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

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

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

For more information about UNIDO, please visit us at www.unido.org
We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master files.
INTERNATIONAL SEMINAR ON THE
Production of Fertilizers

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.
<table>
<thead>
<tr>
<th>Chapters</th>
<th>Paragraphs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1 - 2</td>
</tr>
<tr>
<td>I. World Production, Consumption, and International Trade in Fertilizers</td>
<td>9 - 15</td>
</tr>
<tr>
<td>II. Production and Consumption of Fertilizers in the LCs, LCA and LCLA Regions and in Other Countries Represented at the Seminar</td>
<td>14 - 21</td>
</tr>
<tr>
<td>III. Technology of Production of Ammonia</td>
<td>22 - 29</td>
</tr>
<tr>
<td>IV. Technology of Production of Nitrogen Fertilizers</td>
<td>30 - 34</td>
</tr>
<tr>
<td>V. Technology of Production of Phosphate Fertilizers</td>
<td>35 - 40</td>
</tr>
<tr>
<td>VI. Technology of Production of Potash Fertilizers</td>
<td>41 - 44</td>
</tr>
<tr>
<td>VII. Technology of Production of Complex and Mixed Fertilizers</td>
<td>45 - 51</td>
</tr>
<tr>
<td>VIII. Raw Materials and Intermediates for Fertilizer Production</td>
<td>52 - 56</td>
</tr>
<tr>
<td>IX. Planning, Location, Organization and Economics of Fertilizer Production</td>
<td>57 - 65</td>
</tr>
<tr>
<td>X. Instrumentation, Maintenance and Safety in Fertilizer Plants</td>
<td>66 - 70</td>
</tr>
<tr>
<td>XI. Manufacture of Fertilizer Plant Equipment</td>
<td>71 - 74</td>
</tr>
<tr>
<td>XII. Training of Fertilizer Plant Personnel</td>
<td>74 - 78</td>
</tr>
<tr>
<td>XIII. Demand for and Marketing of Fertilizers</td>
<td>79 - 84</td>
</tr>
<tr>
<td>XIV. Fertilizer and Agriculture</td>
<td>85 - 94</td>
</tr>
<tr>
<td>Chapters</td>
<td>Paragraphs</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>XV. United Nations Fertilizer Manual</td>
<td>95 - 96</td>
</tr>
<tr>
<td>XVI. United Nations Role in Industrial Development</td>
<td>97 - 101</td>
</tr>
<tr>
<td>XVII. Plant Visits</td>
<td>102 - 104</td>
</tr>
<tr>
<td>XVIII. Conclusions and Recommendations</td>
<td>105 - 115</td>
</tr>
<tr>
<td>XIX. Acknowledgements</td>
<td>116 - 119</td>
</tr>
</tbody>
</table>
APPENDICES

I. Names of Participants  53
II. Programme  57
III. List of Background Papers  71
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 21 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:

<table>
<thead>
<tr>
<th>Region</th>
<th>No. Countries</th>
<th>No. Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Asia</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Middle East</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Latin America</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Europe (USSR, Ukrainian SSR, Rumania)</td>
<td>3</td>
<td>18</td>
</tr>
</tbody>
</table>

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

Mr. V. Pelykh
Mr. A. S. Bayram
Mr. V. N. Kasturirangan
Mr. E. Ojurongte
Mr. G. Gaytan Cardenas
Mr. E. Forero Fonseca
Mr. Alemeyahu Makonnen
Mr. R. Petitpas
Mr. Tin Nyunt
Mr. F. W. Parker
Mr. M. Taha Zaki
Mr. R. Ewell
Mr. S. Kimura
Mr. D. J. Borgars
Mr. A. P. Oele
Mr. S. K. Mukherjee
Mr. D. N. Daruvalla
Mr. R. S. Ray
Mr. O. Ruhl
Mr. M. C. Vergheese

Ukrainian SSR
Turkey
India
Nigeria
Mexico
Colombia
ECA
ECLA
ECACE
United Nations Expert
United Nations Expert
United Nations Expert
United Nations Expert
United Nations Expert
United Nations Expert
United Nations Expert
United Nations Expert
United Nations Expert
United Nations

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.
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):

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945/46</td>
<td>2.0</td>
<td>3.1</td>
<td>2.1</td>
<td>7.2</td>
</tr>
<tr>
<td>1954/55</td>
<td>6.3</td>
<td>1.3</td>
<td>6.3</td>
<td>20.3</td>
</tr>
<tr>
<td>1963/64</td>
<td>15.3</td>
<td>12.0</td>
<td>10.8</td>
<td>29.0</td>
</tr>
</tbody>
</table>

The 1963/64 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):
<table>
<thead>
<tr>
<th>Region</th>
<th>Production</th>
<th>Consumption</th>
<th>Surplus (Deficit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Europe</td>
<td>13.8</td>
<td>12.1</td>
<td>1.7</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>4.1</td>
<td>3.8</td>
<td>0.3</td>
</tr>
<tr>
<td>USSR</td>
<td>5.2*</td>
<td>4.2*</td>
<td>1.0*</td>
</tr>
<tr>
<td>USA/Canada</td>
<td>11.0</td>
<td>10.1</td>
<td>0.9</td>
</tr>
<tr>
<td>Japan</td>
<td>1.8</td>
<td>1.8</td>
<td>-</td>
</tr>
<tr>
<td>Asia (except Japan)</td>
<td>1.8</td>
<td>3.8</td>
<td>(2.0)</td>
</tr>
<tr>
<td>Africa</td>
<td>0.9</td>
<td>0.8</td>
<td>(0.3)</td>
</tr>
<tr>
<td>Latin America</td>
<td>0.7</td>
<td>1.2</td>
<td>(0.5)</td>
</tr>
<tr>
<td>Oceania</td>
<td>1.1</td>
<td>1.2</td>
<td>(0.1)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>40.0</td>
<td>39.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

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 percent 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 13 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 $1100 million. The largest exporters of nitrogen in order of size are

* Includes small phosphate
Japan, West Germany, Italy, UCSR 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 \( \text{P}_2\text{O}_5 \) 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 \( \text{N}/\text{P}_2\text{O}_5/\text{K}_2\text{O} \) 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: 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):

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>23.0</td>
<td>36.0</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>17.0</td>
<td>22.0</td>
</tr>
<tr>
<td>K₂O</td>
<td>14.5</td>
<td>19.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>54.5</strong></td>
<td><strong>77.0</strong></td>
</tr>
</tbody>
</table>

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):
<table>
<thead>
<tr>
<th>Region</th>
<th>Kg. per person</th>
<th>Kg. per hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oceania</td>
<td>56</td>
<td>28</td>
</tr>
<tr>
<td>USA/Canada</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>Western Europe</td>
<td>36</td>
<td>117</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>29</td>
<td>61</td>
</tr>
<tr>
<td>Japan</td>
<td>18</td>
<td>275</td>
</tr>
<tr>
<td>USSR</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Latin America</td>
<td>5.0</td>
<td>11</td>
</tr>
<tr>
<td>Africa</td>
<td>2.9</td>
<td>3</td>
</tr>
<tr>
<td>Asia (except Japan)</td>
<td>1.8</td>
<td>3</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>14</strong></td>
<td><strong>25</strong></td>
</tr>
</tbody>
</table>

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 those 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 1963 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 P₂O₅. 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 P₂O₅ by 1970/1971. Baghtha 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 P₂O₅ and 52,000 tonnes of K₂O.

Japan The production of N in 1963 was 1.3 million tonnes while that of P₂O₅ 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 35 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 16,500 tonnes of materials in all types of fertilizers.

20. ECA Region

Argentina The production in 1965 is estimated to be about 4,000 tonnes of N as byproduct 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 1965/1964 was 22,000 tonnes of N, 6,700 tonnes of P2O5 and 5,600 tonnes of K2O.

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 P2O5 and 12,000 tonnes of K2O. 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
tonne per year and fused calcium-phosphate at 12,000 tonnes per year.

Columbia There are two ammonia plants in operation. In 1964
production was 33,450 tonnes of N, and 5,700 tonnes of P₂O₅. The
consumption in 1964 was 32,000 tonnes of N, 50,000 tonnes of P₂O₅ and
29,200 tonnes of K₂O 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
tonne of P₂O₅. Consumption in that year was 240,000 tonnes of N, 68,000
tonne of P₂O₅ and 24,400 tonnes of K₂O. It is estimated that by 1970
the production will reach 550,000 tonnes of N and 116,900 tonnes of
P₂O₅ while the consumption would increase to 645,000 tonnes of N,
164,900 tonnes of P₂O₅ and 13,500 tonnes of K₂O.

Peru The production in 1965 is estimated to be 62,400 tonnes of
N, 36,400 tonnes of P₂O₅ and 4,400 tonnes of K₂O while the consumption
is estimated to be 191,000 tonnes of N, 110,000 tonnes of P₂O₅ and
50,000 tonnes of K₂O. 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 P₂O₅ and 2,600 tonnes
of K₂O. Consumption in 1969/1970 is estimated to be 25,000 tonnes of
N, 12,500 tonnes of P₂O₅ and 4,000 tonnes of K₂O. While a small quantity
of urea is imported for aerial application, Israel exported 210,000 tonnes
of phosphate rock and 260,000 tonnes of potash in addition to 1,000 tonnes of \( \text{P}_2\text{O}_5 \) and 5,000 tonnes of \( \text{K}_2\text{O} \) in processed fertilizers. The estimated exports in 1969/1970 are 900,000 tonnes each of phosphate rock and potash, and 200,000 tonnes of \( \text{P}_2\text{O}_5 \) and 100,000 tonnes of \( \text{K}_2\text{O} \) in processed fertilizers.

**Rumunia** The production of fertilizers in 1965 is estimated to be 197,000 tonnes of N and 132,000 tonnes of \( \text{P}_2\text{O}_5 \). The production planned to 1970 is 1.05 million tonnes of N and 275,000 tonnes of \( \text{P}_2\text{O}_5 \). 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 29,400 tonnes of \( \text{P}_2\text{O}_5 \) and consumption was 54,200 tonnes of N and 47,700 tonnes of \( \text{P}_2\text{O}_5 \). By 1969 production is expected to increase to 112,400 tonnes N, and 36,000 tonnes of \( \text{P}_2\text{O}_5 \) by the addition of two new plants. Estimated consumption in 1969 is 136,500 tonnes of N, 139,000 tonnes of \( \text{P}_2\text{O}_5 \) and 22,500 tonnes of \( \text{K}_2\text{O} \).

**USSR** The USSR has been the second largest producer of fertilizer since 1965 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):

<table>
<thead>
<tr>
<th></th>
<th>1958</th>
<th>1964</th>
<th>1970 (plan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium nitrate</td>
<td>74.4</td>
<td>64.0</td>
<td>44.4</td>
</tr>
<tr>
<td>Ammonium sulphate</td>
<td>21.7</td>
<td>12.9</td>
<td>10.2</td>
</tr>
<tr>
<td>Urea</td>
<td>1.0</td>
<td>13.5</td>
<td>28.6</td>
</tr>
<tr>
<td>Liquid fertilizer</td>
<td>0.2</td>
<td>6.7</td>
<td>7.6</td>
</tr>
<tr>
<td>Compound fertilizer</td>
<td>1.5</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>2.7</td>
<td>1.4</td>
<td>1.7</td>
</tr>
</tbody>
</table>

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):

<table>
<thead>
<tr>
<th></th>
<th>1958</th>
<th>1965</th>
<th>1970 (plan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single superphosphate</td>
<td>96.6</td>
<td>86.5</td>
<td>39.0</td>
</tr>
<tr>
<td>Double superphosphate</td>
<td>—</td>
<td>6.1</td>
<td>36.0</td>
</tr>
<tr>
<td>Compound fertilizer</td>
<td>—</td>
<td>2.5</td>
<td>20.0</td>
</tr>
<tr>
<td>Phosphate slag</td>
<td>3.4</td>
<td>2.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Others</td>
<td>—</td>
<td>2.2</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Compound fertilizers will be principally ammonium phosphates.

Potash fertilizers produced in 1964 totalled 1.9 million tonnes K₂O. The principal potash fertilizer is potassium chloride (40 per cent) and the remainder is made up of various mixed salts, sylvinites, 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.
II. 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.
a) 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 1,500 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 USSR showed no significant difference in the use...
of urea fertilizer on crops with biuret varying from 0.1 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**

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 P₂O₅ was discussed. It was noted that large plants with capacities up to 500 tonnes per day P₂O₅ 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 P₂O₅ have now been developed and production capacity in the USA of superphosphoric acid has already reached 1,000 – 1,200 tonnes P₂O₅ 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 (P₂O₅) 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 K₂O 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 P₂O₅ 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 P₂O₅ 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\(_2\)O\(_5\) 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, electrolytic hydrogen for ammonia synthesis may be favourably considered.

The latest 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 1975 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 phosphorous and furnace type phosphoric acid could constitute low cost sources for production of $P_2O_5$ where low cost electrical power and venturi or suitable rock phosphate are available.

56. There is a current trend to lower transport costs by shipping phosphoric acid (85 - 88 per cent $P_2O_5$ in large quantities instead of phosphate rock and sulphur.
IX. PLANNING LOCATION, ORGANISATION AND ECONOMICS OF FERTILISER 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 need” 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 times 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 utilising modern large scale techniques of fertilizer production.

61. Developing countries are usually faced with serious problems
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 production 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, availability 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 fertilizer factories was recognised. The encouragement of such co-operation is mainly the task of the Regional Economic Commissions of the United Nations.

65. The economic and organizational aspects of the planning of large fertilizer projects in the USSR were discussed with particular reference to the latest developments and rapidly changing technology in this field.
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, such 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 have been discussed with special reference to the fertilizer industry in the chemical sector of the USSR. It is acknowledged that more implementation of safety regulations leads to considerable reduction in loss and prevention 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 Koorakal 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 PERSONAL

74. In the USSR and the Ukrainian SSR 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.
79. In developing countries the use of fertilizers is large, considering their present level of 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 fertilizer application, the economics of fertilizer use, etc.

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

81. The marketing programme should aim at making available the right type of fertilizer, 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 fertilizer usage.

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

(a) It should encompass a decentralized storage and distribution system. The network should extend to the village level so that no farmer need wait more than 1 day to obtain his fertilizer requirements;

(b) In some cases, the ability of 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 organization 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 fertilizer is perhaps less of a problem than marketing.
XIV. FERTILIZERS 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.

90. 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.

91. 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 pro-
vide 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 educa-
tion 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 agri-
culture, 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 farmer's 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 in-
comes. 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.
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. K.C. Verghese.
97. In 1962, the United Nations established a Centre for Industrial Development within the Department of Economic and Social Affairs. The aim of the centre was to promote a better understanding of the nature and requirements of industrial development and to assist governments of underdeveloped countries to accelerate their economic growth by the creation of effective policies.

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

   (a) Research, preparation and industrial policies;
   (b) Industrial service and consultations for support and promotion of industry;
   (c) Bureau of Co-operation for technical assistance and Special real 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 implementation projects;
   (e) Support of field operations in developing countries by several United Nations programmes, such as industrial research institutes, technical-economic surveys, standardisation, etc.;
   (f) Preparation of draft manuals.

100. The Centre was established in order to promote the development of the chemical industrial activity of 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 15 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 CO₂ partly by water scrubbing, partly by alkali 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 90,000 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):

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>Sales Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia anhydrous</td>
<td>95.7</td>
</tr>
<tr>
<td>Ammonium nitrate (34.2 per cent N)</td>
<td>48.9</td>
</tr>
<tr>
<td>Ammonium sulphate</td>
<td>35.0</td>
</tr>
<tr>
<td>Urea</td>
<td>105.0</td>
</tr>
</tbody>
</table>

*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 ammonium 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, single superphosphate and thermally de-fluorinated phosphate rock for cattle feed purposes. The production capacity of this installation was 55,000 tonnes of de-fluorinated phosphate per year containing about 38 per cent P2O5 and 0.2 per cent F (the fluorine content of the feed apatite is 4 per cent F). The fuel consumption is about 700 m3 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 P2O5 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 L.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
8 - 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 combine, 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

RECOMMEND:

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

RECOMMEND:

That the Centre for Industrial Development of the United Nations would 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

RECOMMEND:

That ( ) data on the production, consumption and international trade of fertilizers should be reported on a standard basis in terms of N, P₂O₅ and K₂O, (2) ground phosphate rock should be reported separately from chemical fertilizers, (3) non-fertilizer use of N, P₂O₅ and K₂O 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

RECOMMEND:

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
fertilizers. The Seminar therefore

RECOMMEND:

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

RECOMMEND:

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

RECOMMEND:

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.
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 Combinat 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 1969
Kiev, Ukrainian SSR

LIST OF PARTICIPANTS

Chairman
Mr. P.A. ROZEMKO (Ukrainian SSR)
Director
Mr. N.K. ORIGORIEV (United Nations Headquarters)
Co-Director
Mr. V. PETUKH (Ukrainian SSR)
Technical Director
Mr. K.G. VORONOEV (United Nations Headquarters)
Liaison Officer
Mr. V. KUNTZHOF (Ukrainian SSR)
UNR Representative
Mr. N.A. SUMAYLV
U.N. Representative
Mr. L.N. ANDRII-EVAN (Commissioner, Centre for Industrial Development United Nations)

Country Participants
Argentina
Mr. Oscar GATTI
Mr. Oscar K.N. SIV.ZA

Canada
Mr. L.R. RAJAKINiena

Chile
Mr. Patricio CASTRO DE LA R  
Mr. Jan CARNOGLIA D.C.T.A.LTO

Colombia
Mr. Efrain PORTILLO FONSECA
Mr. Lacer COE .Z
Ethiopia  Mr. Admasu H. GUSE
India    Mr. M. DasDAPAHI
         Mr. V.H. KASTURIRANGAN
Iraq  Mr. Arif Nizam aldin BAyRAKTAR
Israel  Mr. Benjamin LLEVONTIN
         Mr. Y. ARATEN
Japan  Mr. Ayocoichi KAjIMA
       Mr. Takashi WAKIYAMA
Madagascar  Mr. Alain APPRIOU
           Mr. Andre Rabehantsoa
Mexico  Mr. Felipe GAYTAN CARDENAS
Nigeria  Mr. Ebenezor OJURONGHE
Peru  Mr. H. de SOUZA RABILLOUI
Rumania  Mr. Nicolas DAUD
         Mr. Emio IOIuScU
         Mr. Tanase ZAHARESCu
Syria  Miss Nouha ABD
       Mr. Haarallah Khorou
Turkey  Mr. Ali Saip BAyRAH
        Mr. Erkal SabIGOK
United Arab Republic  Mr. Mohammed Ishail LabIB
         Mr. Mustafa HAFEZ ALI

Ukrainian  8SR Participante
         Mr. L.G. CHElnIikENCH
         Mr. P.A. DElrEnKO
         Mr. V.P. JACOII
         Mr. G.G. GORILIIKO
         Mr. M.I. RUKVISHHUKOV
         Mr. F.V. SICHKOV
USSR Participants

- A.N. Afanasiev
- N.I. Antonyshin
- V.S. El'tyanov
- D.A. Koren'kov
- Yu. T. Lifshitz
- A.V. Pfeiffergsky
- N.A. Sabarin
- I.T. Svtsov
- F.V. Turchin

United Nations Experts

- D.J. Borge, BS
- D.N. Darwalla
- R. Geell
- S. Kimura
- S.K. Mekhajer
- A.P. Oule
- F.W. Parker
- R.S. Razi
- C. Rehl
- M. Zakari

Regional Commissions

- Alemanyahu Rakonen (CCA)
- Tin Nyunt (ECAFE)
- R. Petipas (ECLA)

Food and Agriculture Organization (FAO)

- J.W. Cousin
- H. Liman
- R.D. Harain
United Nations Industry Lecturers

Mr. D.J. Bills (representing Mr. Russell Milhaux)

Mr. L.M. Cock
Mr. R. Harder
Mr. R.J. Hard Jr.
Mr. C.J. Pratt
Mr. S. Stelloff
Mr. L.C. de Borst

United Nations Staff

Mrs. V. R.M. Cock
Mrs. T. de Cob bergen
APPENDIX II

UNITED NATIONS
INTER-REGIONAL SEMINAR ON THE PRODUCTION OF
FERTILIZERS ORGANIZED IN THE UNITED NATIONS
AND THE GOVERNMENT OF THE UKRAINIAN S.S.R., KIEV
24 AUGUST - 11 SEPTEMBER 1965

PROGRAMME

TUESDAY, 24 AUGUST 1965

GENERAL

9:00 Registration of Participants

10:00 1. Opening Speech by W.K. Grigoriev, Director of Seminar
       Director of Seminar
       Technological Division
       Centre for Industrial
       Development, United Nations

2. Address of welcome by Representative of P.A. Rosenko
       Representative of
       Ukrainian Government

3. Election of P.A. Rosenko, Deputy Chairman, Council of Ministers,
       Chairman of Seminar
       Ukrainian S.S.R.

4. Message from the Victor Nee, on behalf of
       Commissioner of the United Nations Secretary-
       Technical Assistance
       General

5. Statement of K.M.B. H.A. Shamayev
       Representative

...
6. Message from the 
Commissioner, Centre 
for Industrial Develop-
ment, United Nations

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 
F.V. Turchin 
Present Situation and 
Plans for the Development 
of Industrial Production 
of Phosphates, Nitrate 
and Potassium, Mixed and 
Compound Fertilizers

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

3. Production and Utilization of Chemical Fertilizers in 
the Ukrainian SSR 
A.I. Rukavishnikov 
Ukrainian SSR

Discussion

17:30 Adjournment
5. Fertilizer Production and Consumption in Africa
   Aleemayehu Lakonnen

6. The Fertilizer Industry in Latin America, Present Situation and Perspectives
   Roberto Petitpas

7. Present Status and Future Plans for the Development of the Fertilizer Industry - Nitrogen, Phosphate and Potash - in India
   S.K. Mukherjee

8. Present Status and Future Plans for the Development of the Fertilizer Industry in Japan
   Takashi Wakiyama

Discussion

12:30 Adjournment

14:30 9. Study on Fertilizers in Colombia
       Ifrain Forero Fonseca
       Colombia

    B. Levantin
    Israel

11. Technological and New Process Developments in Israel
    Y. Araten
    Israel

    (not present)
    Iran

Hossein Salimi

Ali Bayram
Turkey


Salvador Bocchieri
Argentina

Discussion

17:30 Adjournment

Thursday, 26 August 1965

14:00 Rapporteur: S.K. Mukherjee


E.O. Ojurongbe
Nigeria


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
   L.B. Rajakaruna
   Ceylon

   H. de Souza Restegui
   Peru

20. Present Status and Future Plans for the Development of the Fertilizer Industry - Nitrogen, Phosphate and Potash - in Romania
   N. Pud
   Romania

Discussion

17:30 Adjournment

Friday, 27 August 1963

SECTION II - Production of Fertilizers (continued)

9:00 Rapporteur: R.S. Ray

21. Experiences in the Development of the Fertilizer Industry in the United Arab Republic
   N. 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.W. O'Hare
   K.W. Kellog Co.

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.R. Kasturirangan
   India

30. Design Criteria for Large Urea e Complete 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.J. Gordiense
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
Mobis Chemical Company

Discussion

12:30 Adjournment

14:30 42. Automation in the Agricultural Chemical Industries

Russell Kilham (B. F. Baker)
Foxboro Company

43. Criteria for Production vs. Importation of Fertilizers

Chapter 4
Draft Fertilizer Manual
(United Nations)
Presented by L.S. Kajikaruma

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

<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Author/Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>Organisation and Project Planning in the USSR and the Economic Analysis of Projects</td>
<td>B.P. Samarina, USSR</td>
</tr>
<tr>
<td>46</td>
<td>Organizational Patterns of Enterprises Producing Fertilizers</td>
<td>Yu T. Lifshits, USSR</td>
</tr>
<tr>
<td>47</td>
<td>Technical Progress and Economics of Production of Fertilizers</td>
<td>Otto Buhl, United Nations Export</td>
</tr>
<tr>
<td>48</td>
<td>Recent Developments in Processes, Equipment and Machinery Affecting Scales of Production of Fertilizers</td>
<td>M.C. Verghese, United Nations</td>
</tr>
<tr>
<td>49</td>
<td>Economics of Scale and Costs of Production of Fertilizers</td>
<td>Chapter 22, Draft Fertiliser Manual (United Nations)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Presented by M.C. Verghese</td>
</tr>
<tr>
<td>50</td>
<td>Planning for Development of Fertiliser Production</td>
<td>Chapter 19, Draft Fertiliser Manual (United Nations)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Presented by H. Taha Zaki</td>
</tr>
<tr>
<td>51</td>
<td>Location of Fertiliser Plants</td>
<td>Chapter 16, Draft Fertiliser Manual (United Nations)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Presented by H. Taha Zaki</td>
</tr>
</tbody>
</table>

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 L. Little, Inc.
   (not present)
   Presented by Robert Ray

53. Marketing of Fertilizers in a Developing Country
   N. 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

57. International Trade in Fertilizer Raw Materials
   Christopher J. Pratt
   Mobil Chemical Company

58. Production, Trade and Price Trends of Phosphate Rock
   H.L.C. Hindridge
   The International Superphosphate Manufacturers Association

SECTION V - Investment

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

17:30 Adjournment

Wednesday, 1st December 1965

SECTION VI - Training

9:00 Rapporteur: D.J. Bergsma

60. System of Training and Advanced Training of Workers in the Mineral Fertilizer Industry
   P.V. Sienkov
   Ukrainian SSR

61. Training and Advanced Training of Engineers and Technicians of Enterprises Producing Chemical Fertilizers
   L.M. Cherewčynenko
   Ukrainian SSR

SECTION VII - United Nations Role in Industrial Development

   United Nations Industrial Development
   Presented by I.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
   I.M. Abdel Rahman
   Commissioner for Industrial Development
   United Nations

   Mr. I.M. Abdel Rahman, at the Opening of the Committee for Industrial Development
65. United Nations Centre for Industrial Development - A Short Review of its Activities
United Nations Centre for Industrial Development
T.C. Verhose

66. Regional and Inter-Regional Cooperation
U. Tin Nyunt
SCAFE

Discussion

12:30 Adjournment

SECTION IX - Fertilizer and Agriculture

67. Fertilizers and the Economics of Crop Production
United Nations Economic Commission for Asia and the Far East
Frank W. Parker
United Nations Economic Commission for Asia and the Far East (with R.P. Christensen, USDA)

68. The FAO Fertilizer Programme under the Freedom From Hunger Campaign: Its Purposes and Accomplishments
FAO
J. M. Couston
FAO

69. Methods of Estimating National Fertilizer Requirements
FAO
R. D. Garner
FAO

70. Essential Agricultural Services Required to Support the Development of Fertilizer Usage in Developing Countries
FAO
W. Lunan
FAO

Discussion

17:30 Adjournment

Thursday, 2 September 1965

9:00 Rapporteur: Taha Zaki
71. Importance of Sulphur in Agriculture  
Samuel L. Tiscále  
(The Sulphur Institute)  
Presented by P. E. Parker

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

73. Azo-Chemical Services in the USSR  
N.I. Artyushin  
USSR

Discussion

12:30 Adjournment

14:30 Rapporteur: R. Dwel

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. Dwel

1. Opening Remarks  
N.K. Grigoriev

2. Adoption of Report on the Proceedings and Recommendations of the Seminar
12:00 1. Chairman of the Seminar resume the Chair

P.A. Resanke
Deputy Chairman
Council of Ministers
Ukrainian SSR

4. Statement by Participants

V.N. Kasturirangan (India)
E. Ojeronke (Nigeria)
E. Janigek (Turkey)
P. Castro Boisier (Chile)

5. Statement on behalf of the USSR

S. Shumayev

6. Address

I.M. Abdel-Rahman
Commissioner, Centre for Industrial Development
United Nations

7. Thanksgiving

N.K. Grigoriev

8. Concluding Address

P.A. Resanke

14:00 Adjournment - Conclusion of Seminar
## APPENDIX III

### BACKGROUND PAPERS

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Title of Paper or Document</th>
<th>Author of Paper or Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>World Overview, People, Food and Fertilizer</td>
<td>Chapter 2 Draft Fertilizer Manual (United Nations)</td>
</tr>
<tr>
<td>2</td>
<td>Famine and Fertilizer</td>
<td>Raymond Ewell Chemical and Engineering News December 14, 1964</td>
</tr>
<tr>
<td>3</td>
<td>Synthetic Ammonia</td>
<td>S. Strelzoff and L.C. Pan Chemico</td>
</tr>
<tr>
<td>4</td>
<td>Production of Ammonia</td>
<td>Chapter 7 Draft Fertilizer Manual (United Nations)</td>
</tr>
<tr>
<td>5</td>
<td>Nitrogen Fertilizers</td>
<td>S. Strelzoff and L.H. Cook Chemico</td>
</tr>
<tr>
<td>6</td>
<td>Economics of Integrated Production Urea, Nitric Acid and Ammonium Nitrate</td>
<td>L.H. Cook Chemico</td>
</tr>
<tr>
<td>7</td>
<td>Production of Ammonia Salts, Nitric Acid and Nitrogen</td>
<td>Chapter 8 Draft Fertilizer Manual (United Nations)</td>
</tr>
<tr>
<td>8</td>
<td>A Review of Urea Synthesis Processes</td>
<td>L.H. Cook Chemico</td>
</tr>
<tr>
<td>9</td>
<td>Production of Urea</td>
<td>Chapter 9 Draft Fertilizer Manual (United Nations)</td>
</tr>
<tr>
<td>Serial No.</td>
<td>Title of Paper or Document</td>
<td>Author of Paper or Source</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>10</td>
<td>Basic Data and Definitions of Fertilizer Materials and Mixtures</td>
<td>Chapter 5 Draft Fertilizer Manual (United Nations)</td>
</tr>
<tr>
<td>11</td>
<td>Fertilizers - A Look Ahead</td>
<td>T.F. Hignett T.V.A.</td>
</tr>
<tr>
<td>12</td>
<td>Phosphatic Fertilizer Properties and Processes</td>
<td>Bulletin No. 8 The Sulphur Institute</td>
</tr>
<tr>
<td>13</td>
<td>New Plants, Changing Rules of Ammonia Game</td>
<td>Chemical and Engineering News 12 July 1965</td>
</tr>
<tr>
<td>14</td>
<td>Questions and Answers on Today's Ammonia Plants</td>
<td>Chemical Engineering June 21, 1965</td>
</tr>
<tr>
<td>15</td>
<td>Centrifugal Compressors Take Over in Large New Ammonia Plants</td>
<td>Chemical Processing December, 1964</td>
</tr>
<tr>
<td>16</td>
<td>Instrumentation for the Fertilizer Industry</td>
<td>The Foxboro Company</td>
</tr>
<tr>
<td>17</td>
<td>General Problems of Fertilizer Projects in Developing Countries</td>
<td>Chapter 20 Draft Fertilizer Manual (United Nations)</td>
</tr>
<tr>
<td>18</td>
<td>A Case Study of a Nitrogenous Fertilizer Project in a Developing Country</td>
<td>Chapter 21 Draft Fertilizer Manual (United Nations)</td>
</tr>
<tr>
<td>19</td>
<td>Sulfur</td>
<td>Chemical Week September 12, 1964</td>
</tr>
<tr>
<td>20</td>
<td>Phosphates</td>
<td>Chemical Week October 24, 1964</td>
</tr>
<tr>
<td>21</td>
<td>Potash</td>
<td>Chemical Week September 14, 1964</td>
</tr>
<tr>
<td>Serial No.</td>
<td>Title of Paper or Document</td>
<td>Author of Paper or Source</td>
</tr>
<tr>
<td>-----------</td>
<td>---------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>22</td>
<td>Activities of the United Nations System in the Field of Industrial Development</td>
<td>E/C.5/34 Special Fund</td>
</tr>
<tr>
<td>23</td>
<td>Activities Related to United Nations Programme of Technical Co-operation</td>
<td>E/C.5/91 Technical Assistance Board</td>
</tr>
<tr>
<td>24</td>
<td>Adding Plant Nutrient Sulphur to Fertilizer</td>
<td>Technical Bulletin 10 The Sulphur Institute</td>
</tr>
<tr>
<td>26</td>
<td>Man, Land, and Food</td>
<td>Foreign Agricultural Report No. 11 U.S.D.A. Lester R. Brown</td>
</tr>
<tr>
<td>27</td>
<td>Role of Fertiliser in Agricultural Production</td>
<td>Chapter 3 Draft Fertiliser Manual (United Nations)</td>
</tr>
<tr>
<td>28</td>
<td>Auxiliary Raw Materials</td>
<td>Chapter 15 Draft Fertiliser Manual (United Nations)</td>
</tr>
</tbody>
</table>