers presented at the Seminar as early as possible.

115. The participants noted with considerable interest that a Seminar on "Project Evaluation" is to be conducted by the Centre for Industrial Development of the United Nations at Prague in October, 1965. Taking into consideration the papers presented at the Kiev Seminar and the papers to be presented at the Prague Seminar, the Seminar

RECOMMENDS:

That the Centre for Industrial Development should prepare a paper on "Project Evaluation in the Fertilizer Industry", which could establish guide-lines for use in developing countries.

XIX. ACKNOWLEDGEMENTS

116. The participants of the Inter-Regional Seminar on the Production of Fertilizers resolved to place on record their deep appreciation and gratitude to the Government of the host country, the Ukrainian SSR, for the excellent arrangements which it made and for its untiring efforts to ensure the success of the Seminar.

117. The Seminar also placed on record its appreciation for the organization of the Seminar by the United Nations Centre for Industrial Development and the Government of the Ukrainian SSR and for the large number of excellent papers presented which were of vital interest to developing countries.

118. The participants also resolved to record their deep appreciation of the various cultural programmes organized by the host country authorities, especially the river steamer trip to Shevchenko's birthplace at Kanev to place a wreath at the monument to his revered memory.

119. The participants resolved to express their warm gratitude to the Directors and workers for the most interesting plant visits arranged by them to the Machine Building and Chemical Combine factories at Sumy and the Chemical Combinat at Lisichansk.

APPENDIX I

INTER-REGIONAL SEMINAR ON THE PRODUCTION OF FERTILIZERS

Organized by

THE UNITED NATIONS AND THE GOVERNMENT OF THE UKRAINIAN SSR

24 August - 11 September 1965

Kiev, Ukrainian SSR

LIST OF PARTICIPANTS

Chairman	Mr. P.A. ROZENKO (Ukrainian SSR)
Director	Mr. N.K. GRIGORIEV (United Nations Headquarters)
Co-Director	Mr. V. PELYKH (Ukrainian SSR)
Technical Director	Mr. M.C. VERGHESE (United Nations Headquarters)
Liaison Officer	Mr. V. KRYZHANOVSKY (Ukrainian SSR)
USSR Representative	Mr. M.A. SHURAYEV
U.N. Representative	Mr. I.H. ABDEL-RAHMAN (Commissioner, Centre for Industrial Development United Nations)

Country Participants

Argentina	Mr. Oscar GATTI Mr. German MEDIVILLA
Ceylon	Mr. L.B. RAJAKARUNA
Chile	Mr. Patricio CASTRO ORTIZ Mr. Jan CARNIGLIA MONTANATO
Colombia	Mr. Efrain FORERO FONSECA Mr. Lazaro GOMEZ

Ethiopia	Mr. Admasu NEGUSE
India	Mr. M. DANDAPANI Mr. V.N. KASTURIRANGAN
Iraq	Mr. Arif Nizam Aldin BAYRAKTAR
Israel	Mr. Benjamin LEVONTIN Mr. Y. ARATEN
Japan	Mr. Ryoichi KAJIMA Mr. Takashi WAKIYAMA
Madagascar	Mr. Alain APPRIOU Mr. André RAMANANTSOA
Mexico	Mr. Felipe GAYTAN CARDENAS
Nigeria	Mr. Ebenezer OJURONGBE
Peru	Mr. H. de SOUZA RENTEGUI
Rumania	Mr. Nicolas DAUD Mr. Emio IONESCU Mr. Tanase ZAHARESCU
Syria	Miss Nouha AWAD Mr. Nasrallah KHOURY
Turkey	Mr. Ali Saip BAYRAM Mr. Erkal SANIGOK
United Arab Republic	Mr. Mohammed ISMAIL LABIB Mr. Mustafa HAFEZ ALI

Ukrainian SSR Participants

Mr. L.S. CHERED[illegible]ICHENKO
Mr. P.A. DMITRENKO
Mr. V.P. EGOROV
Mr. G.G. GORDIENKO
Mr. A.I. RUKAVISHNIKOV
Mr. P.V. SICHKOV

USSR Participants

Mr. A.N. AFFANASIEV
Mr. N.I. ARTYUSHIN
Mr. V.S. ELIYAYEV
Mr. D.A. KOREN'KOV
Mr. Yu. T. LIFSHITZ
Mr. A.V. PETERBURGSKY
Mr. N.A. SABARIN
Mr. I.T. SVETSOV
Mr. F.V. TURCHIN

United Nations Experts

Mr. D.J. BORGARS
Mr. D.N. DARUVALLA
Mr. R. EWELL
Mr. S. KIMURA
Mr. S.K. MUKHERJEE
Mr. A.P. OBLE
Mr. F.W. PARKER
Mr. R.S. RAY
Mr. O. RUHL
Mr. M. TAHA ZAKI

Regional Commissions

Mr. Alemayehu MAKONNEN (ECA)
Mr. Tin NYUNT (ECAFE)
Mr. R. PETITPAS (ECLA)

Food and Agriculture Organization (FAO)

Mr. J.W. COUSTON
Mr. M. LUNAN
Mr. R.D. NARAIN

United Nations Industry Lecturers

Mr. B.J. BALLS (rep[illegible] Mr. Russell MILHAM)

Mr. L.H. COOK
Mr. R. HAEGERMEL
Mr. R.J. LEONARD Jr.
Mr. C.J. PRATT
Mr. S. STRELZOFF
Mr. K.L.C. WINDRIDGE

United Nations Staff

Mrs. V. BLANCOCH
Mrs. Y. de COMACHO

APPENDIX II

UNITED NATIONS
INTER-REGIONAL SEMINAR ON THE PRODUCTION OF
FERTILIZERS ORGANIZED BY THE UNITED NATIONS
AND THE GOVERNMENT OF THE UKRAINIAN SSR, KIEV
24 AUGUST - 11 SEPTEMBER 1965

PROGRAMME

Tuesday, 24 August 1965

GENERAL

9.00	Registration of Participants	
10:00	1. Opening Speech by Director of Seminar	M.K. Grigoriev, Director Technological Division Centre for Industrial Development, United Nations
	2. Address of welcome by Representative of Ukrainian Government	P.A. Rosenko
	3. Election of Chairman of Seminar	P.A. Rosenko, Deputy Chairman, Council of Ministers, Ukrainian SSR
	4. Message from the Commissioner of Technical Assistance	Victor Hoo, on behalf of the United Nations Secretary-General
	5. Statement of UNIDO Representative	A.A. Shumayev

6. Message from the Commissioner, Centre for Industrial Development, United Nations — I.H. Abdel-Rahman

7. Adoption of Agenda

8. Election of Committee to draw up proceedings of the Seminar

12:30 Adjournment

SECTION I - General Introduction to Chemical Fertilizer Production and Requirements

14:30 Rapporteur: F.W. Parker

1. Production of Chemical Fertilizers in the USSR: Present Situation and Plans for the Development of Industrial Production of Phosphates, Nitrates and Potassium, Mixed and Compound Fertilizers — F.V. Turchin

2. World Overview of Fertilizer Production, Consumption, International Trade and Future Needs for Fertilizers — Raymond Dewell, United Nations Expert

3. Production and Utilization of Chemical Fertilizers in the Ukrainian SSR — A.I. Rukavishnikov, P.A. Dmitrenko, Ukrainian SSR

Discussion

17:30 Adjournment

Wednesday, 25 August 1965

SECTION II - Production of Fertilizers

9:00 Rapporteur: M.C. Verghese

4. Present Status and Future Plans for the Fertilizer Industry in the ECAFE Region — U Tin Hyunt

	5.	Fertilizer Production and Consumption in Africa	Alemayehu Makonnen ECA
	6.	The Fertilizer Industry in Latin America, Present Situation and Perspectives	Roberto Petitpas ECLA
	7.	Present Status and Future Plans for the Development of the Fertilizer Industry- Nitrogen, Phosphate and Potash - in India	S.K. Mukherjee United Nations Expert
	8.	Present State and Future Plans for the Development of the Fertilizer Industry in Japan	Takashi Wakiyama Japan
		Discussion	
12:30		Adjournment	
14:30	9.	Study on Fertilizers in Colombia	Efrain Forero Fonseca Colombia
	10.	Present Status and Future Plans for the Development of the Fertilizer Industry - Nitrogen, Phosphate and Potash - in Israel	B. Levontin Israel
	11.	Technological and New Process Developments in Israel	Y. Araten Israel
	12.	Present Status and Future Plans for the Development of the Fertilizer Industry - Nitrogen, Phosphate and Potash - in Iran	Hossein Salimi Iran (not present)

13. Present Status and Future Plans for the Development of the Fertilizer Industry - Nitrogen, Phosphate and Potash - in Turkey — **Ali Bayram, Turkey**

14. Present Status and Future Plans for the Development of the Fertilizer Industry - Nitrogen, Phosphate and Potash - in Argentina — **Salvador Bocchieri, Argentina**

Discussion

17:30 Adjournment

Thursday, 26 August 1965

14:00 Rapporteur: S.K. Mukherjee

15. Present Status and Future Plans for the Development of the Fertilizer Industry - Nitrogen, Phosphate and Potash - Nigeria — **E.O. Ojurongbe, Nigeria**

16. Present Status and Future Plans for the Development of the Fertilizer Industry - Nitrogen, Phosphate and Potash - in Chile — **Juan Carniglia Montesanto, Chile**

17. Present Status and Future Plans for the Development of the Fertilizer Industry - Nitrogen, Phosphate and Potash - in Mexico — **F. Gaytan Cardenas, Mexico**

18.	Present Status and Future Plans for the Development of the Fertiliser Industry - Nitrogen, Phosphate and Potash - in Ceylon	L.B. Rajakaruna Ceylon
19.	Present Status and Future Plans for the Development of the Fertiliser Industry - Nitrogen, Phosphate and Potash - in Peru	H. de Souza Rostogni Peru
20.	Present Status and Future Plans for the Development of the Fertiliser Industry - Nitrogen, Phosphate and Potash - in Rumania	N. Dand Rumania

Discussion

17.30 Adjournment

Friday, 27 August 1965

SECTION II - Production of Fertilizers (continued)

9:00 Rapporteur. R.S. Ray

21.	Experiences in the Development of the Fertiliser Industry in the United Arab Republic	M. Taha Zaki United Nations Expert
22.	Recent Trends in the Technology and Economics of the Production of Ammonia	A.P. Cole United Nations Expert

	23.	Aspects of Large-scale Ammonia Production	T.M. O'Hare M.W. Kellogg Company
	24.	The ICI Naphtha Reforming Process for the Production of Ammonia	D.J. Borgars United Nations Expert
	25.	Natural Gas and Naphtha Reforming Furnaces	Raymond J. Lenard Jr. Selas Corporation of America
		Discussion	
12:30		Adjournment	
14:30	26.	The Use of Low Temperature Carbon Monoxide Conversion Catalyst in Manufacture of Ammonia Synthesis Gas	Robert Habermehl and K. Atwood Catalyst and Chemicals, Inc.
	27.	Comparative Evaluation of Nitric Acid Processes	S. Strelzoff Chemical Construction Corporation
	28.	Nitric Acid and Ammonium Nitrate Production	S.K. Mukherjee United Nations Expert
	29.	Manufacture of Ammonium Sulphate Utilising By-product Gypsum from a Phosphoric Acid Plant	V.N. Kasturirangan India
	30.	Design Criteria for Large Tonnage Complete Recycle Urea Plants	Lucien H. Cook Chemical Construction Corporation
		Discussion	
17:30		Adjournment	

Saturday, 28 August 1965

SECTION II - Production of Fertilizers (continued)

9:00 Rapporteur: D.N. Daruvalla

31.	Development of the Urea Industry	S. Kimura United Nations Expert
32.	Recent Trends in Use of Raw Materials: Patterns of End-products, Processes and Scales of Production in Japan	Ryoichi Kajima Japan
33.	Production of Phosphatic Fertilizers	Chapter 11 Draft Fertilizer Manual (United Nations) Presented by P. Castro Boisier
34.	Production of Nitrogen Solutions	Chapter 10 Draft Fertilizer Manual (United Nations) Presented by Robert Ray
35.	Production of Potash Fertilizers	Chapter 12 Draft Fertilizer Manual (United Nations) Presented by B. Levontin

Discussion

12:30 Adjournment

Monday, 30 August 1965

SECTION II - Production of Fertilizers (continued)

10:00 Rapporteur: A.P. Oele

36.	Production of Mixed Fertilizers.	Chapter 14 Draft Fertilizer Manual (United Nations) Presented by A.P. Oele

37.	Production of Nitrophosphates and Ammonium Phosphates	Chapter 13 Draft Fertilizer Manual (United Nations) Presented by S.K. Mukherjee
38.	Design and Fabrication of Fertilizer Plants in Developing Countries with Special Reference to India	D.N. Daruvalla United Nations Expert
39.	Organization of Safety Techniques and Control of Work Safety at Enterprises Producing Chemical Fertilizers	G.G. Gordienko Ukrainian SSR
40.	Organization of Repairs of Equipment of Enterprises Producing Chemical Fertilizers	V.P. Egorov Ukrainian SSR
41.	Organization for Maintenance Work and its Importance	Christopher Pratt Mobil Chemical Company

Discussion

12:30 Adjournment

14:30	42.	Automation in the Agricultural Chemical Industries	Russell Milham (B.J. Ball) Foxboro Company
	43.	Criteria for Production vs. Importation of Fertilizers	Chapter 4 Draft Fertilizer Manual (United Nations) Presented by L.B. Rajakaruna
	44.	Criteria for Production vs. Importation of Ammonia	Chapter 6 Draft Fertilizer Manual (United Nations) Presented by Christopher Pratt

SECTION III - Planning, Organization and Economics of Production

45.	Organization and Project Planning in the USSR and the Economic Analysis of Projects	B.P. Samarin USSR
46.	Organizational Patterns of Enterprises Producing Fertilizers	Yu F. Lifshits USSR
47.	Technical Progress and Economics of Production of Fertilizers	Otto Buhl United Nations Expert
48.	Recent Developments in Processes, Equipment and Machinery Affecting Scales of Production of Fertilizers	M.C. Verghese United Nations
49.	Economics of Scale and Costs of Production of Fertilizers	Chapter 22 Draft Fertilizer Manual (United Nations) Presented by M.C. Verghese
50.	Planning for Development of Fertilizer Production	Chapter 13 Draft Fertilizer Manual (United Nations) Presented by M. Taha Zaki
51.	Location of Fertilizer Plants	Chapter 16 Draft Fertilizer Manual (United Nations) Presented by M. Taha Zaki

Discussion

17:30 Adjournment

Tuesday, 31 August 1965

SECTION IV - Marketing

9:00	Rapporteur: O. Ruhl		
	52.	Some of the Important Factors to be Reckoned With in Marketing of Fertilizers in Developing Countries	George C. Sweeney, Jr. Arthur D. Little, Inc. (not present) Presented by Robert Ray
	53.	Marketing of Fertilizers in a Developing Country	M. Dandapani India
	54.	Marketing, Distribution and Pricing of Fertilizers	Chapter 18 Draft Fertilizer Manual (United Nations)
	55.	Selection and Utilization of Chemical Fertilizers in the USSR	D.A. Koren'kov USSR
		Discussion	
12:30		Adjournment	
14:30	56.	Demand for Fertilizers	Chapter 17 Draft Fertilizer Manual (United Nations) Presented by F.J. Parker
	57.	International Trade in Fertilizer Raw Materials	Christopher J. Pratt Mobil Chemical Company
	58.	Production, Trade and Price Trends of Phosphate Rock	K.L.C. Lindridge The International Superphosphate Manufacturers Association

SECTION V - Investments

	59.	Capital Investment in the Production of Chemical Fertilizers	V.S. Belyayev USSR

Discussion

17:30 Adjournment

Wednesday, 1 September 1965

SECTION VI - Training

9:00 Rapporteur: D.J. Bergars

60.	System of Training and Advanced Training of Workers in the Mineral Fertilizer Industry	P.V. Sichkov Ukrainian SSR
61.	Training and Advanced Training of Engineers and Technicians of Enterprises Producing Chemical Fertilizers	L.S. Chorodnichenko Ukrainian SSR

SECTION VII - United Nations Role in Industrial Development

62.	Draft Fertilizer Manual	United Nations Industrial Development Presented by K.C. Verghese
63.	Industrial Technology - The Centre's Activities in the Field of Chemical Industries	United Nations Centre for Centre for Industrial Development Technological Division K.C. Verghese
64.	Statement of the Commissioner for Industrial Development, Mr. I.H. Abdel-Rahman, at the Opening of the Committee for Industrial Development	I.H. Abdel-Rahman Commissioner for Industrial Development United Nations

65.	United Nations Centre for Industrial Development - A Short Review of its Activities	United Nations Centre for Industrial Development T.C. Verghese
66.	Regional and Inter-Regional Co-operation	U Tin Nyunt ECAFE

Discussion

12:30 Adjournment

SECTION IX - Fertilizer and Agriculture

67.	Fertilizers and the Economics of Crop Production	Frank W. Parker United Nations Expert (with R.P. Christensen, USDA)
68.	The FAO Fertilizer Programme under the Freedom from Hunger Campaign: Its Purposes and Accomplishments	J.W. Cousten FAO
69.	Methods of Estimating National Fertilizer Requirements	R.D. Narain FAO
70.	Essential Agricultural Services Required to Support the Development of Fertilizer Usage in Developing Countries	M. Lunan FAO

Discussion

17:30 Adjournment

Thursday, 2 September 1965

9.00 Rapporteur: M. Taha Zaki

71. Importance of Sulphur in Agriculture — Samuel L. Tisdale (not present) The Sulphur Institute Presented by F.A. Parker

72. The Development of Agricultural Chemistry in the USSR — A.V. Peterburgsky USSR

73. Agro-Chemical Services in the USSR — N.I. Artyushin USSR

Discussion

12:30 Adjournment

14:30 Rapporteur: R. Ewell

Meeting of the Committee to draw up the draft proceedings of the Seminar

Friday, 3 September to Friday, 10 September 1965

Official Plant Visits

Saturday, 11 September 1965

SECTION X - Concluding Session

10:00 Rapporteur R. Ewell

1. Opening Remarks — N.K. Grigoriev

2. Adoption of Report on the Proceedings and Recommendations of the Seminar

12:00	3.	Chairman of the Seminar resumes the Chair	P.A. Rosenko Deputy Chairman Council of Ministers Ukrainian SSR
	4.	Statement by Participants	V.N. Kasturirangan (India) E. Ojurongbe (Nigeria) E. Saniguk (Turkey) P. Castro Boisier (Chile)
	5.	Statement on behalf of the USSR	A. Shumayev
	6.	Address	I.H. Abdel-Rahman Commissioner, Centre for Industrial Development United Nations
	7.	Thanksgiving	N.K. Grigoriev
	8.	Concluding Address	P.A. Rosenko
14:00	Adjournment - Conclusion of Seminar		

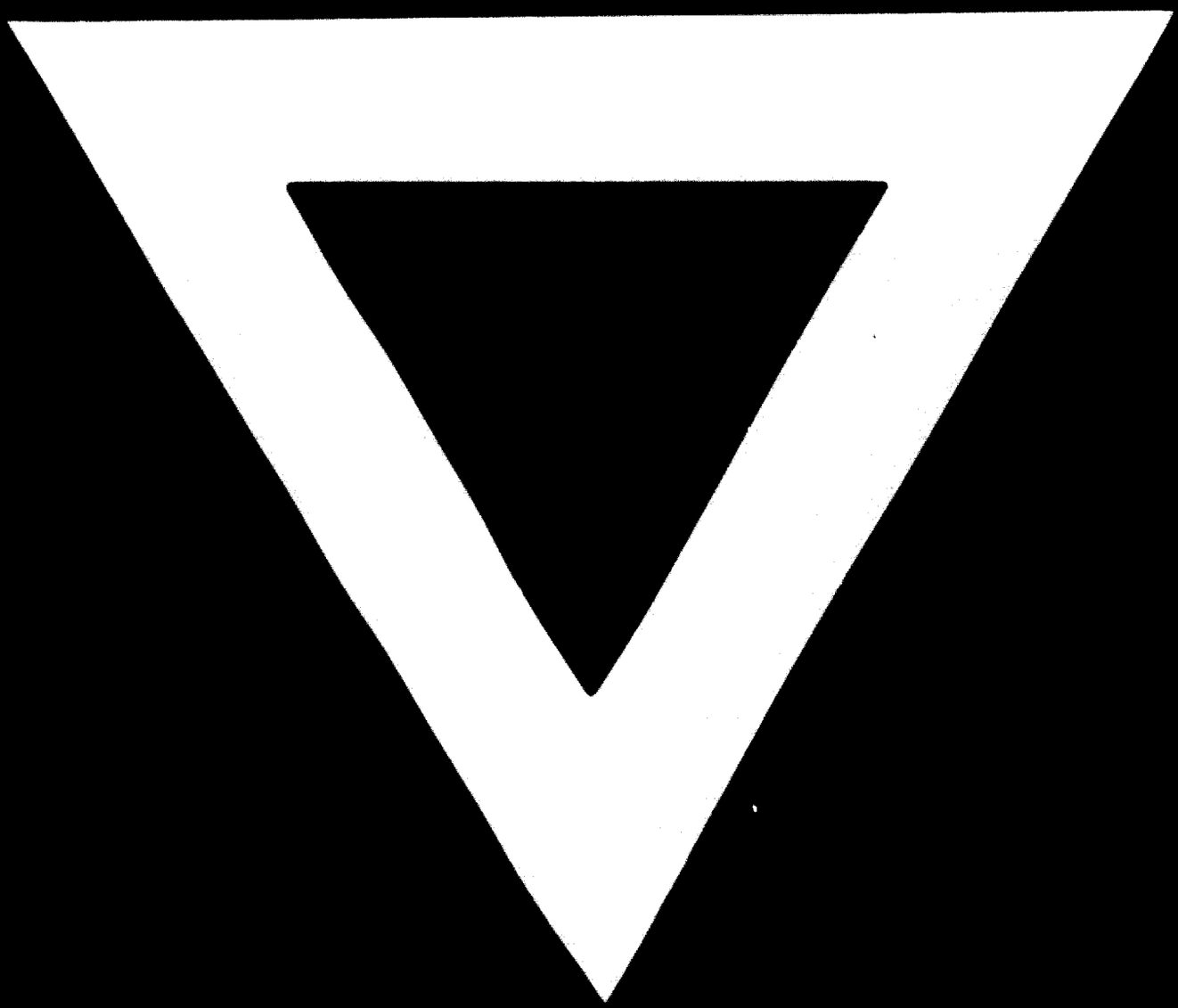
APPENDIX III

BACKGROUND PAPERS

Serial No.	Title of Paper or Document	Author of Paper or Source
1	World Overview, People, Food and Fertilizer	Chapter 2 Draft Fertilizer Manual (United Nations)
2	Famine and Fertilizer	Raymond Ewell Chemical and Engineering News December 14, 1964
3	Synthetic Ammonia	S. Strelzoff and L.C. Pan Chemico
4	Production of Ammonia	Chapter 7 Draft Fertilizer Manual (United Nations)
5	Nitrogen Fertilizers	S. Strelzoff and L.H. Cook Chemico
6	Economics of Integrated Production Urea, Nitric Acid and Ammonium Nitrate	L.H. Cook Chemico
7	Production of Ammonia Salts, Nitric Acid and Nitrogen	Chapter 8 Draft Fertilizer Manual (United Nations)
8	A Review of Urea Synthesis Processes	L.H. Cook Chemico
9	Production of Urea	Chapter 9 Draft Fertilizer Manual (United Nations)

Serial No.	Title of Paper or Document	Author of Paper or Source
10	Basic Data and Definitions of Fertilizer Materials and Mixtures	Chapter 5 Draft Fertilizer Manual (United Nations)
11	Fertilizers - A Look Ahead	T.P. Hignett T.V.A.
12	Phosphatic Fertilizer Properties and Processes	Bulletin No. 8 The Sulphur Institute
13	New Plants Changing Rules of Ammonia Game	Chemical and Engineering News 12 July 1965
14	Questions and Answers on Today's Ammonia Plants	Chemical Engineering June 21, 1965
15	Centrifugal Compressors Take Over in Large New Ammonia Plants	Chemical Processing December, 1964
16	Instrumentation for the Fertilizer Industry	The Foxboro Company
17	General Problems of Fertilizer Projects in Developing Countries	Chapter 20 Draft Fertilizer Manual (United Nations)
18	A Case Study of a Nitrogenous Fertilizer Project in a Developing Country	Chapter 21 Draft Fertilizer Manual (United Nations)
19	Sulfur	Chemical Week September 12, 1964
20	Phosphates	Chemical Week October 24, 1964
21	Potash	Chemical Week September 14, 1964

Serial No.	Title of Paper or Document	Author of Paper or Source
22	Activities of the United Nations System in the Field of Industrial Development	E/C.5/94 Special Fund
23	Activities Related to United Nations Programmes of Technical Co-operation	E/C.5/91 Technical Assistance Board
24	Adding Plant Nutrient Sulphur to Fertiliser	Technical Bulletin 10 The Sulphur Institute
25	Increasing World Food Output	Foreign Agricultural Economic Report No. 25 U.S.D.A. Lester R. Brown
26	Man, Land, and Food	Foreign Agricultural Report No. 11 U.S.D.A. Lester R. Brown
27	Role of Fertiliser in Agricultural Production	Chapter 3 Draft Fertiliser Manual (United Nations)
28	Auxiliary Raw Materials	Chapter 15 Draft Fertiliser Manual (United Nations)



29.3.74