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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Planning of New Fertilizer Production Facilities (Ammonia/Methanol) for Industrial Studies and Development Centre - Phase II

DP/SAU/73/004

Report on Mission to Saudi Arabia

by

M.C. Verghese, Head
Chemical Industries Section
UNIDO, Vienna

22 - 26 October 1976

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Contents

1. Introduction

During the Review Mission by Mr. P.F. Ryan of the Feasibility Studies Section of UNIDO between 24 May and 2 June 1976 for the project Industrial Studies and Development Centre - Phase II (ISDC) DP/SAU/73/004, the authorities requested two short term missions as per the project document one on the Fertilizer Industry and the second on the Petrochemical Industry (page 8 - Report on Mission by Mr. P.F.Ryan UNIDO/IOD.28 dated 8 July 1976). The ISDC and the Kingdom of Saudi Arabia accepted the candidature of Mr. M.C. Verghese, Head - Chemical Industries Section of UNIDO to undertake the fertilizer mission.

The main purpose of the mission was to advise the ISDC on matters concerning the planning and development of fertilizer production, world market trends and long term development strategy.

During discussions with H.E. Abdulaziz Al Zamil - Deputy Director General - Industrial Studies and Development Centre and Mr. Ali Moursi, Project Manager, UNIDO, it was decided that the Consultant should undertake a quick review of the studies already prepared (Annex I) and make recommendations on the validity and viability of the proposals and suggest future plan of action.

The writer is indebted to the UNDP Regional Representative Mr. A. Succar and to Mr. S.M. Hanif the Deputy Regional Representative for all the assistance and advice received during the short mission. The guidance of H.E. Zamil and Mr. Moursi, Project Manager are greatly appreciated (Annexure II).

2. Summary of findings and recommendations

i) The four studies/reports (Annex I) which were reviewed could not be compared on a common basis because

- they were prepared at different periods
- the capacity and end product patterns were different
- the locations were different

ii) The ICI and TFC studies can be compared as both were for the production of 1000 MTD ammonia and 1,600 MTD of urea. But whereas ICI assumes a site on the Gulf coast, the TFC assumes Dammam as the location perhaps to take advantage of the off-site facilities of the existing fertilizer plant (SAFCO).

iii) The Chemico proposal is for the production of 25,000 tons per day of Methanol only and the location is at Al Jubayl.

iv) The proposal prepared by Petromin/W.R. Grace/ C. Itoh/The First Arabian Corporation is for an

integrated Methanol/Ammonia-Urea Complex at Al Jubayl. The capacities proposed are 2,500 short tons per day of Methanol, 1000 short tons per day of ammonia and 1000 short tons per day of urea using the Co_2 integrated facility. The balance of ammonia (1000 - 580 = 420 tons) will have to be sold or converted to Ammonium Nitrate.

All the proposals are reviewed in detail in Section 3.

Recommendations

i) The proposals of ICI and TFC are more or less out of date due to fast changing capital costs, production costs and world market situation. The capital costs of both proposals are on the high side. The Chemico feasibility study for methanol production alone for energy purposes although was attractive two years ago is impractical today. Methanol for formaldehyde production need only be considered as a practical proposition. The only study therefore for immediate serious consideration is by Petromin/W.R. Grace/Itoh/First Arabian.

ii) UNIDO's world-wide study of the Fertilizer Industry 1975-2000 completed in draft form in September 1976 shows that a 1000 metric tons per day ammonia plant and 1720 MTD urea plant at Dec. 1975 prices with no allowance for inflation or interest charges during construction built in a developing country on a "green field" site including one month's storage capacity for feedstock (in case of liquid or solid feedstock) storage for 4,000 tons of ammonia, 75,000 tons of bulk urea and 10,000 tons of bagged urea and including 10-15 MW captive electric power unit but excluding rail, road and harbour facilities, water supply and effluent disposal will cost U.S. $ 179 millions. (Ammonia plant $ 103 million, urea plant $ 67 million and working capital $ 9 million.

Production costs per ton of ammonia including feedstock of natural gas at 50 U.S. cents per 1000 c. ft., other operating costs, depreciation at 8 $\frac{1}{3}$ % and profit at 10% will be U.S.$ 96.00 and for urea $ 102.00

iii) UNIDO's approach is that as per the Lima declaration, all future ammonia/urea plants should be built in areas where cheap natural gas or associated gas

exists such as the Arabian Gulf, North Africa, West Africa, Venezuela/Trinidad and the Indonesian Brunei region. The developed countries with gas cost of $ 1 to $ 2 per 1000 c.ft cannot compete with areas where gas costs only 0.30 to 0.50 $ per 1000 c.ft even if capital costs may be 30% higher due to location factors.

iv) The best assumptions for production costs (F.O.B. costs) should be around $ 100.00/metric ton of Ammonia and $ 120.00/metric ton of urea for a viable project.

v) The capital and production costs for methanol should be adjusted in the light of the above UNIDO findings from the proposals of Petromin/Grace/Itoh/ First Arabian.

vi) UNIDO's projections for world demand of Nitrogen till the year 2000 is given in Section 4.

vii) The recommendations contained in the proposals of Petromin/Grace/Itoh/First Arabian for barge mounted plants as per proposals of Mitsubishi are premature and Saudi Arabia should not be the first country to try out this experiment however documented and theoretically studied. The ship mounted ammonia plant

for Indonesia which has now been given up should serve as a warning.

viii) The integrated approach for a methanol, ammonia and urea project is excellent. The only point to be considered is whether all ammonia should be converted to urea only (no Ammonium Nitrate) and the Co_2 needed for methanol to reduce reformer capacity could be produced by burning cheap natural gas to recover Co_2 by using MEA/Hot potash or other absorbing agents and regeneration.

ix) UNIDO will assist if requested to make macro and micro analysis of the proposals so far made and submit a practical proposal to build an integrated, export-oriented methanol/fertilizer project for Saudi Arabia. Such a neutral proposal can be submitted in 3 months' time and will cost 5 man-months or a total cost of $ 20,000 which will include travel. The Head of the Chemical Industries Section will be responsible and will lead the project team consisting of an Economist (market, demand projections, locations etc) and a production expert (capital cost, process, production costs etc). The work will be carried out in UNIDO, Vienna and the two expert/consultants are now available.

3. Comparison of studies already made

1) ICI Study

a) Capacity - Ammonia 1,000 tonnes/day

Urea 1,600 tonnes/day

b) Location - Gulf Coast

c) Capital Cost - U.S.$ 400 million ± 20
(at June 1975 prices)
Starting 1975 and completion 1979
$ 600 million
(Twice cost of similar plant in Europe)

d) Production Costs - Urea F.O.B. $ 200/tonne
Feedstock gas cost 28 cents/million BTU (Methane)
32 cents/million BTU (Propane)

e) Profitability - DCF return on equity 6%.

f) Forecasts for developing countries 1991/92 (based on TVA figures)

	Million Tonnes N			
	Capacity	- Production	- Demand	- Gap
	33	20	28	3

ii) TFC Study

a) Capacity - Ammonia 1000 tonnes/day
Urea 1600 tonnes/day

b) Location - Dammam - Petromin Industrial Area
Gulf Coast

c) Capital Cost - Fixed Capital Cost $ 320 million
Working Capital $ 24 million
Equity $ 96 million
Loan $ 246.1 million

d) Production Cost - Urea selling price
$ 160/tonne bagged
Natural gas 51 MMSCFD
Electric power 25 MW
Desalined water 4,800 MTD
Project schedule - 4 years

e) Profitability 5.75% as equity.

f) Forecasts - Arthur D. Little

	Million tonnes N	
	1979	1989
World N Consumption	69.632	135.495
Effective world Ammonia Capacity	71.580	-
Design Capacity	94.300	-

1979 - 1989 270 new 1000 MTD Ammonia plants

230 new 1600 MTD Urea plants

iii) Chemico

a) Capacity - 25,000 short tons/day
Fuel grade Methanol
5 trains each 5000 ± S.T/day

b) Location - Gulf Coast - Al Jubayl

NGL - C5 - Pentane

LPG - C3 - Propane

C4 - Butane

C2 - Ethane

c) Capital Cost N.A.

d) Production Costs N.A.

890 MM SCFD - CH_4

950 x 10^9 B.T.U./day

e) Profitability N.A.

f) Forecasts By 1980

13,000 ST/D to Japan

12,000 ST/D to U.S.A.

iv) Petromin/W.R. Grace/C. Itoh/First Arabian

a) Capacity Case I Integrated Co_2

	STPD
Methanol	2,500
Ammonia	1,000
Urea	1,000

b) Location N.A.

c) Capital Cost

	$ Million Methanol	Ammonia	Urea	Total
Battery limits	80.367	57.800	24.000	162.167
Offsites	29.175	20.983	8.713	58.871
	109.542	78.783	32.713	211.038
Location factor	38.340	27.574	11.449	77.363
	147.882	106.357	44.162	298.401
Other plant investment	13.701	8.000	0.600	22.301
Escalation	50.091	29.733	11.638	91.462
	211.674	144.090	56.400	412.164
Interest during construction	9.737	6.628	2.594	18.959
	221.411	150.718	58.994	431.123
Working capital	11.250	2.835	7.425	21.510
	232.661	153.553	66.419	452.633

d) Production Costs

$/S.T Methanol	Ammonia	Urea
97.88	159.75	159.55

e) Profitability 80% operating rate
10% after tax return on equity

4. UNIDO's - World Study of the Fertilizer Industry 1975-2000

The Second General Conference of UNIDO held in Lima, Peru in March 1975 adopted the "Lima Declaration and Plan of Action" which called for accelerated industrial growth in developing countries. A goal was set for increasing the developing countries' share of industrial production to at least 25% of the world total by the year 2000 (the present share was estimated at about 7%).

In 1974/75 developing count4ies produced 19% of the world total of nitrogen fertilizers. It is estimated that by the year 2000, if 40% of world nitrogen is produced in developing countries, they will be meeting their demands and if 50% is produced, there will be sufficient to export to developed countries. Therefore it seems logical to keep these two goals in view and the 25% target in the Lima Declaration is not relevant in the nitrogen fertilizer field.

The following informations are taken from the draft UNIDO study (Annex 3).

a) Forecast of fertilizer demand

The following tabulation shows the present and forecasted use of the nutrients N, P_2O_5 and K_2O in developed and developing countries.

Year	Developed Countries			Developing Countries		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
	- Million tons of plant nutrients -					
1974	27.3	18.9	18.1	11.4	5.3	2.6
1985	53.0	29.0	29.0	28.0	13.0	7.0
2000	101.0	46.0	50.0	64.0	30.0	16.0

b) Production costs and Capital costs

Alternative A - Developing and developed countries self sufficient in fertilizer supplies

Total capital 1980-2000

= $ billion 114 (53 developing + 61 developed)

Alternative B - Developing countries export 20% of their production to developed countries.

Total capital 1980-2000

= $ billion 119 (75 developing + 44 developed)

5. Consultation Meeting on the Fertilizer Industry organized by UNIDO

Based on the Lima Declaration and the decision of the Industrial Development Board (IDB), UNIDO is planning to organize a Consultation meeting of representatives of member countries to discuss the issues facing the development of the fertilizer industry. Issues have been formulated and background papers prepared. These will be discussed in a preparatory meeting being organized in UNIDO Vienna in November 1976. The finalized issues will be submitted to the Consultation Meeting to be held in January 1977 in Vienna. The world wide fertilizer study prepared by UNIDO would by then have been finalized and available. The aim of the consultations is to reach agreements as how best to develop the fertilizer industry and what are the steps to be taken and problems to be solved to locate more production in developing countries.

6. Proposals for UNIDO's assistance to Saudi Arabia for the planning and development of the fertilizer industry

a) See page 8 (ix)

For the analyses of the proposals so far received by ISDC and to prepare a final neutral unbiased and practical proposal.

b) UNIDO is ready to provide the services of a short term Consultant to review the petrochemical proposals if the request is confirmed.

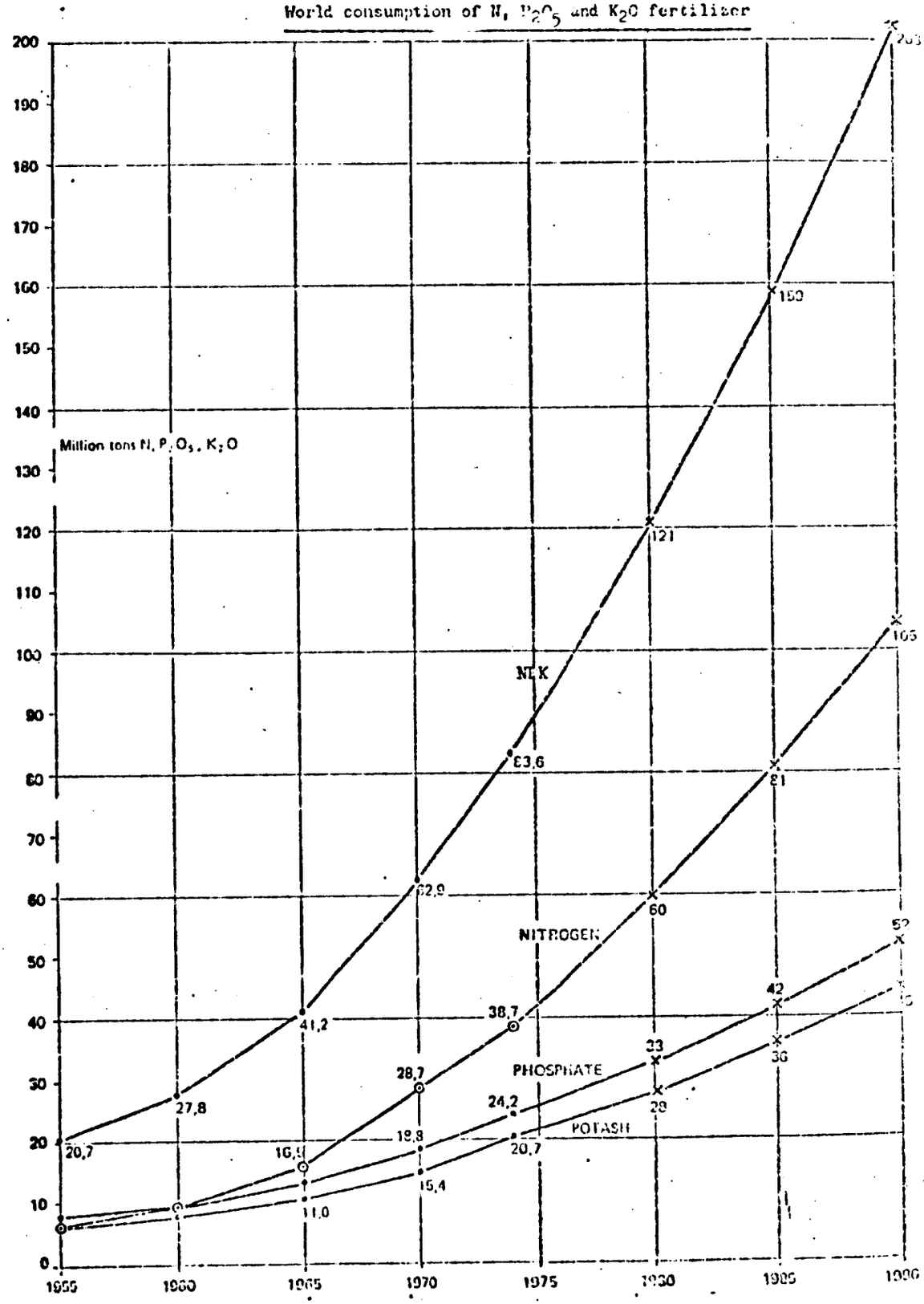
7. ANNEX I - List of studies reviewed

S.No.	Title of Study	Prepared by	Prepared for	Date
i)	1,600 tonnes a day fertilizer urea project Eastern Province project proposal	Agricultural Division of Imperial Chemical Industries Limited (ICI) U.K.	General Petroleum and Mineral Organization	June 1975
ii)	Proposal for proposed fertilizer joint venture between the Kingdom of Saudi Arabia and the Republic of China	Working Group of Petromin and Taiwan Fertilizer Company (TFC)	-	Oct 1975
iii)	Methanol Energy Feasibility Study Al Jubayl Saudi Arabia Vol.I Technical	Chemico Process Plants Company Division of Chemical Construction Corporation, One Penn Plaza New York,N.Y.10001 Chemico Number 08265	The First Arabian Corporation Beirut Lebanon	March 1975
iv)	Draft Prefeasibility study proposed Methanol/Ammonia project in Saudi Arabia	Petromin/ W.R. Grace & Co. C. Itoh & Co First Arabian Corporation	Liaison Committee	Aug. 1976

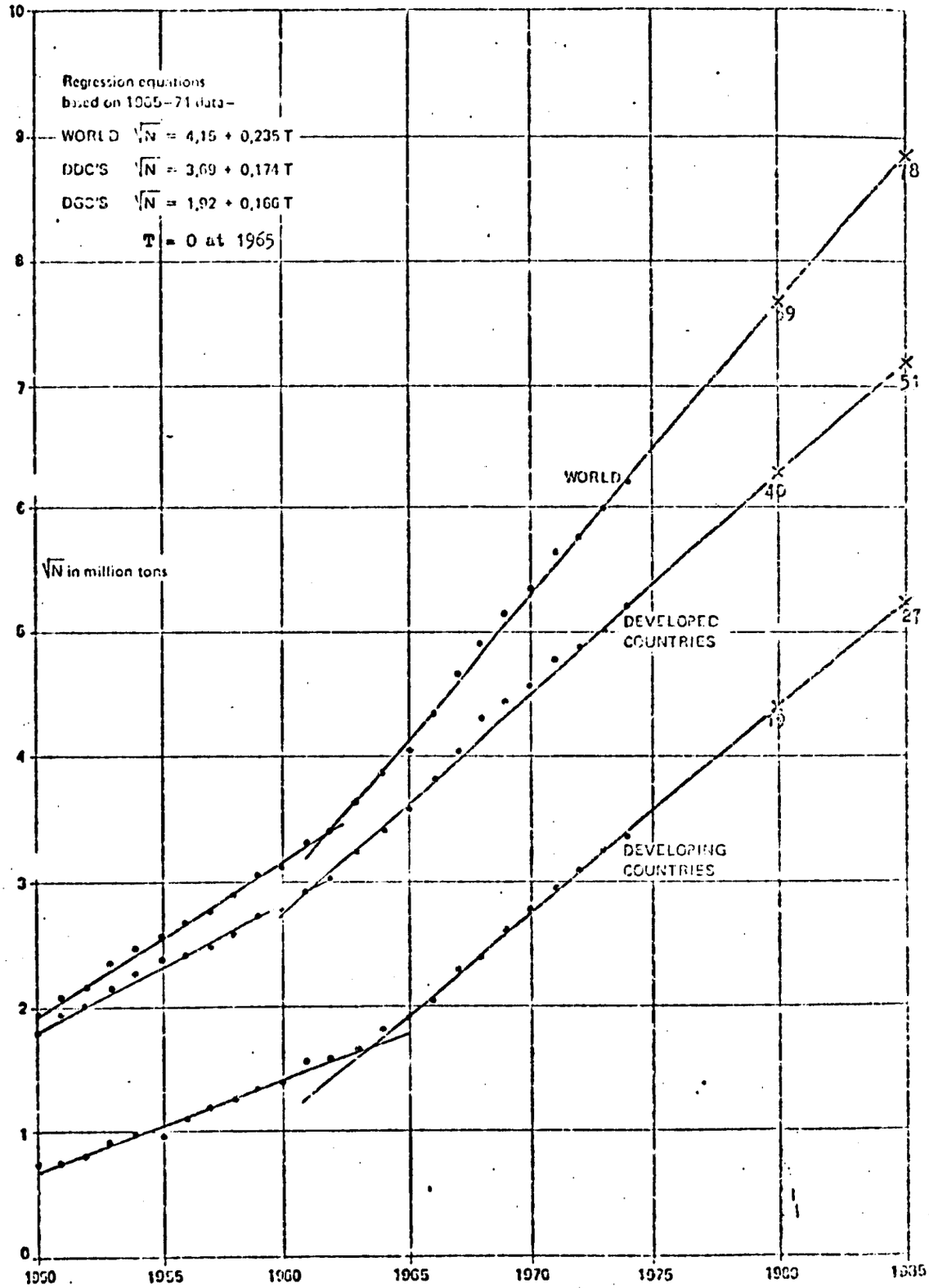
8. ANNEX II - List of persons met

i)	Mr. Abdullati Succar	- Regional Representative of UNDP Saudi Arabia
ii)	Mr. Saiyid Muhammad Hanif	- Deputy Regional Representative UNDP
iii)	Mr. Ali A.H. Mourji	- Project Manager UNIDO ISDC
iv)	H.E. Abdulaziz Al Zamil	- Deputy Director General Industrial Studies and Development Centre Deputy Chairman and First Executive Officer Saudi Basic Industries Corporation (Petrochemicals and Fertilizers)
v)	Dr. Mohammed Khatrawi	- Director Planning and Evaluation Department ISDC
vi)	H.F. Abbar	Director General ISDC

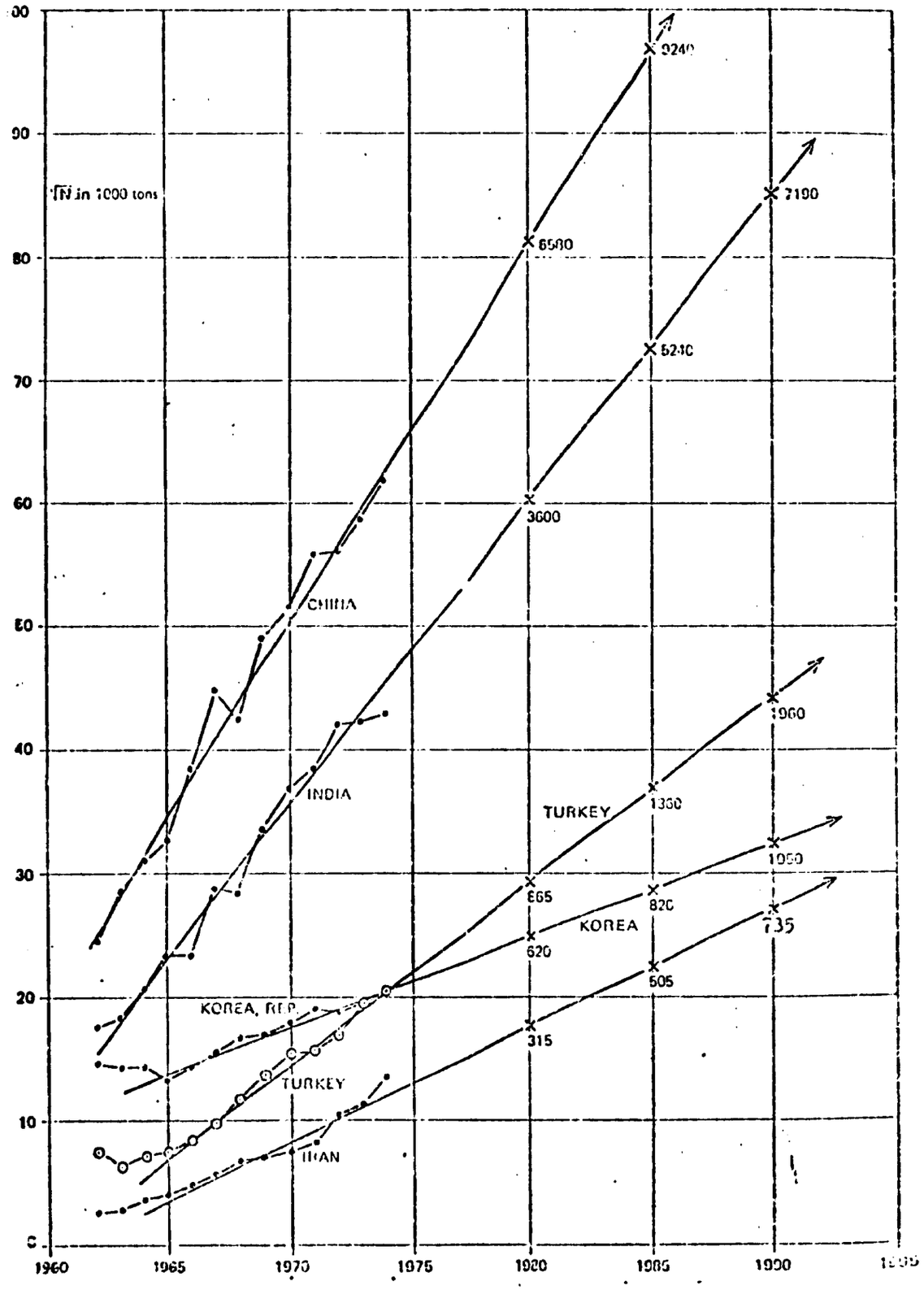
World consumption of N, P_2O_5 and K_2O fertiliser



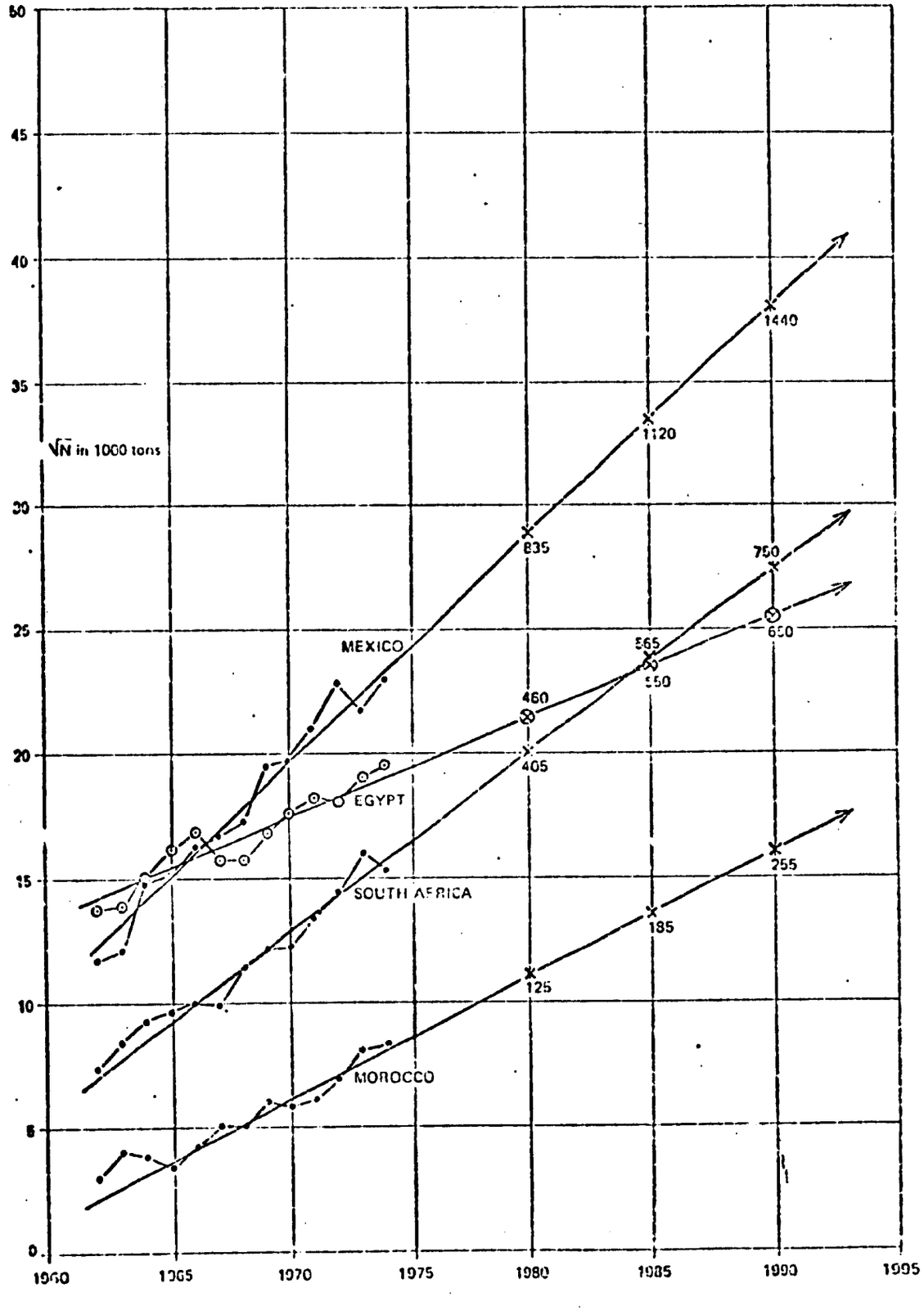
Consumption of nitrogen fertiliser



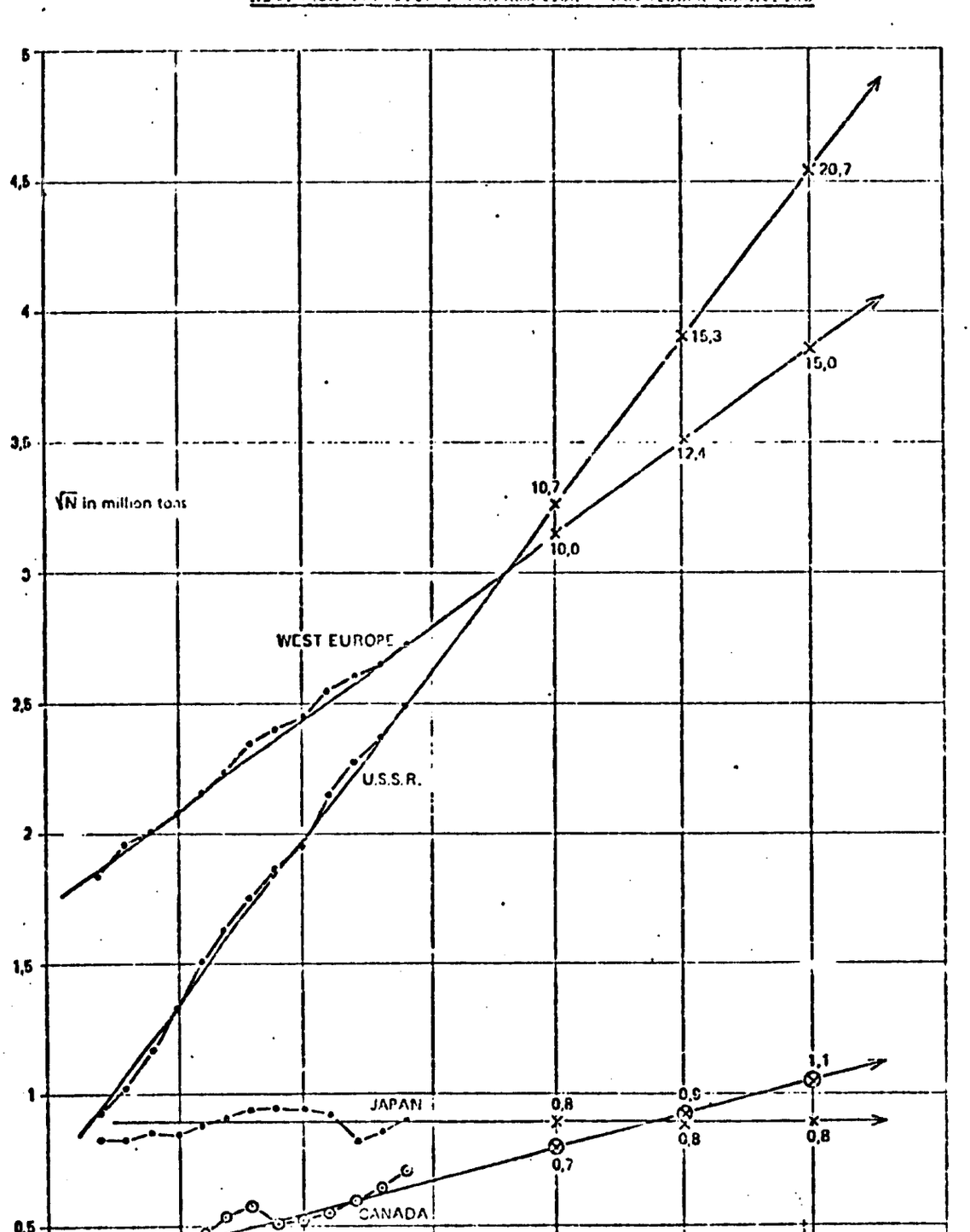
Nitrogen fertilizer consumption - Asian countries



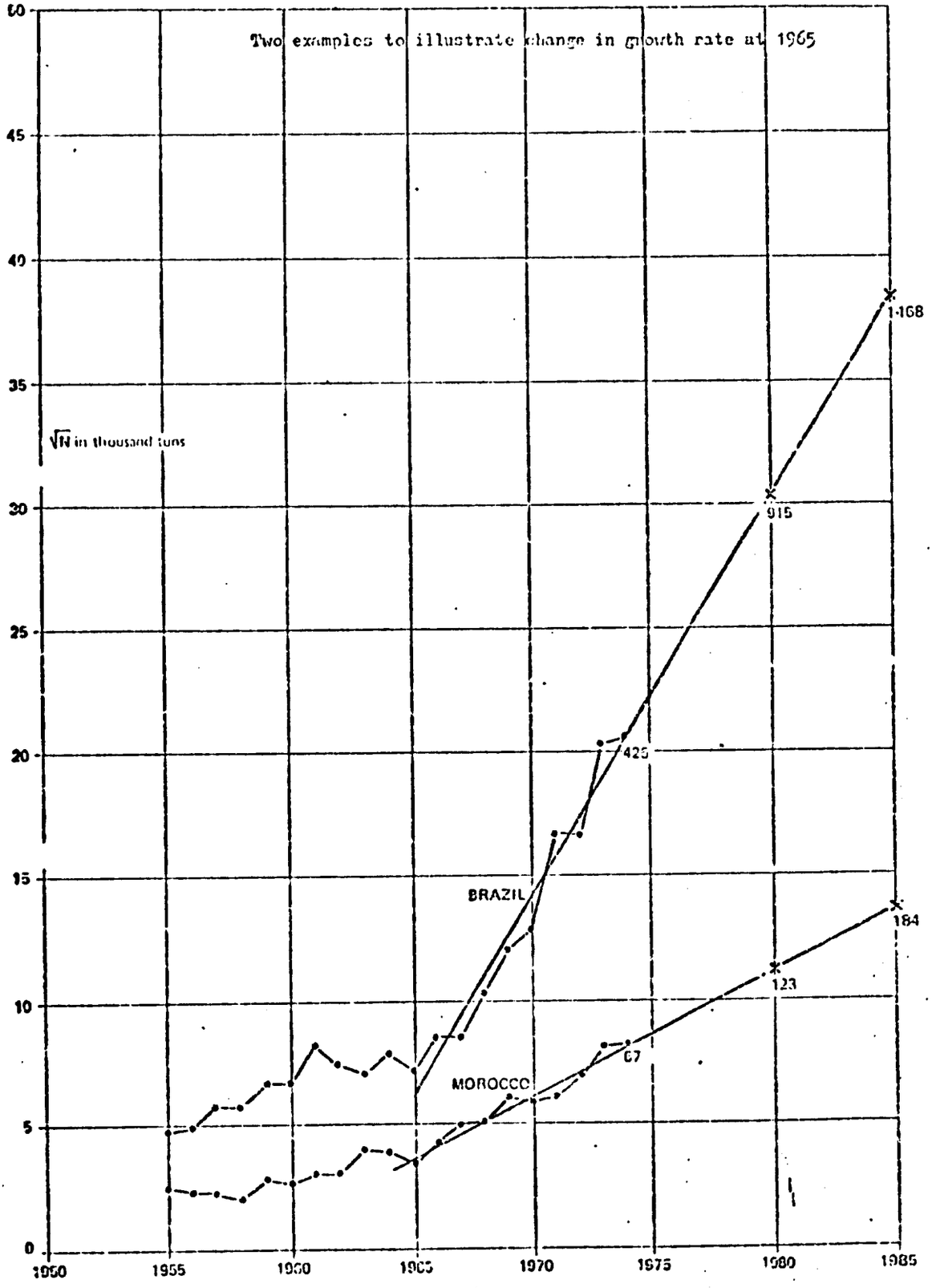
Nitrogen fertiliser consumption - developing countries



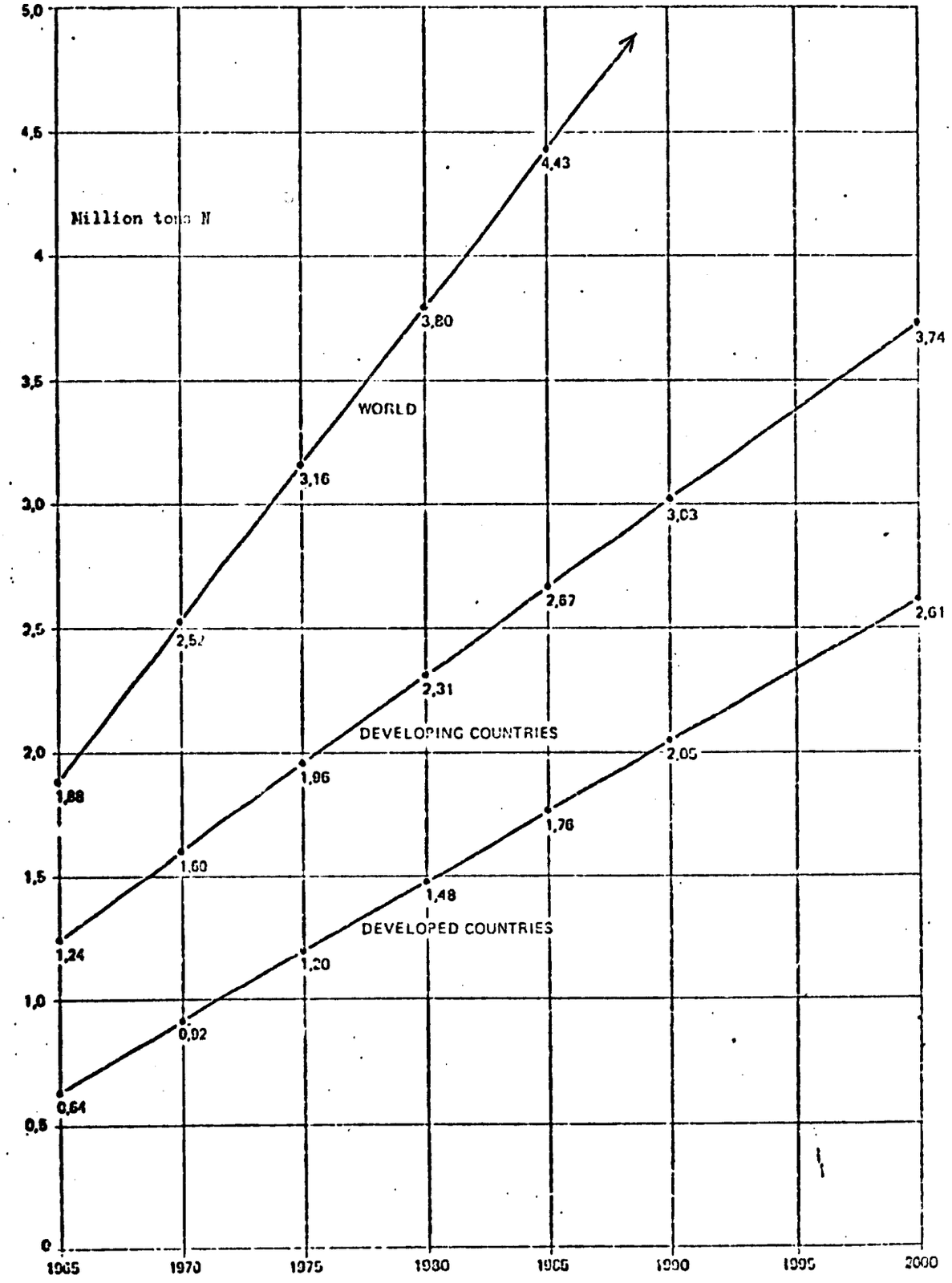
Nitrogen fertiliser consumption - developed countries



Nitrogen fertilizer consumption



Annual increase in nitrogen fertilizer demand



FERTILIZER CONSUMPTION - 1973/74

(Including all countries over 5,000,000 population in 1974)
(All data in thousand tons of nutrients)
(Countries listed in order of N P K consumption)
(Developed countries in capital letters)

	N	P_2O_5	K_2O	NPK
1. U.S.A.	8,277	4,600	4,614	17,491
2. U.S.S.R.	6,256	2,699	3,605	12,560
3. FRANCE	1,833	2,147	1,833	5,813
4. China	3,815	1,390	528	5,733
5. POLAND	1,069	847	1,413	3,329
6. GERMANY, FR	1,101	917	1,163	3,181
7. India	1,835	634	314	2,783
8. JAPAN	821	793	685	2,299
9. UNITED KINGDOM	874	478	498	1,850
10. GERMANY, DR	666	431	658	1,755
11. Brazil	425	725	523	1,673
12. SPAIN	716	481	265	1,462
13. AUSTRALIA	176	1,171	104	1,451
14. CZECHOSLOVAKIA	448	393	576	1,417
15. ITALY	672	476	268	1,416
16. HUNGARY	493	322	387	1,202
17. CANADA	498	480	205	1,183
18. ROMANIA	420	320	53	793
19. Korea, Rep.	411	196	150	757
20. Mexico	531	181	36	748
21. DENMARK	365	155	216	736
22. YUGOSLAVIA	368	193	174	735
23. Turkey	430	280	13	723
24. South Africa	231	327	126	684
25. BULGARIA	328	259	46	633
26. NETHERLANDS	397	107	114	618
27. SWEDEN	253	161	144	568
28. BELGIUM	165	166	193	524
29. Indonesia	350	85	40	475
30. Egypt	390	75	3	468
31. AUSTRIA	132	116	159	407
32. Pakistan	342	56	3	403
33. Korea, DPR	240	112	45	397
34. GREECE	232	141	22	395
35. Colombia	154	100	58	312
36. Iran	177	114	1	292

FERTILIZER CONSUMPTION (cont'd)

	N	P_2O_5	K_2O	NPK
37. Cuba	130	50	97	277
38. Malaysia	113	37	112	262
39. PORTUGAL	142	78	28	248
40. Philippines	146	45	45	236
41. Algeria	94	84	38	216
42. Chile	59	116	14	189
43. Bangladesh	122	44	11	177
44. Vietnam, South	110	34	18	162
45. Thailand	70	45	40	155
46. SWITZERLAND	42	52	54	148
47. Rhodesia	70	44	32	146
48. Morocco	67	45	25	137
49. Peru	81	9	8	98
50. Argentina	51	28	17	96
51. Sri Lanka	51	12	32	95
52. Venezuela	41	23	21	85
53. Sudan	70	-	-	70
54. Vietnam, DR	15	50	5	70
55. Burma	42	15	-	57
56. Ecuador	29	15	9	53
57. Guatemala	32	13	4	49
58. Kenya	20	21	3	44
59. Syria	33	8	2	43
60. Tunisia	19	18	6	43
61. Iraq	25	15	1	41
62. Afghanistan	30	7	-	37
63. Angola	12	8	8	28
64. Ethiopia	9	10	-	19
65. Tanzania	11	5.3	3	19
66. Cameroon	9.3	2.3	4.6	16
67. Mozambique	9.0	3.2	1.8	14
68. Nepal	9.0	4.4	0.6	14
69. Madagascar	5.0	3.5	4.6	13
70. Nigeria	4.7	4.1	2.5	11
71. Mali	5.0	3.8	-	8.8
72. Saudi Arabia	4.0	1.2	3.2	8.4
73. Bolivia	4.8	2.0	1.3	8.1
74. Uganda	4.0	2.4	0.8	7.2
75. Zaire	3.2	1.6	1.8	6.6
76. Ghana	1.0	2.6	2.1	5.7

FERTILIZER CONSUMPTION (cont'd)

	N	P_2O_5	K_2O	NPK
77. Cambodia	1.0	1.0	-	2.0
78. Upper Volta	0.4	0.1	0.1	0.6
79. Yemen, AR	0.4	-	-	0.4
DEVELOPED COUNT.	27,284	18,907	18,087	64,278
DEVELOPING "	11,373	5,346	2,613	19,332
WORLD TOTAL	38,657	24,253	20,700	83,610

Source: FAO Production Yearbook, 1974

NITROGEN FERTILIZER - COUNTRY ANALYSIS - 1973/74

(In thousand tons N)

25 Largest Producers		25 Largest Consumers		25 Largest Surpluses		25 Largest Deficits	
1.U.S.A.	9,152	1.U.S.A.	8.277	1.Japan	1,341	1.China	1,084
2.U.S.S.R.	7,241	2.U.S.S.R.	6,256	2.U.S.S.R.	985	2.India	785
3.China	2,731	3.China	3,815	3.U.S.A.	875	3.Egypt	329
4.Japan	2,162	4.India	1,835	4.Netherlands	816	4.Turkey	295
5.France	1,694	5.France	1,833	5.Belgium	487	5.Denmark	282
6.Germany, FR	1,473	6.Germany, FR	1,101	6.Italy	439	6.Brazil	260
7.Poland	1,366	7.Poland	1,069	7.Romania	434	7.Indonesia	259
8.Netherlands	1,213	8.U.K.	874	8.Germany, FR	372	8.Germany, DR	255
9.Italy	1,111	9.Japan	821	9.Norway	359	9.Mexico	155
10.India	1,050	10.Spain	716	10.Poland	295	10.France	139
11.Romania	854	11.Italy	672	11.Canada	291	11.U.K.	119
12.Canada	789	12.Germany, DR	666	12.Kuwait	289	12.Cuba	110
13.Spain	773	13.Mexico	531	13.Bulgaria	191	13.Vietnam, Sth	110
14.U.K.	755	14.Canada	498	14.Austria	99	14.Philippines	93
15.Belgium	652	15.Hungary	493	15.Trinidad	60	15.Sweden	85
16.Bulgaria	519	16.U.S.S.R.	448	16.Spain	57	16.Sudan	70
17.Korea, Rep.	447	17.Turkey	430	17.Saudi Arabia	57	17.Hungary	69
18.Norway	445	18.Brazil	425	18.Chile	47	18.Colombia	68
19.U.S.S.R.	424	19.Romania	420	19.Korea, Rep.	36	19.Malaysia	67
20.Hungary	424	20.Korea, Rep.	411	20.Finland	34	20.Thailand	62
21.Germany, DR	411	21.Netherlands	397	21.Greece	24	21.El Salvador	61
22.Mexico	376	22.Egypt	380	22.Portugal	22	22.Peru	59
23.Yugoslavia	350	23.Yugoslavia	368	23.Australia	21	23.Morocco	55
24.Pakistan	300	24.Denmark	365	24.South Africa	16	24.Sri Lanka	51
25.Kuwait	289	25.Indonesia	350	25.Qatar	14	25.Pakistan	42

Source: FAO Production Yearbook, 1974

SUMMARY OF SUPPLY/DEMAND FOR FERTILIZER - 1974-2000

(In million tons N, P_2O_5, K_2O, NPK)

	Developed Countries			Developing Countries			World		
Nitrogen	Demand	Supply	Balance	Demand	Supply	Balance	Demand	Supply	Balance
1973/74	27.28	31.65	+4.37	11.37	6.87	-4.50	38.65	38.52	-0.13
1979/80	40.27	41.67	+1.40	19.96	17.19	-2.77	60.23	58.86	-1.37
1984/85	52.7	n.p.	n.p.	28.5	n.p.	n.p.	81.2	n.p.	n.p.
1989/90	66.9	n.p.	n.p.	38.6	n.p.	n.p.	105.5	n.p.	n.p.
1999/2000	100.6	n.p.	n.p.	63.5	n.p.	n.p.	164.1	n.p.	n.p.
Phosphate									
1973/74	18.91	20.12	+1.21	5.35	3.77	-1.58	24.26	23.89	-0.37
1979/80	23.92	26.29	+2.37	9.13	9.04	-0.09	33.05	35.31	+2.28
1984/85	28.7	n.p.	n.p.	13.3	n.p.	n.p.	42.0	n.p.	n.p.
1989/90	34.1	n.p.	n.p.	18.2	n.p.	n.p.	52.3	n.p.	n.p.
1999/2000	46.3	n.p.	n.p.	30.4	n.p.	n.p.	76.7	n.p.	n.p.
Potash									
1973/74	18.09	20.07	+1.98	2.61	1.04	-1.57	20.70	21.11	+0.41
1979/80	23.63	30.41	+6.78	4.58	1.55	-3.03	28.21	31.96	+3.75
1984/85	29.3	n.p.	n.p.	6.8	n.p.	n.p.	36.1	n.p.	n.p.
1989/90	35.7	n.p.	n.p.	9.3	n.p.	n.p.	45.0	n.p.	n.p.
1999/2000	50.5	n.p.	n.p.	15.9	n.p.	n.p.	66.4	n.p.	n.p.
NPK									
1973/74	64.28	71.84	+7.56	19.33	11.68	-7.65	83.61	83.52	-0.09
1979/80	87.82	98.37	+10.55	33.67	27.76	-5.91	121.49	126.13	+4.64
1984/85	110.7	n.p.	n.p.	48.6	n.p.	n.p.	159.3	n.p.	n.p.
1989/90	136.7	n.p.	n.p.	66.1	n.p.	n.p.	202.8	n.p.	n.p.
1999/2000	197.4	n.p.	n.p.	109.8	n.p.	n.p.	307.2	n.p.	n.p.

n.p. = Not possible to estimate at this time.

PAST CONSUMPTION AND FUTURE DEMAND FOR NITROGEN FERTILIZER

(Regional summary)

In million tons N

	Past consumption				Future demand			
DEVELOPING COUNTRIES	1960	1965	1970	1974	1980	1985	1990	2000
Asia *	1.3	2.4	5.8	8.4	15.3	22.0	29.9	49.5
- China	(0.6)	(1.1)	(2.7)	(3.8)	(6.6)	(9.3)	(12.4)	(20.2)
- India	(0.2	(0.5)	(1.4)	(1.8)	(3.6)	(5.2)	(7.2)	(12.0)
- Rest of Asia	(0.5)	(0.8)	(1.7)	(2.8)	(5.1)	(7.5)	(10.3)	(17.3)
Africa	0.2	0.5	0.7	1.1	1.7	2.4	3.2	5.1
Latin America	0.4	0.7	1.2	1.8	2.9	4.1	5.5	9.0
Total, DGC's	1.9	3.6	7.7	11.3	19.9	28.5	38.6	63.6
DEVELOPED COUNTRIES								
U.S.A.	2.5	4.2	6.8	8.3	11.6	14.6	18.0	25.8
Canada	0.1	0.2	0.3	0.5	0.7	0.9	1.1	1.7
West Europe	3.0	4.3	5.0	7.4	10.0	12.4	15.0	21.0
East Europe	0.9	1.6	3.0	3.8	6.2	8.3	10.7	16.5
U.S.S.R.	0.7	1.7	3.8	6.3	10.7	15.3	20.7	34.0
Japan	0.6	0.7	0.9	0.8	0.8	0.8	0.8	0.8
Oceania	0.0	0.1	0.2	0.2	0.3	0.4	0.6	0.8
Total, DDC's	7.8	12.8	21.0	27.3	40.3	52.7	66.9	100.6
Total, World	9,7	16.4	28.7	38.6	60.2	81.2	105.5	164.2

For comparison, future demand as calculated by regression equations based on aggregate data for DDC's, DGC's and World:

Developing countries $\sqrt{N} = 1.92 + 0.166T$	19.4	27.5	36.8	59.3
Developed countries $\sqrt{N} = 3.69 + 0.174T$	39.7	51.4	64.6	95.6
Sum of developed + developing	59.1	78.9	101.4	155.4
Total, WORLD $\sqrt{N} = 4.15 + 0.235T$	58.9	78.3	100.5	153.1

FUTURE DEMAND FOR NITROGEN FERTILIZER

Detailed data on countries and regions

(In thousand tons N)

(Countries listed in order of estimated population in year 2000)

	Regression equations based on 1965 - 74	Future demand 1980	1985	1990	2000
ASIA*					
China	$\sqrt{N} = 35.41 + 3.048T$	6,580	9,290	12,460	20,190
India	$\sqrt{N} = 22.79 + 2.481T$	3,600	5,240	7,190	12,020
Indonesia	$\sqrt{N} = 7.68 + 1.117T$	595	900	1,270	2,190
Pakistan	$\sqrt{N} = 8.62 + 1.297T$	790	1,190	1,680	2,920
Bangladesh	$\sqrt{N} = 6.25 + 0.557T$	215	300	410	665
Philippines	$\sqrt{N} = 6.88 + 0.522T$	230	320	430	685
Thailand	$\sqrt{N} = 4.64 + 0.439T$	125	180	245	400
Turkey	$\sqrt{N} = 7.19 + 1.484T$	865	1,360	1,960	3,500
Iran	$\sqrt{N} = 3.63 + 0.949T$	315	505	735	1,330
Korea Rep.	$\sqrt{N} = 13.80 + 0.743T$	620	820	1,050	1,580
Vietnam,DR	$\sqrt{N} = 8.44 + 0.254T$	150	185	220	300
Vietnam, South	$\sqrt{N} = 5.30 + 0.762T$	280	420	595	1,020
Korea, DPR	$\sqrt{N} = 9.06 + 0.731T$	400	560	745	1,200
Malaysia	$\sqrt{N} = 5.36 + 0.466T$	150	215	290	470
Sri Lanka	$\sqrt{N} = 6.50 + 0.098T$	64	72	80	99
Other countries	$\sqrt{N} = 8.50 + 0.626T$	320	440	585	925
Total, Asia*	(Sum of above)	15,299	21,997	29,945	49.494
AFRICA					
Egypt	$\sqrt{N} = 15.55 + 0.397T$	460	550	650	865
South Africa	$\sqrt{N} = 9.12 + 0.731T$	405	565	750	1,205
Sudan	$\sqrt{N} = 4.54 + 0.437T$	125	175	240	395
Algeria	$\sqrt{N} = 2.52 + 0.713T$	175	280	415	755
Morocco	$\sqrt{N} = 3.67 + 0.495T$	125	185	255	440
Rhodesia	$\sqrt{N} = 6.13 + 0.204T$	84	105	125	175
Other countries	$\sqrt{N} = 8.08 + 0.769T$	385	550	745	1,225
Total, Africa	(Sum of above)	1,759	2,410	3,180	5,060
LATIN AMERICA					
Brazil	$\sqrt{N} = 6.09 + 1.611T$	915	1,470	2,150	3,900
Mexico	$\sqrt{N} = 15.23 + 0.909T$	835	1,120	1,440	2,210
Colombia	$\sqrt{N} = 5.81 + 0.531T$	190	270	365	595
Central America*	$\sqrt{N} = 8.57 + 0.578T$	295	405	530	830
Argentina	$\sqrt{N} = 4.63 + 0.288T$	80	110	140	215
Peru	$\sqrt{N} = 7.84 + 0.134T$	97	110	125	155
Venezuela	$\sqrt{N} = 4.47 + 0.159T$	47	58	71	100
Chile	$\sqrt{N} = 5.19 + 0.227T$	74	95	120	170
Cuba	$\sqrt{N} = 9.75 + 0.293T$	200	245	290	400
Dominican Rep.	$\sqrt{N} = 2.60 + 0.377T$	68	105	145	250
Other countries	$\sqrt{N} = 8.22 + 0.113T$	100	110	120	150
Total, Latin America	(Sum of above)	2,901	4,038	5,496	8,975
Total, DCS's	(Sum of above)	19,959	28,505	38,621	63,529

Central America = 6 countries

DEVELOPED COUNTRIES

U.S.A.	$\sqrt{N} = 67.82 + 2.649T$	11,570	14,590	17,970	25,770
Canada	$\sqrt{N} = 13.77 + 0.787T$	655	870	1,120	1,710
West Europe	$\sqrt{N} = 66.41 + 2.243T$	10,010	12,380	15,000	21,000
East Europe	$\sqrt{N} = 41.29 + 2.487T$	6,180	8,290	10,700	16,470
U.S.S.R.	$\sqrt{N} = 42.93 + 4.043T$	10,730	15,320	20,740	34,020
Japan	$\sqrt{N} = 28.28$ (constant)	800	800	800	800
Occania	$\sqrt{N} = 9.74 + 0.555T$	325	435	560	850
Total, DDC's	(Sum of above)	40,270	52,685	66,890	100,620
Total, WORLD	(Sum of above)	60,229	81,190	105,511	164,149

SUPPLY/DEMAND BALANCE OF NITROGEN FERTILIZER

Regional summary

(In million tons N)

	Consumption/Demand		Available Supply		Surplus (+) Deficit (-)	
	1974	1980	1974	1980	1974	2000
DEVELOPING COUNTRIES						
Asia*	8.46	15.30	5.56	13.40	-2.90	-1.90
- China	(3.82)	(6.58)	(2.59)	(5.14)	(-1.23)	(-1.44)
- India	(1.83)	(3.60)	(1.00)	(3.34)	(-0.83)	(-0.26)
- Rest of Asia	(2.81)	(5.12)	(1.97)	(4.92)	(-0.84)	(-0.20)
Africa	1.11	1.76	0.43	1.58	-0.68	-0.18
Latin America	1.80	2.90	0.88	2.21	-0.92	-0.69
Total, DGC's	11.37	19.96	6.87	17.19	-4.50	-2.77
DEVELOPED COUNTRIES						
U.S.A.	8.27	11.57	8.69	10.01	+0.42	-1.56
Canada	0.50	0.65	0.75	1.28	+0.25	+0.63
West Europe	7.33	10.01	8.92	10.69	+1.54	+0.68
East Europe	3.83	6.18	4.17	7.00	+0.34	+0.82
U.S.S.R.	6.26	10.73	6.88	10.26	+0.62	-0.47
Japan	0.82	0.80	2.05	2.21	+1.23	+1.41
Oceania	0.22	0.33	0.19	0.22	-0.03	-0.11
Total, DDC's	27.28	40.27	31.65	41.67	+4.37	+1.40
TOTAL, WORLD	38.65	60.23	38.52	58.86	-0.13	-1.37

SUPPLY/DEMAND BALANCE OF NITROGEN FERTILIZER

Detailed data on countries and regions

(in thousand tons N)

(Countries listed in order of estimated population in the year 2000)

	Consumption/Demand		Available supply		Surplus (+) Deficit (-)	
	1974	1980	1974	1980	1974	1980
ASIA *						
China	3,815	6,580	2,594	5,143	-1,221	-1,437
India	1,835	3,600	998	3,335	-837	-265
Indonesia	350	595	86	534	-264	-61
Pakistan	342	790	285	714	-57	-76
Bangladesh	122	215	123	213	+1	-2
Philippines	146	230	50	90	-96	-140
Thailand	70	125	8	15	-62	-110
Turkey	430	865	128	360	-302	-505
Iran	177	315	136	431	-41	+116
Korea, Rep.	411	620	425	771	+14	+151
Vietnam, D.R.	15	150	nil	nil	-15	-150
Vietnam, South	110	280	nil	nil	-110	-280
Korea, D.P.R.	240	400	228	397	-12	-3
Malaysia	113	150	44	50	-69	-100
Sri Lanka	51	64	nil	39	-51	-25
Other countries	228	320	456	1,304	+228	+984
Total, Asia *	8,455	15,299	5,561	13,396	-2,894	-1,903
AFRICA						
Egypt	380	460	48	525	-332	+65
South Africa	231	405	235	435	+4	+30
Sudan	70	125	nil	nil	-70	-125
Algeria	93	175	49	210	-44	+35
Morocco	67	125	11	100	-56	-25
Rhodesia	70	84	57	70	-13	-14
Other countries	202	385	27	241	-175	-144
Total, Africa	1,113	1,759	427	1,581	-686	-178

	Consumption/Demand		Available supply		Surplus (+) Deficit (-)	
	1974	1980	1974	1980	1974	1980
LATIN AMERICA						
Brazil	425	915	157	482	-268	-433
Mexico	531	835	357	924	-174	+91
Colombia	154	190	82	127	-72	-63
Central America *	200	295	32	67	-168	-230
Argentina	51	80	36	39	-15	-41
Peru	80	97	20	72	-60	-25
Venezuela	41	47	5	102	-36	+55
Chile	59	74	102	115	+43	+41
Cuba	130	200	19	155	-111	-45
Dominican Rep.	41	68	nil	nil	-41	-68
Other countries	92	100	74	130	-18	+30
Total, Latin America	1,804	2,901	884	2,213	-920	- 688
Total, DGC's	11,372	19,959	6,872	17,190	-4,500	-2,769
DEVELOPED COUNTRIES						
U.S.A.	8,275	11,570	8,692	10,010	+417	-1,560
Canada	500	655	751	1,284	+251	+629
West Europe	7,385	10,010	8,925	10,686	+1,540	+676
East Europe	3,830	6,180	4,166	7,002	+336	+822
U.S.S.R.	6,255	10,730	6,878	10,253	+623	-477
Japan	820	800	2,052	2,212	+1,232	+1,412
Oceania	215	325	185	223	-30	-102
Total, DDC's	27,280	40,270	31,649	41,670	+4,369	+1,400
Total, WORLD	38,652	60,229	38,521	58,860	-131	-1,369

* Central America = 6 countries

COMPARISON OF NITROGEN DEMAND PROJECTIONS FOR 1979/80 (1)

(in million tons N)

	TVA(2) March 1974	IBRD (3) July 1975	Joint working group April 1976	This report Table 8(b)
Developed market economies				
North America	11.24-12.54	11.7	11.24	12.22
West Europe	9.22-9.74	10.0	9.47	10.44
Oceania	0.22-0.39	1.6	0.28	0.32
Japan	0.75-1.09		0.81	0.80
Israel	0.04-0.05		0.04	0.04
South Africa	0.33-0.41		0.42	0.41
Total, DDME	21.80-24.22	23.3	22.26	24.23
Developing market economies				
Africa	7.52-9.21	0.8	0.77	0.75
Near East		9.3	8.53	8.74
Far East				
Latin America	2.85-3.29	3.0	2.94	2.90
Total, DCME	10.37-12.50	13.1	12.24	12.39
Centrally planned economies				
East Europe + USSR	14.80-16.48	14.3	15.10	16.48
Socialist Asia	6.13-7.56	6.6	5.96	7.13
Total, CPE	20.93-24.04	20.9	21.06	23.61
Developed regions	36.60-40.70	37.6	37.36	40.71
Developing regions	16.50-20.06	19.7	18.20	19.52
WORLD	53.10-60.76	57.3	55.56	60.23

(1) Projections in Table 8(b) have been re-grouped in this Table to conform to the regional grouping used by TVA, IBRD and the UNIDO/FAC/World Bank Working Group on Fertilizers.

(2) "World Fertilizer Market Review and Outlook", National Fertilizer Development Center, Tennessee Valley Authority, Muscle Shoals, Alabama, March 1974.

(3) "Fertilizer Requirements of Developing Countries, Revised Outlook in 1975", Report No. 830, IBRD, Washington. July 1975.

(4) Unpublished projections prepared by the Centre d'Etude de l'Azote (Zurich) for the UNIDO/FAO/World Bank Working Group on Fertilizers, April 1974.

ANNUAL INCREASE IN NITROGEN FERTILIZER DEMAND

	1965	1970	1975	1980	1985	1990	2000
Developing countries							
Asia*	489	722	957	1,191	1,425	1,659	2,126
- China	(215)	(307)	(400)	(492)	(584)	(676)	(860)
- India	(117)	(178)	(239)	(299)	(360)	(421)	(543)
- Rest of Asia	(157)	(237)	(318)	(400)	(481)	(562)	(723)
Africa	57	75	92	110	128	145	181
Latin America	91	122	152	182	212	242	303
Total, DCC's	637	919	1,201	1,483	1,765	2,046	2,610
Developed countries							
U. S. A.	360	430	501	571	642	712	853
Canada	22	28	34	41	47	53	66
West Europe	298	349	399	449	500	550	651
East Europe	205	268	330	393	455	518	642
U. S. S. R.	348	512	676	840	1,003	1,168	1,495
Japan	nil	nil	nil	nil	nil	nil	nil
Oceania	11	13	16	19	22	26	31
Total, DDC's	1,244	1,600	1,956	2,313	2,669	3,026	3,738
Total, World	1,881	2,519	3,157	3,796	4,434	5,072	6,348

Based on regression equations of the type $\sqrt{N} = A + BT$ given in Table 8(b)

Annual increase in N demand = $\frac{dN}{dT} = 2AB + 2B^2T$

ANNUAL RATE OF GROWTH OF NITROGEN FERTILIZER DEMAND

(Percent per year)

	1965	1970	1975	1980	1985	1990	2000
Developing countries							
Asia*	19.9	13.1	9.8	7.8	6.5	5.5	4.3
- China	(17.1)	(12.0)	(9.2)	(7.5)	(6.3)	(5.5)	(4.3)
- India	(20.8)	(13.7)	(10.2)	(8.1)	(6.8)	(5.8)	(4.5)
- Rest of Asia	(20.7)	(13.6)	(10.2)	(8.1)	(6.7)	(5.8)	(4.5)
Africa	12.3	9.4	7.6	6.4	5.5	4.9	3.9
Latin America	13.3	10.0	8.0	6.6	5.7	5.0	4.0
Total, DCC's	18.8	12.5	9.3	7.4	6.2	5.3	4.1
Developed countries							
U. S. A.	7.9	6.6	.6	4.9	4.4	4.0	3.3
Canada	11.4	8.9	7.2	6.1	5.3	4.7	3.8
West Europe	6.8	5.7	5.1	4.5	4.0	3.7	3.1
East Europe	12.2	9.3	7.6	6.4	5.5	4.8	3.9
U. S. S. R.	18.8	12.8	9.7	7.8	6.5	5.6	4.4
Japan	nil	nil	nil	nil	nil	nil	nil
Oceania	10.9	8.6	7.1	6.0	5.2	4.6	3.8
Total, DDC's	9.7	7.9	6.6	5.7	5.1	4.5	3.7
Total, World	12.8	9.6	7.6	6.4	5.5	4.8	3.9

Based on regression equations of the type $\sqrt{N} = A + BT$ given in Table 8(b)

Annual rate of growth (percent per year) $= \frac{dN}{NdT} = \frac{2AB + 2B^2T}{A^2 + 2ABT + B^2T^2}$

Capital and production costs of ammonia-urea plants in developing countries

Feedstock	Natural Gas		Naphtha		Fuel Oil		Coal	
Feedstock price ($)[a]	0.5/1,000scf		140/ton		80/ton		12.5/ton	
Output: ammonia tons/day	1,000	600	1,000	600	1,000	600	1,000	600
urea tons/day	1,720	1,030	1,720	1,030	1,720	1,030	1,720	1,030
urea '000 tons/year[b]	516	310	516	310	516	310	483	290
Capital costs ($m): ammonia[c]	103	72	115	80	140	98	195	130
urea[c]	67	47	67	47	67	47	67	47
Total fixed capital	170	119	182	127	207	145	262	177
Working capital	9	5	17	10	14	8	12	7
Total	179	124	199	137	221	153	274	184
Total: $/ton/N/yr.	754	871	839	962	931	1,075	1,234	1,381
Production costs ($/ton urea):								
Feedstock and fuel[d]	13.7	13.7	73.0	73.0	52.4	52.4	26.3	26.3
Other operating costs[e]	25.9	30.0	27.2	31.8	29.5	34.4	36.5	44.1
	39.6	43.7	100.2	104.8	81.9	87.8	52.8	70.4
Depreciation (8 1/3 per cent)[f]	27.5	32.0	29.5	34.2	33.4	39.0	45.4	50.9
	67.1	75.7	129.7	139.0	115.3	126.8	104.9	121.3
Profit (10 per cent)[g]	34.7	40.0	38.7	44.2	42.8	49.4	56.7	63.4
Total	102	116	168	183	158	176	162	185

a/ The assumptions underlying the feedstock prices are that naphtha and fuel oil are imported: natural gas is in surplus; and the coal-based plant is located near the coalfield.

b/ The annual outputs are calculated assuming 300 days a year at full production for natural gas, naphtha and fuel oil, and 280 days for coal.

c/ The division between ammonia and urea is somewhat arbitrary since the two plants use a common site and facilities. The ammonia plant costs include a 10-15 mW power station to make the plants independent of external power supplies. The capital costs:

(i) Are based on December 1975 prices;
(ii) Make no allowance for inflation or for interest charges during plant construction;
(iii) Exclude road and rail connections to the site, water supply and effluent disposal outside the site boundary, as well as housing and amenities for employees;
(iv) Include a 10 per cent contingency allowance and pre-operating expenses at 2.5 per cent of fixed capital;
(v) Refer to plants in developing countries on a "green field" site;
(vi) Include one month's storage capacity for feedstock/fuel; and for the large plants, storage capacity for 4,000 tons ammonia, 75,000 tons bulk urea and 10,000 tons bagged urea.

d/ Includes feedstock for ammonia production, and fuel for steam and power generation. Where natural gas is available as a feedstock, it is also used as fuel; in the other plants, coal is used as fuel. Where coal is used as feedstock, a relatively low-grade material (a calorific value of 5,500 cal/kg) is assumed. The same material is used as fuel in the naphtha and fuel oil-based plants, but at a cost of $ 17.5 a ton to allow for higher transport costs.

e/ Includes bags (50 kg. polythene) at $ 6.9 a ton, taxes and insurance at 0.5 per cent of fixed capital, selling expenses at $ 1.6 a ton for the larger plant and $ 2.0 a ton for the smaller plant, and maintenance. Maintenance is taken as 2.5 per cent of capital for natural gas and naphtha ammonia plants; 2.75 per cent for fuel oil ammonia plants; 3 per cent for coal ammonia plants; and 3.5 per cent for urea plants.

f/ This gives complete depreciation over twelve years.

g/ This is an arbitrary figure and is low for any normal commercial organization.

Nitrogen fertilizers - plant required and total capital cost: 1980-2000 (Alternative B)

(Except where otherwise stated all figures are in million metric tons of nitrogen)

	Developing countries				Developed countries			
	1980	1985	1990	2000	1980	1985	1990	2000
Ammonia								
Forecast demand	20.0	28.5	38.6	63.5	40.3	52.7	66.9	100.6
Exports/imports	-2.8	-	+5.0	+17.8	+1.4	-	-5.0	-17.8
Production	18.6	30.9	47.3	83.6	43.7	55.7	65.7	88.6
Utilization per cent	60.0	71.0	77.5	83.0	80.0	86.0	89.0	89.0
Production capacity	31.0	43.7	61.2	106.3	54.6	65.1	73.7	99.2
Increase in capacity		12.7	17.5	45.1		10.5	8.6	25.5
Capacity replaced		0.4	0.6	5.5		3.0	3.8	19.4
Total new capacity		13.1	18.1	50.6		13.5	12.4	44.9
Plants (1,000 t/day)		48	67	186		50	46	165
Cost: $ billion		5.4	7.9	22.5		4.1	3.8	13.4
Solid fertilizers								
Production	16.6	26.4	38.4	70.6	31.9	41.6	50.3	68.8
Utilization per cent	60.0	69.5	76.5	82.5	80.0	85.0	87.5	89.0
Production capacity	27.7	38.0	50.2	85.5	39.2	49.0	56.8	77.2
Increase in capacity		10.3	12.2	35.3		9.1	7.8	20.4
Capacity replaced		0.3	0.5	4.9		2.2	2.8	14.2
Total new capacity		10.6	12.7	40.2		11.3	10.6	34.6
Urea plants (1,720 t/day)		40	49	154		43	41	132
Cost: $ billion		2.8	3.4	10.4		2.2	2.0	6.2

Notes: See page 43

Nitrogen fertilizers - plant required and total capital cost: 1980-2000 (Alternative A)

(Except where otherwise stated, all figures are in million metric tons of nitrogen)

	Developing countries				Developed countries			
	1980	1985	1990	2000	1980	1985	1990	2000
Ammonia								
Forecast demand	20.0	28.5	38.6	63.5	40.3	52.7	66.9	100.6
Production	18.6	29.4	41.8	69.0	43.7	57.2	71.2	108.1
Utilization per cent	60.0	71.0	77.5	83.0	80.0	86.0	88.0	88.0
Production capacity	31.0	41.6	54.1	82.9	54.6	67.1	81.3	123.2
Increase in capacity		10.6	12.5	28.8		12.5	14.2	41.9
Capacity replaced		0.4	0.6	5.5		3.0	3.8	19.4
Total new capacity		11.0	13.1	34.3		15.5	18.0	61.3
Plants (1,000 t/day)		40	50	126		57	66	225
Cost: $ billion		4.4	5.7	14.5		4.7	5.7	18.9
Solid fertilizers								
Production	16.6	24.9	34.1	54.1	31.9	43.1	54.4	84.3
Utilization per cent	60.0	70.0	76.0	82.5	80.0	84.5	86.0	87.5
Production capacity	27.7	35.9	44.7	65.7	39.9	51.0	62.6	96.5
Capacity increase		8.2	8.8	21.0		11.1	11.6	33.9
Capacity replaced		0.3	0.5	4.9		2.2	2.8	14.2
Total new capacity		8.5	9.3	25.9		13.3	14.4	48.1
Urea plants (1,720 t/day)		33	36	99		51	55	184
Cost: $ billion		2.3	2.4	6.6		2.6	2.8	9.0

Notes: (1) N production is higher than demand (in 1980 an allowance is made for imports to developing countries) to cover increases in stocks, and losses in the conversion of ammonia to solid fertilizers.

(2) The N production as urea is lower than it is as ammonia because some ammonia is used directly as a fertilizer; there are losses in converting ammonia to urea; and some ammonia is used in making ammonium phosphates.

Summary of plants required and total capital cost, 1980-2000

(Costs in billion $US)

	Developing countries				Developed countries			
	1980-85	1985-90	1990-2000	1980-2000	1980-85	1985-90	1990-2000	1980-2000
Alternative A								
No. of 1,000 tpd ammonia plants	40	50	126	216	57	66	225	348
No. of 1,720 tpd urea plants	33	36	99	168	51	55	184	290
No. of 600 tpd phosphate complexes	21	28	92	141	14	47	121	182
Ammonia capital	4.4	5.7	14.5	24.6	4.7	5.7	18.9	29.3
Urea capital	2.3	2.4	6.6	11.3	2.6	2.8	9.0	14.4
Phosphate capital	3.0	4.0	12.5	19.5	1.3	4.8	12.0	18.1
Total capital	9.7	12.1	33.6	55.4	8.6	13.3	39.9	61.8
Alternative B								
No. of 1,000 tpd ammonia plants	48	67	186	301	50	46	165	261
No. of 1,720 tpd urea plants	40	49	154	243	43	41	132	216
No. of 600 tpd phosphate complexes	21	56	111	188	14	22	100	136
Ammonia capital	5.4	7.9	22.5	35.8	4.1	3.8	13.4	21.3
Urea capital	2.8	3.4	10.4	16.6	2.2	2.0	6.2	10.4
Phosphate capital	3.0	8.2	15.4	26.6	1.3	1.9	9.7	12.9
Total capital	11.2	19.5	48.3	79.0	7.6	7.7	29.3	44.6

Notes: (1) Capital costs for developing countries are based upon the costs given in Tables 1 and 2 / For developed countries, the capital cost is assumed to be 77 per cent of that in a developing country. The cost of a replacement plant is assumed to be 70 per cent of the cost for a new plant, since such plants will usually be built on a developed site.

(2) It is assumed that new phosphate fertilizer production will be 20 per cent TSP and 80 per cent M/DAP.

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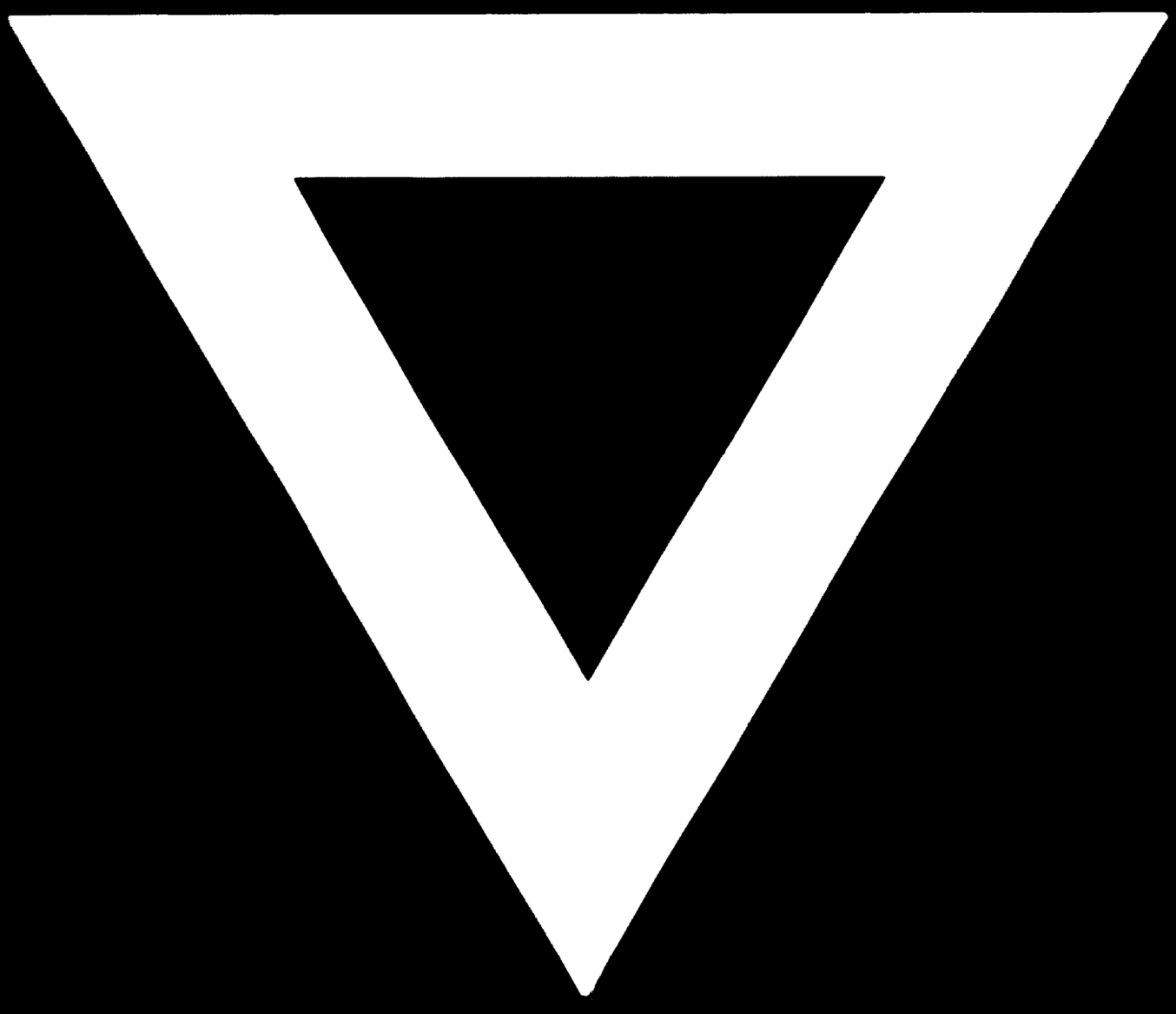

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