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DATE: 1st July 1976

TERMINAL REPORT

REPORT PART 1: SUMMARY REPORT

REPORT PART 2: STUDY OF THE USE OF FERTILIZERS, AMMONIUM NITRATE FOR EXPLOSIVES, AND AMMONIA IN LIBERIA.

REPORT PART 3: REVIEW OF FERTILIZERS AND THEIR RAW MATERIALS, MANUFACTURE, PROCUREMENT, SHIPMENT, DISTRIBUTION, AND APPLICATION, AND PREPARATORY STUDY OF A FERTILIZER BULK BLENDING AND BAGGING PLANT.

REPORT PART 4: FEASIBILITY STUDY AND ASSESSMENT OF AN AMMONIA PLANT, A NITRIC ACID AND AMMONIUM NITRATE PLANT, AND A NPK COMPOUND BLENDING AND GRANULATION PLANT AS PROPOSED BY N-REN CORPORATION.

LIBERIA
(IS/LIR/74/012)

by
Karl Kjeldgaard
expert of the United Nations Industrial Dvelopment Organization,
acting as Executive Agency for
the United Nations Development Programme.

This report has not been cleared with the United Nations Industrial Development Organization which does not therefore necessarily share the views presented (1)

(1) To be ommitted after clearance by UNIDO.

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ABBREVIATIONS

AN	Ammonium nitrate
AS	Ammonium sulphate
N	Nitrogen
P	Phosphorus
K	Potassium
O	Oxygen
MTPD	Metric tons per day (24 hours)
STPD	Short tons per day (24 hours)
MTPY	Metric tons per year
STPY	Short tons per year
NPK (17-17-17)	Means a NPK compound fertilizer containing 17% or 170 kgs. of N per metric ton, 17% or 170 Kgs. of P_2O_5 per metric ton and 17% or 170 Kgs. of K_2O per metric ton.
DAP	Di-ammonium-phosphate
MAP	Mono-ammonium-phosphate.
KCl	Potassium chloride, equal to Muriate of potash

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Date: 1st July 1976

TERMINAL REPORT

REPORT PART 1

SUMMARY REPORT

L I B E R I A

(IS/LIR/74/012)

by

Karl Kjeldgaard,

expert of the United Nations Industrial Development Organization,
acting of Executing Agency for
the United Nations Development Programme.

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1.1 Introduction

1.1.1 As a developing country Liberia finds herself at the threshold of commencing the application of chemical fertilizers in the tree crop plantations and in the fields, where upland rice, swamp rice and other tropical crops are grown.

Until now, chemical fertilizers have been spread at an optimal scale only in some of the rubber plantations operated by concessions, while the initiation and usefulness of fertilization is still being contemplated in the other important plantations of palm oil trees, coconut trees, coffee trees, and cocoa trees, where big increases of the cultivated areas are projected for the next years.

Fertilizers have been utilized so far in the rice fields merely in a very few and scattered areas. A series of fertilizer field trials have been carried out during the last years under the programme of the Ministry of Agriculture with assistance of experts from UNDP /FAO and USAID.

1.1.2 Since 1962 Exchem-West African Explosives and Chemicals Ltd. have established an explosives manufacturing plant at Charlesville, which supplies the explosives to the mining industry in Liberia and other West African countries.

All raw materials like ammonium nitrate, sodium nitrate, TNT, etc. for the manufacture and preparation of the explosives in this plant are being imported.

1.1.3 In the autumn of 1974 the Government of Liberia received from N-Ren Corporation a proposal on a chemical complex, consisting on an ammonia plant, a nitric acid and ammonium nitrate plant, and a NPK compound blending and granulation plant, to be built in Liberia.

The proposed factory should deliver NPK compound fertilizers to the growing domestic market, ammonium nitrate to the Exchem explosives plant, and the limited quantity of ammonia used in the rubber plantations for latex stabilization.

The design capacities of the complex has been suggested at 100.000 short tons of NPK compounds per year, 28.000 short tons of ammonium nitrate low density grade for explosives per year, and 3 000 short tons of excess ammonia per year for the rubber plantations.

The raw materials of the complex would be naphtha and fuel oil No. 2 delivered from Liberia Refining Company based on imported petroleum, and besides, imported di-ammonium-phosphate and imported muriate of potash.

1.1.4 In March 1976 the Government of Liberia received a revised and up-dated proposal from N-Ren Corporation with two alternatives: Alternative A corresponding to the previous alternative with some modifications, and Alternative B based on imported ammonia and no ammonia plant but otherwise identical to alternative A.

The end-products and design capacities of the revised proposal are similar to the qualities and figures given above, except that the quantity of ammonium nitrate has been slightly decreased to 25.000 short tons per year, because the phosphatic raw material has been changed from di-ammonium phosphate to mono-ammonium phosphate, which contains less ammonia and which also would have to be imported.

1.1.5 The Government of Liberia has asked its agency Liberian Development Corporation (LDC) to study and assess the feasibility of the N-Ren proposal and its relevance to Liberian conditions.

In the beginning of 1975 LDC requested through the Ministry of Planning and Economic Affairs and the Ministry of Foreign Affairs the United Nations Development Programme to furnish through the United Nations Industrial Development Organization technical assistance to carry out the above-mentioned feasibility and assessment study. UNDP/UNIDO have complied with this request and delegated the writer to Liberia on said mission.

Originally, this assistance had been defined in a job description of 30 July 1975 which, however, to some degree anticipated that the assessment study would conclude the project to be feasible and recommendable for realization.

1.1.6 Upon my arrival to Liberia, my tentative review of the N-Ren proposal book led me to conclude that the proposal after a detailed study and assessment would prove to be unfeasible.

Consequently, at the start and during the progress of my task it has being agreed with LDC to revise the job description, as follows:

(1) Study of the use of fertilizers, ammonium nitrate for explosives, and ammonia in Liberia.
(Report Part 2.)

(2) Review of fertilizers and their raw materials, manufacture, procurement, shipment, distribution, and application, and preparatory study of a fertilizer bulk blending and bagging plant.
(Report Part 3).

(3) Feasibility study and assessment of a chemical complex, consisting of an ammonia plant, a nitric acid and ammonium nitrate plant, and a NPK compound blending and granulation plant as proposed by N-Ren Corporation.
(Report Part 4).

1.1.7 My mission in the field started 20th December 1976 and will end 18th July 1976.

1.6

1.2 Summary

Report Part 2

1.2.1 This report part deals with the present consumption of NPK fertilizers, ammonium nitrate for explosives, and ammonia for the rubber plantations and the forecast maximum consumption of NPK fertilizers over the ensuing years in Liberia.

1.2.2. The import statistics of the Ministry of Planning and Economics Affairs on fertilizers, ammonium nitrate and sodium nitrate for explosives, and ammonia are reproduced and discussed in the report.

In addition, the various fertilizer grades and the respective quantities which have been imported through one of the largest import agents during 1969-1974 into Liberia are listed.

The few grants of fertilizers received by Liberia from abroad in recent years are given in the report.

1.2.3 The farming and tree crop plantations in Liberia are described and the cultivated areas at present and as projected over the next five years until 1981/82 are reviewed and broken down into the respective figures for wild oil palm areas, oil palm plantations, coconut plantations, coffee farms and plantations, cocoa farms and plantations, and the various field crops, etc. The traditional and still overwhelming field crop is upland rice, while rainfed and irrigated swamp rice is growing in importance.

The cultivated acreage is now 1,2 million, but may increase with approximately 250.000 acres to 1.45 million acres in 1981/82 if the projected increases for the next five years are realized. However, the total land area of Liberia is 26 million acres, which it is generally believed could nearly all be productively utilized. Therefore, Liberia has a huge land reserve.

The information and data on the subject have benevolently been made available by the Ministry of Agriculture.

1.2.4 Typical fertilizer application schemes for palm oil trees, coconut trees, coffee trees, cocoa trees and rubber trees have kindly been suggested by Liberian Produce Marketing Corporation and Firestone Plantations Company and are given in the report. In these schemes the grades and yearly quantities of fertilizers to be applied are stated in function of the ages of the trees.

1.2.5 Calculations have been made on how big the consumption of NPK fertilizers and other fertilizers may grow as maximum at optimal and full fertilization in all the tree crop plantations for palm oil, coconut, coffee, cocoa, and rubber production at the present cultivated areas of 412.000 acres in total and, besides, if the total plantation acreage is increased to 586.800 acres as projected for the next five years until 1981/82.

Separate calculations have been made on the possible maximum fertilizer consumption at the present sizes and at the projected sizes, of the respective tree plantations.

In the calculations certain assumptions on felling ages and age distribution of the trees have been made which may not prevail in practice. Besides, fertilization at the typical rates as mentioned under the above item 1.2.4 has been assumed.

However, through these calculations it has been endeavoured to find the maximum possible quantities of fertilizer consumption, and any actual deviations from the basic assumptions of the calculations will definitely result in lower figures.

1.2.6 The results of the fertilizer field trials which have been carried out during the last 3-4 years in Liberia are mentioned and summarized in the report. All these trials have been arranged under the programmes of the Ministry of Agriculture. The first few trials on both upland rice fields and swamp rice fields were made under the supervision of Mr. Alan Carpenter, USAID agronomist, while the major series of trials in the swamp rice fields have been managed and supervised by Dr. Yen-Sun Puh, UNDP/FAO technical officer.

The results have been copied from Mr. Alan Carpenter's terminal report (see references) and have most kindly and helpfully been made available by Dr. Puh during interviews.

Based on information received from Dr. Puh, the usual rates of fertilization made by the swamp rice farmers in Taiwan and Thailand are stated in the report for comparison. According to Dr. Puh the rates applied by the farmers in these countries are lower than the optimal rates found during experimental tests.

Dr. Puh has pointed out that potassium - containing fertilizers are not applied to the swamp rice fields in Taiwan and Thailand, as the soil in these countries gives only a small response or no response to potassium.

1.2.7 The question of soil acidity in rice fields as mentioned by Dr. Puh during the interviews is shortly described in the report.

1.2.8 The unsuitability of nitrate fertilizers for swamp rice fields is explained in the report.

1.2.9 The fertilization programme in rice fields by Ministry of Agriculture is summarized in the report.

1.2.10 A forecast of the fertilizer consumption of rice and other field crops is given.

Report Part 3

1.2.11 This report starts with a short review of the nutritional elements needed for the growth of trees and plants and of the principles and need of fertilization in dependence of crops and virginity or nutritional lack or depletion of the soil.

1.2.12 The report points out that the densely populated countries with continuous and intensive agriculture need high fertilization of the fields while other countries like Liberia with a scattered population, field rotation through the fallow principle, and large reserves of arable land will remain relatively small consumers of fertilizers.

1.2.13 A list on the major fertilizer grades being manufactured and sold on the world market nowadays is given.

The important difference between chemical compound fertilizers and physical blends of fertilizers is explained.

1.2.14 The manufacture of fertilizers is expounded in broad lines.

The main conditions for establishing a fertilizer industry, like the reliable and feasible supply of raw materials and utilities on a long term basis, large capital requirements, modern technology, satisfactory management, operation and maintenance personnel, secure and sufficiently big marketing outlet, etc. are given.

The raw materials and process routes for the production of the different fertilizers are reviewed.

In particular, the competitiveness of large capacity ammonia plants over small capacity ammonia plants is explained and stressed. Ammonia is the basic intermediate of any and all nitrogeneous fertilizers.

The economic factors ruling the operation of ammonia plants, such as raw materials, investments, plant size, plant design, specific energy consumption, construction and start-up year, etc. are dealt with in broad terms.

1.2.15 From the explanations given in the report it can be deduced that a large, say 1,000 MTPD ammonia plant based on cheap natural gas and constructed around 1970-1972 can produce ammonia at a total manufacturing cost, which is around 1/10 - 1/6 of the total manufacturing cost of a small, say 100 STPD ammonia plant based on high cost naphtha and if constructed for start-up around 1978-1980.

1.2.16 A general introduction on the fertilizer factories which have been built during rhe last decade is given. All new factories have been very large in capacity and placed either where raw materials are cheap and readily available or in the middle of big market areas of fertilizers.

1.2.17 The formulae calculation method and the limited freedom in making different grades of NPK fertilizer compounds from a limited number of straight fertilizers are explained.

1.2.18 The procurement of fertilizers is described as an integrated process which must be planned, organized, and performed in all steps.

The detailed aspects of purchasing, shipment from abroad, storage, transportation, distribution, and application of fertilizers are explained.

A non-exclusive list of international fertilizer brokers and exporters is given.

1.2.19 The business purpose, the technology, the investments and the operating costs of a fertilizer bulk blending and bagging plant are outlined and described in details.

The selection of the straight fertilizers for the bulk blended products on basis of least-cost analysis and the least-cost analysis computating methods are mentioned.

The personnel and workers, exclusive administrative personnel of such plant are listed.

A list is given on reputated contractors and equipment suppliers of a bulk blending and bagging plant, and a set of typical basic information for the design of a particular plant is stated.

REPORT PART 4

1.2.20

1.2.21 A feasibility study and assessment has been carried out in details of both the original proposal of September 1974 and the revised proposal of February 1976 as submitted by N-Ren Corporation to the Government of Liberia.

In the study the financial and contractual terms, the technology and the quoted plant units and deliveries, and the manfacturing costs of both proposals have been perused and evaluated.

1.2.22 The availability and prices of naphtha and fuel oil no.2 from Liberia Refining Company have been examined and checked.

1.2.23 Spot checks have been made on the present import prices, c.i.f. Monrovia of the main raw materials and the present market prices, c.i.f. Monrovia of the finished products of the N-Ren proposals.

The spot checks have been made through the kind collaboration and assistance of the import agent company U.L.R.C., Monrovia and the internationally reputated West German Badische Anilin-und Soda-Fabriken (BASF), which is represented by ULRC in Liberia. There is all reason to believe that the prices quoted by BASF/ULRC on a c.i.f., Monrovia basis and used for the spot checks are a true reflection of the competitive world price conditions as prevailing at the same basis.

1.3 Conclusions and recommendations

Report Part 2

1.3.1 As far as it can be judged from the import statistics of the Ministry of Planning and Economic Affairs, the annual import of fertilizers until 1975 do not surpass the order of 10.000 metric tons, which is a very insignificant quantity as compared to the fertilizer quantities consumed in North American and West European countries. Hardly, more than 6.000 metric tons or, as absolute maximum, 8.000 metric tons out of the 10.000 metric tons per year are comprised by NPk compound fertilizers.

The balance is represented by straight type fertilizers like ammonium sulphate, urea, triple super-phosphate, rock phosphate, muriate of potash, Kieserite, etc.

Until now, most of these fertilizers have been used by the Firestone Rubber Plantations and a few other rubber plantations owned by concessions.

The other tree crop plantations for palm oil, coconut, coffee and cocoa have not applied any fertilizers so far.

During 1975 around 600 - 700 metric tons of NPK (15-15-15) compound fertilizer and probably less than 200 - 300 metric tons of ammonium sulphate were distributed and sold to the rice farmers by the Ministry of Agriculture. Similar quantities of fertilizers are scheduled for distribution to the rice farmers during 1976.

1.3.2 The above total quantity of fertilizers are exclusive of the ammonium nitrate and sodium nitrate, which are being imported by Exchem-West African Explosives and Chemicals Ltd. at Charlesville for the manufacture of explosives for the mining industry, etc. in Liberia and other West African countries.

However, in the import statistics these materials are entered as fertilizers, but have for the elaboration of the present report been subtracted from the import statistics on fertilizers. It is recommended that these materials are listed as raw materials for explosives in the future import statistics.

According to Exchem, approximately 12.000 metric tons of ammonium nitrate were imported to its factory in Liberia during 1975. Exchem points out that the annual import quantity fluctuates with the consumption of explosives of the mining industry in Liberia and other West African countries.

1.3.3 According to the import statistics around 1.500-2.000 metric tons of ammonia per year is imported by the rubber plantations for latex statibilization. The ammonia is brought in pressure vessels owned by the rubber plantations from U.S.A and, maybe, other countries probably by the latex container ships during the return voyage.

1.3.4 There can be doubt that the yields of the tree crop plantations can be increased economically if optimal fertilization is initiated and applied also in the other plantations than those rubber plantations owned by concessions, where fertilizers are now being used.

Forecast calculations on the maximum fertilizer consumption in the tree crop plantations have been made under the following assumptions

- All rubber plantations are fertilized at the same rates per acre as actually in Firestone Rubber Plantations.
- All plantations and farms for palm oil, coconut, coffee, and cocoa production are fertilized at the typical rates per acre as advised by LPMC.
- All trees are felled at certain ages, as they become unproductive, and are replaced by seedlings.
- Even age distribution of the trees.

The calculation results are, as follows:

	Forecast maximum consumption of tree crop plantations — Metric tons per year, MTPY: Rubber plantations	Plantations for palm oil, coconut, coffee, and cocoa	Total
At present 412.000 acres of plantations.			
NPK fertilizers	29.400	18.900	48.300
Straight fertilizers	8.400	1.700	10.100
Total	37.800	20.600	58.400
At 586.800 acres of plantations as projected until 1981/82.			
NPK fertilizers	35.[illegible]00	28.600	64.000
Straight fertilizers	10.000	7.500	17.500
Total	[illegible]5.[illegible]00	36.100	81.500

Under the quantities of NPK fertilizers given in the above tabulation are included several different compound grades. The grades to be used depend upon the species of trees, time of season, etc. and must be chosen strictly out of agronomic reasons.

The straight fertilizers of the tabulation are ammonium sulphate, urea, triple superphosphate, and, most important, rock phosphate, muriate of potash and Kieserite.

NPK compound fertilizers are used when the application of all the three main nutrients shall take place at the same time. Straight fertilizers are used when only one or two nutrients are needed. Consequently, any further use of NPK compounds as apparent from the tabulation may not be possible and ought to be considered only out of strictly agronomic points of view.

It is added that the recommended grades and rates of fertilizers to be applied to trees are dependent mainly on the species, ages, growth, etc. of the trees and not or only to a limited extent on the soil conditions. (See item 1.3.5).

It is emphasized that the annual fertilizer consumption cannot exceed on an average scale the figures of the tabulation through the years, unless the plantation areas are enlarged above the acreages as stated. Any deviation from the assumed even age distribution of the trees would not make the average figures over the years bigger, but would result in corresponding fluctuations in the yearly quantities and qualities to be used from one year to the next.

Attention is drawn that the desired benefit from fertilization of tree crops requires a proper and sufficient care and weed clearance of the plantations. Any excessive or incorrect fertilization and/or less care of the trees and/or less clearance of the ground may lead to smaller crop yields or even destruction of the trees. Therefore, fertilization will necessitate training, reliability and experience of the labour and supervision experts. This means that fertilization should not be initiated and accelerated, until skilled and reliable labour and experts are available.

Since the present fertilizer consumption of the plantations, apart from the Firestone plantations and a few other rubber plantations, is negligible, it is most probable that the actual consumption of the plantations will start growing slowly during the next years, but may not reach the order of the forecast figures of the tabulation before after say 10 years or more.

1.3.5 The fertilizer trials as carried out during the last years under supervision by Mr. Alan Carpenter and Dr. Yen-Sun Puh in upland rice fields and swamp rice fields have proven that Liberian soil is deficient in phosphorus, while it shows no yield response or, at least, no economical response to potassium.

This implies that NPK compound fertilizers are not feasible for Liberian fields. Besides, fertilizers containing nitrate like ammonium nitrate based calnitro and some NPK compounds should not be used in swamp rice fields because most of the nitrate content would not reach the plant roots at the water submerged and reduced soil conditions.

It may seem contradictory that NPK compounds are advantageous to tree crops while potassium is needless for Liberian fields. According to the fertilizer field trials Liberian soil is relatively rich in potassium as characteristic of many soils which have never been intensively and continuously cultivated. However, most tree crops and in particular palm oil and coconut do require for optimal growth and production more potassium than can be liberated from any soil. While, Liberian soil, as far as the fertilizer trials are representative, is able to supply enough potassium from the slow, but steady decomposition of the soil minerals for the optimal growth and production of rice and other field crops during the next number of years. Anyway, unlike tree plantations the recommended grades and rates of fertilizers to be applied to field crops are determined mainly by the soil conditions.

Nitrogen is always necessary for swamp rice fields. Upland rice fields show a small response to nitrogen according to the few fertilizer field trials made by Mr. Alan Carpenter.

At the writing of this report the optimal fertilization rates to be concluded from Dr. Puh's swamp rice field trials were not yet available.

The fertilizers as suitable for Liberian fields are urea or ammonium sulphate as straight nitrogeneous fertilizers and triple superphosphate as straight phosphorous fertilizers and/or straight NP fertilizers like MAP and DAP. Other trade marked NP type fertilizers are sold on the world market but for swamp rice fields they ought not contain nitrate. It goes without saying that any NP fertilizer under consideration must contain N and P_2O_5 in the desired ratios and must be selected strictly in accordance with the agronomic requirements. For field crops other than swamp rice calnitro may be used like urea and AS as straight nitrogeneous fertilizer.

As mentioned under above item 1.3.1 the annual fertilizer consumption for the rice fields is not more than 1.000 metric tons at present.

If the fertilization rates found by Mr. Alan Carpenter from the very few trials would be representative, full fertilization of all rice fields in Liberia at present and at the increased acreage as projected until 1981/82 would amount as follows:

Forecast maximum consumption of rice fields

	Metric tons per year, MTPY		
	Upland rice fields	Swamp rice fields	Total
Present cultivated area, acres	379.000	37.000	416.000
Urea (46%N)			
Application rate:			
Kgs fertilizer/acre	16	91	
Kgs N /acre	7	41	
Number of crops per year	1	3	
Annual quantity, MTPY	6.100	10.100	16.200
Triple superphosphate (45%P_2O_5):			
Application rate:			
Kgs. fertilizer/acre	18	32	
Kgs P_2O_5 /acre	7	14	
Number of crops per year	1	3	
Annual quantity, MTPY	6.800	3.600	10.400
Total quantity, MTPY	12.900	13.700	26.600
Projected cultivated area, acres	406.000	77.900	483.900
Urea (46%N):			
Application rate:			
Kgs. fertilizer/acre	16	19	
Kgs. N /acre	7	41	
Number of crops per year	1	3	
Annual quantity, MTPY	6.500	21.300	27.800
Triple superphosphate (45%P_2O_5):			
Application rate:			
Kgs. fertilizer/acre	18	32	
Kgs. P_2O_5 /acre	7	14	
Number of crops per year	1	3	
Annual quantity, MTPY	7.300	7.500	14.800
Total quantity, MTPY	13.800	28.800	42.600

Certainly, it may last a number of years before the consumption of fertilizers in the fields may reach the forecast figures of the tabulation, because fertilization requires capital, experience, etc. and farmers are conservative and do not want to risk to invest so much in fertilizers that their title of the land may become at stake at low harvests due to bad weather or diseases or pests or at failing market of the crops.

In the future, when cultivation will be continuous and intensive the nutrients of the soil will gradually diminish. Consequently, more fertilizers will have to be applied, and the consumption of fertilizers will increase over and above the tabulated figures.

1.3.6 A permanent fertilizer center ought to be established in Liberia to operate currently to investigate the use of fertilizers on crops and soils, to instruct farmers and plantations in the use of fertilizers, to make field visits, soil tests, agronomy trials, demonstrations, etc.

The same center may also advise on disease and pest control, crop selection, crop varieties, agricultural methods, etc.

FAO/UNIDO can assist Liberia in establishing such a center.

1.3.7 As pointed out in chapter 2.2.13 of Report 2, a large scale application of fertilizers among plantations and farmers is an integrated and complexed process, which will require to be dealt with, organized, and co-ordinated by the Liberian authorities in order to be a success.

Report Part 3

1.3.8 The establishment of a fertilizer factory requires that a feasibly priced and reliable supply of raw materials has been secured, that the design and capacity as selected will make the plant competitive in terms of investment and operating costs, and that ample marketing outlets at feasible prices of the finished products are at disposal. Besides, the factory must have a qualified personnel for the operation and maintenance.

1.3.9 At any rate, a fertilizer factory always costing a tremendous amount of money ought to be bought on basis of competitive tendering by reputated contractors. A fertilizer factory should never be purchased based on a single quotation from any company, irrespective how tempting the quotation might look at first hand.

1.3.10 The procurement and import of fertilizers into Liberia ought to be oriented against the best interests of the farmers and plantations and remain a liberal trade free of customs or any other duties in order to safeguard the least cost fertilizers in the appropriate qualities and quantities at the increasing or varying demands of the market.

1.3.11 When the consumption of fertilizers in Liberia reaches a substantial quantity, the procurement, shipment, storage, transportation, and distribution ought to be performed and organized through a co-operative enterprise to bring about the overall lowest cost of the transactions.

1.3.12 The procurement, storage, transportation, and distribution of fertilizers may suitably by coordinated and carried out through the Liberian Produce Marketing Corporation in order to save in investment and operating cost through the joint use of stores, transportation vehicles, personnel and workers.

Such saving will be possible as the handling of the agricultural produces is time lagged to the handling of fertilizers.

Care must be taken that the agricultural produces in jute or similar bags are not contaminated by any remains or spills of fertilizer particles or dust from breakage of fertilizer bags.

The same enterprise may deal with other agricultural needs, like tools and machinery, seeds, chemicals, etc.

The enterprise ought not be given any monopoly or concession, but must be able to compete with the private business to safeguard the interests of the farmers and plantations.

1.3.13 An analysis of logistics by specialized experts on the whole fertilizer and produce operation may be advisable in order to plan adequately and economize on the investments and operating costs of the administration, stores, and transportation vehicles.

1.3.14 Liberia may coordinate its purchasing and shipment of fertilizers and, for that matter, other crucial goods and services with neighbouring countries.

1.3.15 Fertilizer bulk blending and bagging plants are installed in the great fertilizer consuming countries in North America and Europe for the needs of local areas on NPK fertilizers in order to obtain a saving through the purchase of straight fertilizers from competing suppliers and a saving in the long distance shipment.

It may be suitable for Liberia to install a bulk blending and bagging plant on the same premises within a number of years when the domestic consumption of NPK fertilizers has reached the order of say 30.000 metric tons per year.

The estimated total investment of such plant with an annual capacity of 30.000 metric tons will be approximately US $0,5 million for fixed assets and approximately US $0,5 million for working capital.

The variable plus fixed operating costs, exclusive cost of the fertilizer materials will amount to US $15-30 per metric ton.

The yearly salary budget, exlcusive wages of the administrative personnel will be in the order of US 95.000 at 1975/1976 price level and under Liberian conditions.

A fertilizer bulk blending and bagging plant can be bought from a series of alternative reputated contractors and equipment suppliers. Delivery and construction time is estimated at 6 - 12 months.

1.3.16 NPK bulk blended fertilizers are a less satisfactory product with a certain tendency to become heterogeneous in the bags or in bulk as compared to NPK compounds (chemical blends) imported from abroad. Consequently, NPK blending must take place within the local marketing area, and transportation of the blends in bags or in bulk to the customers must be lenient, without vibrations and limited to say 50 - 100 kms. NPK blends are not suitable for export and long distance shipment and undue handling.

1.3.17 Most logically, a bulk blending plant is installed on a co-operative initiative from the various consumers and operated as a co-operative enterprise. Anyhow, the blended products will need to meet the approval and requirements of the clients and will be accepted only if they will be substantially cheaper than the imported NPK compounds.

If the market of bulk blends will expand in the future over and above the capacity of a first plant, another similar plant will suitably be constructed at another market center location in order to shorten the transportation distanoe of the blended products.

1.3.18 Indeed, it would be entirely against the idea of establishing a fertilizer bulk blending plant if any company would be assigned the concession rights for such a plant by the Government of Liberia. By all means, the fertilizer import and blending business ought to remain a liberal trade free of any customs or any other duties.

Report Part 4

Summary

1.3.19 A fertilizer plant in Liberia as proposed by N-Ren Corporation will have to depend upon either imported petroleum or imported ammonia, and, besides, imported phosphatic and potassic raw materials. Liberia does not dispose of any indigenous raw materials for the manufacture of fertilizers and ammonium nitrate (33.5% N).

1.3.20 Although the proposed plant has relatively a very small capacity as compared to the modern size fertilizer plants, which have been built during the last 10 years around the world, the domestic market of Liberia, as it is to-day and it may still be during the next years, will be able to consume merely approximately 60-70% of the annual production of ammonium nitrate (33,5% N) and in the order of 15-35% of the annual production of NPK fertilizers.

1.3.21 The annual production of the proposed plant at a stream factor of 80% as typical for developing countries will total approximately 18.000 metric tons of ammonium nitrate (33,5% N) and approximately 73.000 metric tons of NPK fertilizers.

1.3.22 The domestic consumer in Liberia of the ammonium nitrate (33.5% N) would be entirely Exchem-West African Explosives and Chemicals Ltd. at Charlesville, which possesses the exclusive rights on explosives manufacturing, blending and preparation in Liberia, and which covers practically all the market on explosives in the West African countries. The consumption of explosives is a function of the production of the mining industry, the construction of roads etc. in the marketing areas.

1.3.23 In Liberia the present and future consumers of NPK fertilizers are and will be the tree plantations, in particular the rubber plantations and other plantations operated by the concessions. The plantations may prefer NPK fertilizers admixed with micronutrients and Kieserite. The N-Ren proposal does not include, but could probably be suplemented with the extra equipment for such admixture. At any rate, it would be necessary to check carefully with the concessions whether the NPK grades to be manufactured in a Liberian factory would be acceptable and suitable for their purposes.

1.3.24 In case of field crops, such as rice it is not feasible at present and probably for a number of years to apply to the Liberian soil potassium (K), which is one of the three constituents of NPK fertilizers.

In swamp rice fields the nitrate content or 50% of the N constituent of the NPK fertilizers of the proposed plant will be lost to the atmosphere, before the plants can make use of it.

Therefore, NPK fertilizers are not economic and suitable for the fields in Liberia. The same may be valid in some other African countries.

1.3.25 At any rate, any production of a Liberian factory in excess of the domestic market would need to be exported to other African countries, where a serious competition from the international exporters having much lower manufacturing costs due to modern and large sized technology and indigenous raw materials would have to be faced.

Since most African countries consume small amounts of fertilizers, the excess fertilizer production would have to be sold to several countries.

With respect to AN (33,5%) the surplus production could only be sold outside the West African region to the other African countries, which do dispose of their own explosive manufacturing, blending, and preparation facilities.

Besides, the export of ammonium nitrate (33,5% N), which is classified as an explosive, would require the construction of a new ocean harbour with stores complying with "the US Coast Guard Regulations" which may not permit this harbour to be used for other commodities and ships. Please note that Exchem at Charlesville is not allowed to land their import of AN (33,5% N) in the Monrovia and Buchanan harbours.

1.3.26 The prices quoted in the revised N Ren proposal are appreciably higher than those in the previous proposal, even though the extent of supplies of both alternatives A and B of the revised proposal are less as compared to the previous proposal. The increased prices can be explained by the drastic inflation on capital goods from 1974 to 1976.

1.3.27 The apparent profits of a Liberian factory as demonstrated in the previous and revised N-Ren proposal are entirely unrealistic.

The reasons of this are that N-Ren have based their fictive estimates on hypotetical and extremely low raw material prices which cannot be obtained to-day in Liberia, and because they consider the factory to be able to operate continuously at design capacity all through the year corresponding to a stream factory of 100%. Undoubtedly, the raw material prices will increase during the next years, and even a stream factory of 80% is optimistic in a developing country.

In the revised proposal straight line depreciation over 14 years of only 85% of the investments has been anticipated by N-Ren instead of a period of 10 years and 100% of the investments as it ought to.

It is noted that the raw material costs make out the major part of the manufacturing costs of the end-products. A less, but still important part is formed by the depreciation and interest on the investments.

Furthermore, N-Ren does not account adequately for the cost of maintenance and repair of the factory during operation, shutdowns, and annual overhauls.

Besides, N-Ren has not made any allowances for harbour fees and local transportation of raw materials and end-products or any depreciation and interest on the additional capital to be financed and paid by the Government of Liberia for site preparation, indigenous supplies and construction works, auxiliary equipment, ex battery limit installations and provisions, harbour facilities etc.

1.3.28 The revised N-Ren proposal includes the battery limit process plants and facilities and expatriate services, but excludes the indigenous building materials, civil engineering works, and salaries of local personnel and workers.

The investments and financing of the N-Ren supplies and services are, as follows:

	Alternative A Million US $	Alternative B Million US $
Investments, working capital and pre-operating interest	55,9	49,3
Financing		
Equity		
N-Ren Corporation's shares	4,3 (8%)	3,8 (8%)
Government of Liberia's shares	10,0 (18%)	8,8 (18%)
Long term debt Supplier's loan	41,6 (74%)	36,7 (74%)
Total	55,9(100%)	49,3(100%)

The long term debt or loan is required by N-Ren Corporation to be 100% surety quaranteed by the Government of Liberia. Repayments on the long term loan and payments of accrued interest will start 6 months after commissioning of the plant, irrespective of the plant will be operating or not.

Therefore, the commitment of the Government of Liberia as related to the N-Ren supplies and expatriate services, but exclusive of additional commitments would be:

	Alternative A Million US $	Alternative B Million US $
Paid up Government of Liberia's shares	10,0	8,8
Repayments on long term debt	41,6	36,7
Payments of accrued interest	14,4	12,4
Total	66,0	57,9

There can be no doubt at all, that the plant and services as offered by N-Ren Corporation are much more expensive and includes a fat profit to N-Ren Corporation as compared to bidding on competitive terms.

Thus, the modest capital retained in the factory as N-Ren shares corresponding to 8% of the above investments would surely be a part only of the extra profit secured by N-Ren Corporation under the contract terms as offered and to be paid and guaranteed by the Government of Liberia.

In this context, it shall be mentioned that N-Ren Corporation is a branch-off or the remains or the left-over of the previous U.S.A. contractor C & I/Girdler Inc., which got into financial troubles around 1970-1972 and was bought and taken over by another contractor. The capital at disposal for N-Ren Corporation either through own funds or through bankers may be relatively limited.

The guarantees, warrantees, and liability as offered by N-Ren Corporation are very unsatisfactory, narrow and of little legal value. Besides, N-Ren is grouped into a series of Belgian, U.S.A. and Bermuda corporations which means that any legal action later on against N-Ren probably might be bound to fail.

Nevertheless, the modest share capital retained by N-Ren Corporation would entitle this company to a 30% ownership of the Liberian factory.

1.3.29 The annual deficit of a Liberian fertilizer factory has been calculated on the following bases:

- Prevailing ex-Liberian refinery prices on naphtha and fuel oil No.2 without any allowance for additional fractionating cost to fulfil the naptha specification required by N-Ren Corporation.

- Prevailing c.i.f. Monrovia prices on imported phosphatic and potassic raw materials.

- Electricity cost as prevailing in Monrovia for large industrial consumers, while other utility costs as foreseen by N-Ren Corporation.

- Straight-run depreciation over 10 years and 3,7% p.a. average interest on battery limit investments and expatriate services of above item 1.3.28 exclusive electric power station.

- 10% p.a. interest on working capital.

- Maintenance cost at 2,5% p.a. on the battery limit investments and expatriate services of above item 1.3.28, excluding electric power station.

A stream factor of 80%.

- Ex factory prices on end-products equal to prevailing cif. Monrovia prices on imported fertilizers and AN.
- Labour and staff costs as foreseen by N-Ren Corporation
- US $ 200 per metric ton of imported ammonia for Alternative B.

The annual deficits as calculated are, as follows:

	Annual deficit
Alternative A	US $ 6,3 million
Alternative B	US $ 3,3 million

At an imported price of US $ 220 per metric ton on ammonia as figured by N-Ren Corporation, the annual deficit of alternative B would increase by US $0,5 million to US $ 3,8 million.

Evidently, the ex factory prices which can be obtained from the exported end-products will be substantially lower than the c.i.f. Monrovia prices on these products imported from abroad at to-day's level. A discount of say US $ 50 per metric ton to cover loading, freight, insurance, and unloading costs and import agents' fees on a yearly quantity of for instance 70.000 metric tons would make the above annual deficits to increase by US 3.5 million.

Moreover, the above annual deficits do not include any allowances for harbour fees and local transportation of imported raw materials and exported products or any depreciation and interest or other charges related to the large extra investments of the Government as explained under the subsequent items 1.3.30 and 1.3.31

1.3.30 Further to the investments on N-Ren Corporation's battery limit supplies and expatriate services of above item 1.3.28, the Government of Liberia would be obliged to furnish, pay, and finance, as follows:

- Price escalation on N-Ren Corporation's battery limit supplies and expatriate services during the delivery and construction period. These amounts would probably have to be paid cash and could very well reach the order of US $ 5-10 million or more

- Additional fractionating equipment at Liberia Refining Company.

- Site of plant and site preparation.

- Auxiliary equipment, indigenous building materials, and civil engineering works at battery limit plant.

- Ex battery limit installations, harbour facilities in existing harbour, new harbour for AN export, etc.

- Housing of personnel and workers.

- Stores, transportation, distribution, and farmers' credits for the domestic fertilizer market.

- Consultants and staff during contract period to control the interest of Government of Liberia.

- Training and employment of plant staff and workers during final construction period.

- Supply of raw materials of factory.

- Repair of factory and loss of production due to possible maloperation during the first start-up and operation years.

Seemingly, the N-Ren Corporation does not permit the Government of Liberia to convert any of the above investments into share capital. At any rate, these investments could only be recovered through sky-high fertilizer prices in the domestic market which would imply any import of fertilizers to be prohibited for many years.

1.3.31 Referring to chapter 4.9.5 of Report Part 4 the Government of Liberia would be asked and would have to pay to ICI/Kellogg a large license fee on their naphtha reforming process as soon as the Liberian factory would start to produce. This claim presupposes that the ICI/Kellogg patents on said process are in force in Liberia.

1.3.32 The technical references on the Ammopac units of N-Ren Corporation would have to be checked carefully through visits by neutral experts to existing units in operation before signing of any contract. In particular, it would be imperative to control the technical references of N-Ren Corporation on naphtha reforming. It is emphasized that naphtha reforming is a much more stringent and difficult operation than natural gas reforming.

1.3.33 All supplies on raw materials would have to be secured on a long term delivery, freight and price basis before any signing of contract.

1.3.34 A Liberian fertilizer factory would give employment possibilities for around 100 Liberian nationals and no more.

1.3.35 The plant units offered by N-Ren Corporation would hardly meet the environmental protection standards now being in force in most industrial countries.

1.3.36 Liberia Refining Company has no access to any crude petroleum to be able to produce a naphtha with the high naphthenic contents as specified by N-Ren.

It is stressed that any deviation of the naphtha actually to be supplied to the fertilizer factory from the naphtha specified by N-Ren may form a legal escape by N-Ren from any liability on the naphtha reforming process of the Ammopac ammonia plant.

1.3.37 In conclusion and referring to the above, it is disrecommended that the N-Ren proposed plant would be accepted and constructed in Liberia.

1.4 Acknowledgements.

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The typing and printing of my reports has been a big job, and I very much appreciate and convey my thanks to the personnel of Liberian Development Corporation, who have been very busy and diligent in the process of this work.

1.5 People Met

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- Mr. C. Keleti, Senior Industrial Development Officer.

United Nations Development Programme, Monrovia.

- Mr. Arvind Bam, Resident Representative.
- Mr. Carl-Erik Wiberg, Deputy Resident Representative.
- Mr. L.H. Randall, UNIDO Senior Industrial Development Field Advisor.
- Mr. Steve Glovinsky, Programme Officer.

The Liberian Development Corporation, Monrovia.

- Mr. Hilary B. Wilson, Sr., General Manager.
- Mrs. Marie E. Parker, Deputy General Manager.
- Mr. Jakob Fogstad, UNIDO Project Manager General at LDC(LIR/75/001).
- Mr. George W.W. Dennis, Comptroller.
- Mr. William T. Diggs, Sr., Manager of Project Research and Evaluation Division.
- Mr. J.C.N. Howard, Jr., Manager of Consultancy and Training Division.
- Mrs. Clara Nyambuya, Assistant Manager of Public Relations.
- Mrs. Bindu D. Hickson, Office Manager.
- Mr. John Kronah, Maintenance Engineer.
- Mr. Wesley Herron, Research Assistant.
- Miss Monah Payne, Executive Secretary.
- Mrs. Beatrice Barclay, Deputy Executive Secretary
- Miss Doris Grines, Secretary.
- Miss Cecilia Nimene, Secretary.

- Mr. Nathaniel G. Boykai, Clerk Typist.
- Mr. Harris Zumoh, Clerical Assistant.
- Mr. Amos Gallah, Printing Assistant.

Ministry of Agriculture.

- Hon. Louis A. Russ, Minister of Agriculture.
- Dr. Patrick Bropleh, Deputy Minister of Agriculture.
- Mr. Joshua Cooper, Director of Planning Division.
- Mr. Patrick M. Vorzi, Director of Rice Division.
- Dr. Yen-Sun Puh, UNDP/FAO Technical Officer, University of Liberia Farm, College of Agriculture and Forestry.
- Mr. Edouard T. Voel, UNDP/FAO Project Manager.
- Mr. Tommy Hsu, UNDP/FAO Gardening Advisor.
- Miss Candi Rubin, USAID Administrative Assistant.
- Mr. John S. Rowe, USAID Advisor, Research and Statistics Section.

Ministry of Finance.

- Mr. David Walsh, Financial Analyst of Concession Secretariate.
-

Ministry of Justice.

- Mr. J. Newton Garnett, Assistant Minister for Codification.

Ministry of Land and Mines.

- Hon. Goda Baker, Deputy Minister of Lands and Mines.
- Dr. Eric Neufville, Acting Director of Mines.
- Mr. William Steward, Director of Hydrological Survey.

Ministry of Planning and Economic Affairs.

- Mr. Philip Gadegbeka, Assistant Minister for Statistics.
- Mr. Lewis Kaidjuway, Chief of Foreign Trade Statistics.

Exchem-West African Explosives and Chemicals Ltd., Harbel

- Mr. J. Y. Roy, General Manager
- Mr. ohn Martin, Plant Manager.
- Mr. G. Fisher, Accounting Manager.

Firestone Plantations Company, Harbel.

- Dr. Murdock Ross, Manager of Botanical Research (Dr. Ross had to leave his office on urgent matter shortly before the meeting and left message to meet Dr. Muir instead.)
- Dr. John K. Muir, Agronomist.
- Mr. Kona Beysolow, Purchasing Manager.

Liberian Rubber Planters Association, Monrovia

- Mr. E.K. Porte, General Secretary.

Liberian Produce Marketing Corporation, Monrovia

- Mr. Erik Boholt, Manager of Agricultural Development Division

Liberia Refining Company, Gardnersville, Monrovia

- Mr. P.H. Duggan, Manager of Technical Services.

Mezbau Inc., Monrovia

- Mr. L. Bauchau, Managing Director.

National Port Authority of Liberia, Monrovia.

- Mr. James F. McGinn, Ex-Port Captain and Ex Captain, Volunteer Executive of International Executive Service Corps, New York, U.S.A.

Scanship (Liberia) Inc., Monrovia.

- Mr. Morten L. Ipsen, General Manager.

ULRC -

United Liberia Rubber Corporation, Monrovia.

- Mr. Ulrich Stoewer, Manager of General Goods Department.

WARDA-West Africa Rice Development Association, Monrovia.

- Dr. H. Will, Research Coordinator.
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REPORT PART 2.

STUDY OF THE USE OF FERTILIZERS, AMMONIUM NITRATE FOR EXPLOSIVES, AND AMMONIA IN LIBERIA.

LIBERIA

(IS/LIR/74/012)

by

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expert of the United Nations Industrial Development Organization
acting as Executing Agency for
the United Nations Development Program

This report has not been cleared with the United Nations Industrial Development Organization whih does not therefore necessarily share the views presented (1).

(1) To be omitted after clearance by UNIDO

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ABBREVIATIONS

AN ammonium nitrate

AS ammonium sulphate

N nitrogen

P phosphorus

K potassium

O oxygen

MTPD metric tons per day (24 hours)

STPD short tons per day (24 hours)

MTPY metric tons per year

STPY short tons per year

NPK (17-17-17) means a NPK compound fertilizer containing 17% or 170 kgs. of N per metric ton, 17% or 170 kgs. of P_2O_5 per metric ton, and 17% or 170 kgs. of K_2O per metric ton.

DAP di-ammonium - phosphate.

MAP mono-ammonium-phosphate.

LIST OF TEXT CORRECTIONS.

Page 2.18, line 15 from top:

Read: 11 Kgs P_2O_5/acre

Page 2.18, line 19/20 from top:

Read: Urea (46%N): 16 Kgs/acre (corresponding to 7 Kgs. N/acre)

Page 2.18, line 25/26 from top:

Read: Urea (46%N): 91 Kgs/acre (corresponding to 41 Kgs N/acre)

Page 2.20, line 18 from top:

Read: Southeast Asia.

Page 2.32, line 2 from top:

Read:

Case (see text) A B C

Page 2.48, line 10 from top:

Read: extremely complexed process

Page 2.55, line 4 from bottom:

Read: which carry the bags

2.1 Import statistics on fertilizers, ammonium nitrate for explosives, and ammonia.

The import statistics are collected and issued by the Ministry of Planning and Economics Affairs. The source of this information is the import entry forms which importers are required to file with customs officials.

The import statistics list the figures on imported quantities and the values, c.i.f. Monrovia on, among other commodities, crude fertilizers, manufactured fertilizers, ammonium nitrate and sodium nitrate, and ammonia. The import statistic figures on said items are reproduced in the subsequent tabulation for 1972 - 1974 and the first three quarters of 1975. The import figures for the 4th quarter of 1975 were not yet ready from the Ministry of Planning and Economic Affairs at the writing of this report.

Ammonium nitrate and sodium nitrate are imported into Liberia for the manufacture of explosives. These materials are not used as fertilizers in Liberia. Liquid ammonia is imported by the rubber plantations.

The imported sodium nitrate is registered in the import statistics under commodity No. 271200 as natural sodium nitrate and crude fertilizer, but ought to be filed as done in the tabulation under a new commodity No. 571101 as sodium nitrate and as a basic material for explosives. Natural sodium nitrate was previously found in Chile but the deposits have been exhausted many years ago.

On basis of information received from the importing agents and companies it seems that calcium nitrate and calnitro, which is the fertilizer grade of ammonium nitrate mixed with limestone, have never been imported into Liberia in the past.

Consequently, the quantities of commodity as registered in the import statistics under the fertilizer code No. 561101 - Calcium and Ammonium nitrate comprise entirely ammonium nitrate for explosives. It is recommended that in the future statistics this commodity is filed as a separate commodity under the main code No. 571 - Explosives and pyrotechnic products.

The quantities of the import statistics have been recalculated into metric tons as given in the tabulation, and the specific import prices, c.i.f. Monrovia in US$ per metric ton are stated for the respective commodities in the tabulation. They are average figures of the period concerned and calculated by dividing the values of the import statistics with the quantities in metric tons.

Moreover, in the tabulation, the figures of the codes 271100 and 561101 have been deducted from the total codes 271 and 561 respectively.

From the figures of the tabulation it is obvious that they are not all correct. Figures which most probably or even distinctly must be wrong are put within brackets in the tabulation. One reason to the incorrect figures may be that some commodities other than fertilizers have been declared as fertilizers by the importers to the customs. It is noted that fertilizers contrary to many other porducts are duty free. A spot check in the Ministry of Planning and Economic Affairs of a few import entry forms proved an instance where a highly costly plastic material actually subject to import duty had been declared and imported as a duty-free fertilizer. This ofcourse is a mistake or even a fraud. On the other hand, this does not preclude the cheaper materials other than fertilizers have been filed as fertilizers in the statistics.

At any rate, the above mentioned tabulation and import statistics classify the fertilizers into a few main commodity codes which however do not describe the detailed categories of the fertilizers. Thus, in another subsequent tabulation are given the quantities of the various grades of fertilizers, which have been imported during 1969 - 1974 by one of the major import companies. This tabulation has cooperatively been made available by the import company (ULRC).

During 1975 Liberia has received a grant on 500 metric tons of NPK compound fertilizer (15-15-15) from United Kingdom and another grant on 20 metric tons of triple superphosphate from West Germany.

Attached:

- Tabulation on import statistic on fertilizers, ammonium nitrate, and ammonia.
- Tabulation of fertilizers imported by U.L.R.C.

Tabulation of Import Statistics on Fertilizers, Ammonium Nitrate and Ammonia.

Fertilizers, crude and manufactured.
Commodity Code 271: (excl. 271200)

Fertilizers, crude (Total).

	Quantity: Metric tons
1972	(2.863)
1973	509
1974	308
1975, 1st quarter	-
1975, 2nd quarter	-
1975, 3rd quarter	-

Commodity Code 271100:

Natural Fertilizers, Animal, Vegetable.

	Quantity Metric tons	Specific import price (average) US$ per Metric ton
1972	(2.132)	40
1973	470	37
1974	138	149
1975, 1st quarter	-	-
1975, 2nd quarter	-	-
1975, 3rd quarter	-	-

Commodity Code 271200 (proposed cancelled).

Natural Sodium Nitrate. This material is Chilean salpeter is no more available on the world market. These figures registered under this number are supposed to comprise manufactured sodium nitrate which probably is used as basic material for the manufacture of explosives, and thus, they are indicated below under a proposed new commodity code No. 571101.

Commodity Code 271300:

Natural phosphate, nothing else specified:

	Quantity Metric tons	Specific import price (average) US$ per metric ton
1972	682	28
1973	38	34
1974	3	38
1975, 1st quarter	352	33
1975, 2nd quarter	-	-
1975, 3rd quarter	-	-

Commercial Code 271400:

Natural potassic salt, fertilizer.

	Quantity Metric tons	Specific import price (average) US$ per metric ton
1972	46	96
1973	-	-
1974	167	95
1975, 1st quarter	-	-
1975, 2nd quarter	-	-
1975, 3rd quarter	-	-

Commodity Code 561: (excl. proposed new 571102)

Fertilizers, manufactured (total).

	Quantity Metric tons
1972	5.697
1973	4.802
1974	11.885
1975, 1st quarter	544
1975, 2nd quarter	729
1975, 3rd quarter	110

Commercial Code 561101:

Calnitro and calcium nitrate (revised text).

	Quantity Metric tons	Specific import price (average) US$ per metric ton
1972	-	
1973	-	
1974	-	
1975, 1st quarter	-	
1975, 2nd quarter	-	
1975, 3rd quarter	-	

(The figures of the import statistics on ammonium nitrate for explosives are moved to below code No. 571102).

Commodity Code 561102:

Sulphate of annonia.

	Quantity Metric ton	Specific import price (average) US$ per metric ton
1972	3	44
1973	126	72
1974	164	156
1975, 1st quarter	49	160
1975, 2nd quarter	-	-
1975, 3rd quarter	-	-

Commercial Code 561109:

Other nitrogeneous fertilizers (except natural).

	Quantity Metric tons	Specific import price (average) US$ per metric ton
1972	2.575	93
1973	2.556	98
1974	1.988	227

1975, 1st quarter	22	111
1975, 2nd quarter	361	(281)
1975, 3rd quarter	4	(465)

Commercial Code 561200:

Phosphatic fertilizers, etc.

	Quantity Metric tons	Specific import price (average) US$ per metric ton
1972	1.699	95
1973	1.214	95
1974	3.627	117
1975, 1st quarter	309	214
1975, 2nd quarter	24	158
1975, 3rd quarter	2	(1056)

Commercial Code 561300:

Potassic fertilizers, etc.

	Quantity Metric tons	Specific import price (average) US$ per metric ton
1972	542	85
1973	715	84
1974	2.905	73
1975, 1st quarter	25	(812)
1975, 2nd quarter	2	(1803)
1975, 3rd quarter	16	(2687)

Commercial Code 561900:

Manufactured fertilizers, nothing, else specified.

	Quantity Metric tons	Specific import price (average) US$ per metric ton
1972	878	97
1973	191	142
1974	3.208	177
1975, 1st quarter	137	(327)
1975, 2nd quarter	341	(1020)
1975, 3rd quarter	87	(436)

Explosives.

Proposed commodity code 571101 (previous 271200) Sodium nitrate.

	Quantity Metric tons	Specific import price (average) US$ per metric tons
1972	136	94
1973	1.561	49
1974	3.961	51
1975, 1st quarter	1.430	50
1975, 2nd quarter	1.434	51
1975, 3rd quarter	3.426	41

Proposed commodity code 571102: (See 561101).

Ammonium nitrate for explosives.

	Quantity Metric tons	Specific import price (average) US$ per metric ton
1972	8.546	73
1973	6.703	68
1974	(32.238)	(49)
1975, 1st quarter	783	240
1975, 2nd quarter	(6.190)	(98)
1975, 3rd quarter	6.037	177

Ammonia.

Commodity Code 513610:

Ammonia.

	Quantity Metric tons	Specific import price (average) US$ per metric ton
1972	1.778	239
1973	1.3[illegible]9	208
1974	1.940	220
1975, 1st quarter	222	365
1975, 2nd quarter	574	260
1975, 3rd quarter	542	358

TABULATION ON QUANTITIES AND GRADES OF FERTILIZERS IMPORTED BY U.L.R.C. DURING 1969 – 1974

QUANTITIES IN METRIC TONS.

	1969	1970	1971	1972	1973	1974	Total 1969 - 1974
NPK (12:12:17:2)	–	230	150	–	325	–	705
NPK (13:13:21)	–	–	–	283	–	480	763
NPK (12:24:12)	255	–	–	–	–	–	255
NPK (15:15:15)	–	–	2565	4255	40	3203	10.063
NPK (15:15:6+4)	892	729	–	10	8	142	1.781
NPK (13:13:13:+5)	–	–	–	–	2715	–	2.715
Ammonium Sulphate (21% N)	–	30	–	120	30	588	768
Triple Superphosphate (45% P_2O_5)	15	–	[illegible]	185	–	–	310
Hyperphosphate (rock phosphate)	6	154	410	838	705	502	2.615
Muriate of potash (60% K_2O)	270	74	120	1482	80	895	2.921
Sulphate of potash (50% K_2O)	–	–	100	–	10	10	120
Urea (46% N)	125	80	103	135	–	80	523
Kieserite ($MgSO_4$,H_2O, 25% MgO	–	–	157	1300	381	870	3.128
TOTAL	1.563	1.297	4.975	8.668	4.294	6.770	26.667

2.2. The use of Fertilizers.

2.2.1 Cultivated land and crops.

The Ministry of Agriculture has readily submitted the following information on cultivated land and crops in Liberia:

	Existing: 1974-1975 1.000 acres		Projected increase: (1976-1981 or 1977-1983) 1.000 acres	
Wild oil palm areas:		332	–	
Oil palm plantations:				
Liberian owned farms	8		?	
Concessions	10		?	
Total		18		41,1
Coconut plantations:		0		21,5
Coffee				
Small farms	51		–	
Plantations	0		24,2	
Total		51		24,2
Cocoa				
Small farms	45		–	
Plantations	0		28,0	
Total		45		28,0
Nurseries for tree seedlings:		5		2
Rubber Plantations:				
Liberian owned farms	154		?	
Concessions	144		?	
Total		298		60

2.12

Upland rice fields:				
Traditional farms	379		27	
Rainfed swamp rice fields:				
Traditional farms	32		14,8	
Irrigated swamp rice fields:				
Total rice fields	5	416	26,1	67,9
Sugar cane plantations:	0			6
Citrus and other fruits trees:				
Traditional farms	14			-
Intercropping with rice in traditional farms:				
Cassava	79		3,0	
Sugar cane	18		-	
Corn	14		1,6	
Eddoe	2		-	
		(113)		(4,6)
Minor crops (sweet potatoe, ground nuts tomato sesame seed, peppers, eggplants, cucumber, onions).				
Total cultivated area	15		3,6	
		1,194		254

2.2.2 Farming and Plantations.

Liberia has a huge land reserve. The cultivated acreage of 1.2 million is only a small part of the total land area of 26 million acres, mostly covered by rain forests and swamps. Although there is little systematic evaluation of the arable potential of the land reserve, it is generally believed that a substantial part of the area being in the state of nature could be productively utilized.

Liberia is parsely populated. The rural population lives in small villages scattered around in the country. The farm land of each village is placed around the fillage with the natural land surrounding the village and its small farming acreage in most places.

In the traditional farming rice is the major crop. Minor crops like cassava, sugar cane, corn, etc. are usually being intercropped with the rice. The average size is 3,5 acres of the mary small household farms, with an average of 5,4 people per farm household. Every house-hold grows several vegetables like sweet potato, tomato, peppers, eggplants, cucumber, onions etc. on a tiny garden plot and may have a few citrus fruit and banana trees. Some farms have coffee and cocoa trees. Relatively few farms have livestock, while chickens on the other hand are raised by the mojority of farm households.

The farming method applied at the villages follows the traditional West African bush fallow principle. An area near the village is cleared by felling of trees and burning, and the rice seeds are sown. After a very few uears of cultivation when the corop yield decreases, the area is left fallow, and the farming is moved to another plot near the village. The areas left fallow are gradually covered by secondary wild forest or bush. After a series of years under fallow conditions, the areas are cleared a new and farming is resumed. In this manner, the farming areas move slowly around the village.

The traditional farmer household have always lived on a self-subsistence basis, but during the last years the production of rice is being increased and the farmers have started to sell rice as the road system and traffic facilities have been improved. The Government pays much attention and efforts to stimulate the domestic production of rice, as rice still needs to be improted from abroad to cover most of the consumption of the urban population.

The first rubber plantations, were established in the 1920's and rubber is an important export commodity from Liberia.

Most of the oil palm plantations have been founded since 1963.

Intercropping in the tree plantations is not recommended, except that cover crops (legumes covers) are established to control weeds and keep the moisture in the ground.

The Government has impressive projects for expansion of the farming and plantations as listed in details in the next chapter.

2.2.3 Break-down of projected increase of cultivated land and crops during 1976 - 1981.

	1,000 acres
Oil palm plantations.	
Ivorien/Liberian Technical Assistance Agreement	37,5
Central Montserrado Project	3,6
	41,1
Coconut plantations.	
Ivorien/Liberian Technical Assistance Agreement	20
Central Montserrado Project	1,5
	21,5
Coffee plantations.	
Ivorien/Liberian Technical Assistance Agreement	10
Upper Lofa Project	7
Upper Bong Project	7,2
	24,2
Cocoa plantations.	
Ivorien/Liberian Technical Assistance Agreement	15
Upper Lofa Project	5,8
Upper Bong Project	7,2
	28,0
Rubber plantations. (1977 - 1983)	
New planting	42
Rehabilitation of previous plantations	18
	60

Upland rice fields (1 crop/per year).

Upper Lofa Project	14
Upper Bong Project	13
	27

Rainfed swamp rice fields (1 crop per year).

Upper Lofa Project	4,8
Upper Bong Project	5,0
Ministry of Agriculture Projects	5,0
	14,8

Irrigated swamp rice fields (2-3 crops per year).

Cestors Project	20
Dube Project	2,1
Ministry of Agriculture Projects	4,0
	26,1

Minor Crops.

Upper Bong Project:	3,0
Cassava	1,6
Corn	3,6
Legumes and pulses	8,2

2.2.4 Maturity, felling, and replanting of trees in plantations.

	Planted trees per acre (Recommended Number)	Age when production is reached, in years	Optimal age in average for felling and replanting of trees, in years
Oil palm trees	57	3	220
Coconut trees	57	4	25
Coffee trees	535	3	Expected 15
Cocoa trees	430	3	Expected 20
Rubber trees	150	4	17

The above age figures are approximate and may deviate depending upon local conditions, etc. The felling of old trees and replanting of new trees should be based upon statistics on the productivity of the trees in variation to age in the respective plantations.

2.2.5 Fertilizer trials in rice fields.

Fertilizer trials in rice fields in LIberia have been carried out at the results as given below:

Trials during 1972 by Mr. Alan Carpenter, Agronomist, Mr. John Wilson, etc.

Trials on the response and application procedures were carried out duiring 1972 by Mr. Alan Carpenter, Mr. John Wilson etc. under the co-operation programme of the Ministry of Agriculture.

According to Mr. Alan Carpenter's report the results of the over-all trials under said programme have suggested that the upland rice farmers can increase the yields by growing a new variety of rice and even more by adding small doses of fertilizers, containing phosphorus.

In the studies by Mr. John Wilson on upland rice fields there was no or a slight response to nitrogen and no response to potassium, and there was found no advantage from delayed or split fertilizer application.

In other areas, there may be some response to nitrogen.

According to Mr. Alan Carpenter's report, there is evidence to believe that the results from the few trials on upland rice made in 1972 will be typical throughout whole Liberia, when the variety rice-fertilizer package is adopted.

With respect to swamp rice Mr. Alan Carpenter reports that phosph is universally required in swamp rice fields in Liberia. No differences in yield have been found whether rock phosphate, triple superphosphate or compound fertilizer phosphorus has been used. No response to potassium has ever been shown in irrigated fields in Liberia, except in an old report from Firestone Plantations. Extra nitrogen as ammonium sulphate (AS) or Urea should be applied during the crop growth according to Mr. Alan Carpenter.

Mr. Alan Carpenter suggests in his report the following fertilizer applications:

- Upland rice, soil conditions like trial farm in Bong County:
- For each crop:
  Triple superphosphate (45% P_2O_5) 25 kgs/acre, (corresponding to 11 kgs., N_2O_5/acre)
- Upland rice, soil conditions like trial farm near Foya in upper Lofa County:
  For each crop:
  Urea (46% N)
  (corresponding to 4 kgs. N/acre) 16 kgs/acre
  Triple superphosphate (45% P_2O_5) 18 kgs/acre
  (corresponding to 7 kgs. P_2O_5/acre)
  Swamp rice (both rainfed and irrigated)

  For each crop:
  Urea (46% N)
  (corresponding to 14 kgs. N/acre) 91 kgs/acre
  Triple superphosphate (45% P_2O_5) 32 kgs/acre
  (corresponding to 14 kgs. P_2O_5/acre)

Trials carried out during 1973-1975 under the supervision of Dr. Yen-Sun Puh, Technical Officer (Soil Fertility), FAO.

During three years Dr. Yen-Sun Puh has conducted more than 100 fertilizer trials on swamp rice fields around in Liberia. The trials have been carried out at several locations of each of the following areas: Foya, Cape Mount, Salala, Gbanga, Belefener, Ghedin, and Techein. Conclusions can be made from 86 of the trials while the remaining trials are ruled out due to incidences of diseases and pests during the trials.

In each trial a series of different fertilizer applications were tested, as follows:

N-P_2O_5 - kgs/ha (1 ha = 2,471 acres):

0-0-0 (blind test),
0-0-0 80-0-0,
0-30-0, 40-30-, 80-30-0,
0-60-0, 40-60-0, 80-60-0,
80-60-30, 80-60-60, 40-6-30.

The fertilizers used during the trials were:
Ammonium sulphate (20% N), triple superphosphate (45% P_2O_5), and muriate of potash (60% K_2O).

The fertilizer field test results have now been collected and sent by Dr. Puh to FAO, Rome for economic evaluation, before Dr. Puh's report and recommendations will be submitted.

Meanwhile, on face of the facts already available from the trials Dr. Puh is able to substantiate the above recommendations of Mr. Alan Carpenter and to conclude, as follows:

1. Severe lack of phosphorus is characteristic of Liberian soil.

2. According to general experience on cultivation of rice, nitrogen is essential in swamp rice fields, but nitrogen alone cannot increase the rice yield to any appreciable extent. In some areas, yield even decreases at addition of nitrogen alone. But nitrogen added with phosphrous will always increase the yield of rice.

3. Some few areas show good response to potassium, but in most places potassium gives only little response in yield of rice. Even though the yield of rice may increase a little in the latter cases, an addition of potassium will not be profitable, as the extra yield will not be able to cover the extra cost of fertilizers.

2.2.6 Soil acidity in rice fields.

According to Dr. Puh, the Liberian soil is a strong acid. The use of ammonium sulphate fertilizer will gradually increase the acidity of the soil. On the other hand, in general paddy rice does not care much about soil acidity. The whole range from acid to alkaline conditions in the soil is usually suitable for the paddy rice. Meanwhile, so far Dr. Puh has not investigated whether any addition of limestone to the Liberian soil eventually being fertilized with ammonium sulphate may increase the rice yield as a separate effect.

In Taiwan the soil in the swamp rice fields has a PH - value around 5,5.

In Sierra Leone and Thailand where mangroves are present they absorb sulphur compounds from the atmosphere. This leads to an accumulation of sulphur compounds in the soil where they are oxydized into sulphuric acid, which results in a PH -value as extremely low as 3 in the ground. The soil of this category is called cat clay or sulphate soil and makes problems to rice cultivation.

2.2.7 Fertilization of swamp rice fields in Southeast Africa.

Dr. Puh, has stated his experience from Taiwan (Formosa) and Thailand as follows:

Fertilizers field tests carried out in Taiwan by the authorities have proved a small response in swamp rice yield to addition of potassium, but not to an extent that fertilization by potassium is profitable. In Thailand similar tests have shown no response to potassium, not even in rice yield. Consequently, potassium-containing fertilizers are not applied in Taiwan and Thailand.

The usual rates of fertilization made by the farmers in Taiwan and Thailand are, as follows:

Taiwan

per crop:

80 kgs. N/ha	=	33 kgs. N/acre
80 kgs. P_2O_5/ha	=	33 kgs. P_2O_5/area

In Taiwan the farmers apply ammonium sulphate (AS) or urea and single superphosphate. Other branches of fertilizers are available and being used.

AS and single superphosphate are produced in Taiwan, and a few years ago a urea plant has been constructed in Taiwan

However, through many years the farmers have been used to AS and still have a preference to AS rather than urea, because AS is less hygrescopic then urea and does not tend to cake at opening of the bags in the fields during humid weather as urea does.

Besides, when referred to the same quantity of nitrogen content AS gives 5% some rice yield than urea. In practice, this only means that correspondly more urea will have to be used. At the final end, the choice between AS and urea will depend upon prices and availability of the fertilizers.

Thailand.

Per crop:

30 kgs. N/ha = 13 kgs/acre

30 kgs. P_2O_5/ha = 13 kgs/acre

In Thailand the fertilizers being used are "Ammophos" (a trade named fertilizer imported from West Germany and an ammonium phosphate compound) and urea.

Dr. Puh has pointed out that the experimental tests in Taiwan and Thailand show that it is economical to apply even higher fertilizer rates than given above and as applied in practice by the farmers. However, the farmers limit the application because they are conservative, have little cash money available and do not want to be involved in any undue risk on their property on occasion of the purchase of fertilizers as would occur if the harvest becomes abnormally small because of bad weather or incidences of diseases or pests.

2.2.8 Nitrate fertilizers are not suitable for swamp rice.

Under the flooded conditions in a swamp rice field the soil is devoid of oxygen and is either directly or through the metabolism of micrprgamos,s reducing to oxygen-containing components.

Consequently, the use of nitrate fertilizers in swamp rice fields implies the risk that the nitrate form is reduced into gaseous nitrogen and as such diffuses through the soil and escapes into the atmosphere. Thus a part of the nitrate will be lost without any fertilizing benefit to the plants.

Nitrate fertilizers are ammonium nitrate as calnitro or as component in certain compound fertilizers, calcium nitrate, or sodium notrate, and for the above reasons they ought not be used either alone or as a component in any N-P-K, N-P, and N-K compound fertilizers for swamp rice fields.

Ammonium sulphate, urea, or any compound fertilizer containing the nitrogen as urea, AS, or any other ammonium salts like di-or mono-ammonium phosphate, all containing the nitrogen in a reduced state, are satisfactory for swamp rice fields, as they are not decomposed and lost due to the reducing conditions of the soil.

2.2.9 Fertilization programme in rice fields by Ministry of Agriculture.
The Ministry of Agriculture pays great importance to introduce the practice of fertilization of the rice fields by the farmers with the aim to increase the national rice production.

Thus, during the last few years the Ministry of Agriculture has purchased and imported N-P-K compound fertilizer (15-15-15) from abroad and distributed and sold the fertilizer through the co-operatives to the farmers at a sales price, which by January 1976 was US$ 13,06 per 100 lbs. bag (corresponding to US$ 288 per metric ton).

The Ministry of Agriculture has put emphasis to distribute a compound fertilizer in order to facilitate the application of the fertilizer to the farmers. The choice of the NPK (15-15-15) has been made because of policy on purchasing and supply rather than any specific need for this particular quality. No information was available whether the N portion of the N-P-K (15-15-15) contains nitrogen in the form of nitrate or not.

During 1975 the Ministry of Agriculture distributed NPK (15-15-15) and ammonium sulphate to the rice farmers for the fertilization, as follows:

Upland rice:	5.300 acres
Swamp rice :	1.700 acres
Total	7.000 acres

Application:
N-P-K (15-15-15) 200 lbs/acre = 91 kgs/acre, corresponding to 636 metric tons in total and AS 100 lbs/acres = 45 kgs/acre, as topdressing where severe lack of nitrogen was observed.

During 1976 the Ministry of Agriculture intends to distribute fertilizers for 10% more acreage. Some of the upland rice fields of last year have been planted with tree crops (oil palm, coffee, and cocoa), and the farmers have reclaimed new swamp rice fields. Therefore, the distribution of fertilizers during 1976 is envisaged, as follows:

Upland rice:	1.900 acres
Swamp rice :	5.800 acres
	7.700 acres

Application:
N-P-K (15-15-15) 200 lbs/acre = 91 kgs/acre, corresponding to 700 metric tons in total and AS 100 lbs/acre = 45 kgs/acre, as topdressing where severe lack of nitrogen is observed.

The Ministry of Agriculture foresees that the fertilizer consumption by the rice farmers will increase by approximately 10% per year during the next years.

2.2.10 Fertilizer application schemes for tree crops.

The Liberian Produce Marketing Corporation, Agricultural Development Division has been most helpful in submitting the attached typical fertilizer application schemes for oil palm trees, coconut trees, coffee trees, and cocoa trees. However, according to LPMC fertilizers have been applied very little for these trees in Liberia so far. LPMC points out that in new plantings fertilizers should be used only if the ground is kept cleared around the trees, as otherwise the growth of the weeds will prevail and suppress the young trees. It is regretfully experienced that the farmers do not clear the grounds around the trees in a satisfactory manner.

The Firestone Plantations Company has very willingly made its attached typical fertilizer application scheme for rubber trees available. No contact has been made to other rubber plantation companies. Meanwhile, there is no doubt that fertilizers are extensively being applied in the rubber plantations in Liberia, in particular in the plantations owned by the concessions. It can be concluded that the rubber plantations are the only important consumers of fertilizers in Liberia at the time being.

It can be assumed that the rubber plantations of Firestone are being fertilized to the optimal extent. The consumption of fertilizers in the rubber plantations may increase, until the remaining plantations owned by other concessions or Liberian nationals reach the same degree of fertilization as the Firestone Plantations. Any further increase of the fertilizer consumption of the rubber plantations will not occur, unless the rubber plantation areas are being expanded.

Attached:

Fertilizer application schemes

- Oil palm trees
- Coconut trees
- Coffee trees
- Cocoa trees
- Rubber trees

Fertilizer application scheme

Crop: Oil palm trees, 57 trees per acre.

Soil conditions: -

Typical scheme:

For both small holders and industrial plantations:		
1st year after planting:		
Urea (46% N)	250 gr/tree	= 14 kgs/acre
For small holders:		
2nd year after planting:		
N-P-K (17-14-14 or 15-15-15)	500 gr/tree	= 28 kgs/acre
For industrial plantations:		
2 nd year after planting:		
N-P-K (8-10-15)	500 gr/tree	= 28 kgs/acre
For small holders:		
3rd year after planting:		
N-P-K (12-15-17)	750 gr/tree	= 43 kgs/acre
For industrial plantations:		
3rd year after planting:		
Triple superphosphate (45% P_2O_5)	400 gr/tree	= 23 kgs/acre
Muriate of potash (60% K_2O)	750 gr/tree	= 43 kgs/acre
For small holders and industrial plantations:		
4th year after planting:		
Triple superphosphate (45% P_2O_5)	500 gr/tree	= 28 kgs/acre
Muriate of potash (60% K_2O)	1.000 gr/tree	= 57 kgs/acre
5th year after planting and each year onwards:		
Triple superphosphate (45% P_2O_5)	500 gr/tree	= 28 kgs/acre
Muriate of potash (60% K_2O)	500 gr/tree	= 28 kgs/acre

Remarks: The final application will depend upon the soil conditions, the growth and state of the trees, and leaf analysis and productivity. As the nuts are rich on potassium absorbed by the tree roots, the oil palm trees need to be added muriate of potash after the trees have reached production age.

Source of information: The Liberian Produce Marketing Corporation Agricultural Development Division, Monrovia.

Fertilizer application scheme.

Crop: Coconut trees, 57 trees per acre

Soil conditions:-

Typical scheme:

1st year after planting:	
Urea (46% N)	500 gr/tree = 29 kgs/acre
2nd year after planting:	
Urea (46% N)	250 gr/tree = 14 kgs/acre
Muriate of potash (60% K_2O)	500 gr/tree = 29 kgs/acre
Kieserite (26% MgO)	500 gr/tree = 29 kgs/acre
3rd year after planting:	
Triple superphosphate (45% P_2O_5)	500 gr/tree = 29 kgs/acre
Muriate of potash (60% K_2O)	1.000 gr/tree = 57 kgs/acre
Kieserite (26% MgO)	500 gr/tree = 29 kgs/acre
4th year after planting:	
Triple superphosphate (45% P_2O_5)	500 gr/tree = 29 kgs/acre
Muriate of potash (60% K_2O)	2.000 gr/tree =104 kgs/acre
Kieserite (26% MgO)	500 gr/tree = 29 kgs/acre
5th year after planting: and each year onwards	
Muriate of potash (60% K_2O)	2.000 gr/tree =104 kgs/acre
Kieserite (26% MgO)	1.000 gr/tree = 57 kgs/acre

Remarks: The final application will depend upon the soil conditions and the growth and state of the trees. As the nuts are rich in potassium absorbed by the tree roots, the coconut trees need to be added muriate of potash after the trees have reached the production age.

Source of information: The Liberian Produce Marketing Corporation Agricultural Development Division, Monrovia.

Fertilizer application scheme.

Crop: Coffee trees, 535 [illegible] per acre

Soil conditions:-

Typical scheme:

1st year after planting: AS (21% N)	50 gr/tree	= 27 kgs/acre
2nd year after planting: AS (21% N)	150 gr/tree	= 80 kgs/acre
3rd year after planting: N-P-K (12-15-18)	450 gr/tree	= 241 kgs/acre
4th year after planting and each year onwards: N-P-K (12-15-18)	600 gr/tree	= 321 kgs/acre

Remarks: The final application will depend upon the soil conditions and the growth and state of the trees. The above scheme originates from AFCC, the French Institute of Coffee and Cocoa and is based upon a typical West African soil.

Source of information: The Liberian Produce Marketing Corporation,
Agricultural Development Division,
Monrovia.

Fertilizer application scheme.

Crop: Cocoa trees, 430 trees per acre

Soil conditions:-

Typical scheme:

At planting: Rock phosphate (30-36% P_2O_5)	12 oz/tree	= 146 kgs/acre
2nd year after planting: AS (21% N)	2 oz/tree	= 24,5 kgs/acre
3rd year after planting: AS (21% N)	2 oz/tree	= 24,5 kgs/acre
4th year after planting: N-P-K (12-15-18)	8 oz/tree	= 98 kgs/acre
5th year after planting and each year onwards: N-P-K (12-15-18)	11 oz/tree	= 134 kgs/acre

Remarks: The final application will depend upon the soil conditions and the growth and state of the trees. The above scheme originates from AFCC, the French Institute of Coffee and Cocoa, and is based upon a typical West African soil.
1 oz. = 28,4 gr.

Source of information: The Liberian Produce Marketing Corporation, Agricultural Development Division, Monrovia.

Fertilizer application scheme.

Crop: Rubber trees, 150 trees per acre.

Soil Condition:-

Typical scheme.

For new planting and replanting after felling old trees:

At planting.

Rock phosphate (30-36% P_2O_5)	5 oz/tree	= 21,3 kgs/acre

For new planting:
1st year at 3rd month after planting:

N-P-K (15-15-15)	5½ oz/tree	= 23,4 kgs/acre
Rock phosphate (30-36% P_2O_5)	2 oz/tree	= 8,5 kgs/acre
Kieserite (26% MgO)	1 oz/tree	= 6,3 kgs/acre

For replanting:
1st year at 3rd month after planting:

N-P-K (15-15-15)	3½ oz/tree	= 14,9 kgs/acre
Rock phosphate (30-36% P_2O_5)	2 oz/tree	= 8,5 kgs/acre
Kieserite (26% MgO)	1 oz/tree	= 4,2 kgs/acre

For new planting and replanting:
1st year at 6th month after planting:

N-P-K (15-15-15)	3½ oz/tree	= 14,9 kgs/acre
Rock phosphate (30-36% P_2O_5)	2 oz/tree	= 8,5 kgs/acre
Kieserite (26% MgO)	1 oz/tree	= 4,2 kgs/acre

2nd year at 15th month after planting:

N-P-K (15-15-15)	7 oz/tree	= 29,7 kgs/acre
Rock phosphate (30-36% P_2O_5)	2½ oz/tree	= 10,7 kgs/acre
Kieserite (26% MgO)	2 oz/tree	= 8,5 kgs/acre

2nd year at 18th month after planting:

N-P-K (15-15-15)	9 oz/tree	= 38,3 kgs/acre
Rock phosphate (30-36% P_2O_5)	2½ oz/tree	= 10,7 kgs/acre
Kieserite (26% MgO)	2 oz/tree	= 8,5 kgs/acre

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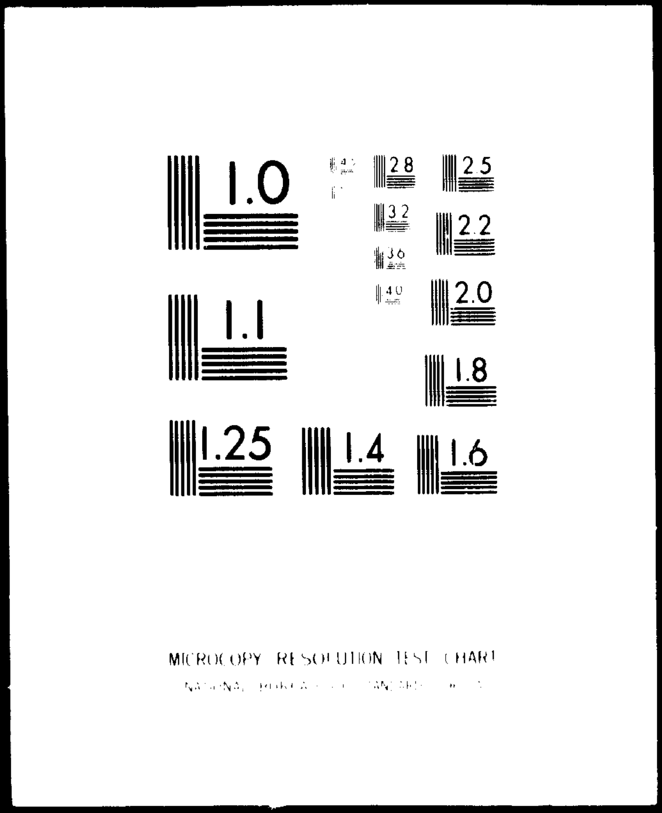

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3rd year at 27th month after planting:		
N-P-K (15-15-15)	14 oz/tree	= 59,4 kgs/acre
Rock phosphate (30-36% P_2O_5)	2¼ oz/tree	= 10,7 kgs/acre
Kieserite (26% MgO)	3½ oz/tree	= 14,9 kgs/acre
4th year at 40th month after planting:		
N-P-K (15-15-15)	18 oz/tree	= 76,4 kgs/acre
Rock phosphate (30-36% P_2O_5	2 oz/tree	= 8,5 kgs/acre
Kieserite (26% MgO)	4½ oz/tree	= 19,2 kgs/acre
5th year at 52nd month after planting:		
N-P-K (15-15-15)	21 oz/tree	= 89,1 kgs/acre
No rock phosphate		
Kieserite (26% MgO)	5 oz/tree	= 21,4 kgs/acre
6th year at 64th month after planting:		
N-P-K (15-15-15)	24 oz/tree	= 101,9 kgs/acre
Kieserite (26% MgO)	5½ oz/tree	= 23,4 kgs/acre
7th year and each year onwards:		
N-P-K (15-15-15)	27 oz/tree	= 114,6 kgs/acre
Kieserite (26% MgO)	6,2 oz/tree	= 26,3 kgs/acre

Remarks: The final application will depend upon the soil donditions, the growth and state of trees, and productivity. 1 oz. = 28,4 gr. Instead of N-P-K (15-15-15) given in the above scheme; Firestone prefers to use 13-13-13 + 5 MgO.

Source of information: Firestone Plantations Company, Harbel, Liberia.

2.2.11 Forecast fertilizer consumption of tree crops.

In the attached fertilizer consumption schemes the annual consumption figures on the various fertilizer grades have been calculated for the various tree crops on the acreage presently being cultivated and on the increased acreages as projected to 1981, respectively.

The calculations have been made under certain assumptions, which may differ from the existing conditions, as follows:

1. The trees have been assumed to be felled at a certain age depending upon the species and replaced by young trees to grow up.
2. The trees have been assumed to have an even age distribution, i.e. the same percentage of trees on each year of age.
3. The typical fertilizer application schemes given previously have been supposed in all respective plantations.

It should be noted that the need of fertilizers of tree crops is mostly governed by the species of trees and to a less extent by the soil condition, which however must be acceptable to the trees.

The following essentials related to fertilizer consumption of tree crops ought to be brought forward:

1. The present acreage of tree crops is around 412,000 acres.
2. Probably, most rubber plantations other than the Firestone Plantations are not fertilized at optimal rates as may be supposed in the case of Firestone.
3. No appreciable fertilization of the oil palm, coconut, coffee, and cocoa plantations and farms takes place at present.
4. The acreage of tree crops are projected to increased by 42% to approximately 586.800 acres during the next five years.

Therefore, on basis of the above mentioned fertilizer consumption schemes the attached fertilizer consumption tabulations have been worked out for three cases. The results of the three cases are summarized below:

Forecast fertilizer consumption of tree crops.

Case			
Total acreage of all tree crops	As existing 412.000 acres	As existing 412.00 acres	As projected for 1981 586.800 acres
Fertilization of rubber plantations	All at typical application rates	All at typical application rates	All at typical application rates
Fertilization of all other tree plantations and farms	None as at present	All at typical application rates	All at typical application rates
Fertilizer grades:	Annual fertilizer consumption, Metric tons		
Ammonium sulphate		492	743
Urea		13	78
NPK (17-14-14)		11	11
NPK (15-15-15)	29.449	29.449	35.378
NPK (12-15-17)		17	17
NPK (12-15-18)		18.838	28.523
NPK (8-10-15)		14	72
Triple superphosphate		440	1.515
Rock phosphate	1.411	1.735	2.228
Muriate of potash		476	3.653
Kieserite	6.981	6.981	9.280
Contents in total			
N	4.417	6.792	8.931
P_2O_5	4.887	8.024	11.021
K_2O	4.417	8.090	12.648

In reality the fertilizers consumed as to qualities and quantities may differ from the figures suggested in the above tabulation for a series of reasons, for instance such as:

1. Felling and replanting of trees will not be optimal.

2. The age distribution of trees will be different.

3. Application of fertilizers will depend to some degree upon the soil properties and other agricultural factors.

4. Availability and cost of fertilizers on the market.

5. Financial standing of plantation owners and farmers.

6. Training and skill of plantation personnel and farmers.

7. Market and price situation of final products of trees.

This means that the actual consumption of fertilizers on trees crops may lay behind substantially in comparison to the figures of the summary given above.

On the contrary, the actual consumption of fertilizers on tree crops cannot expand beyond the figures of the summary, unless the acreage of cultivated land will be extended more than projected.

Attached:

Fertilizer consumption scheme:

- Oil palm trees, small holders, 8.000 acres
- Oil palm trees, industrial plantations, 10.000 acres
- Oil palm trees, industrial plantations, 51.100 acres
- Coconut trees, 21.500 acres.
- Coffee trees, 51.000 acres.
- Coffee trees, 75.200 acres.
- Cocoa trees, 45.000 acres
- Cocoa trees, 73.000 acres.
- Rubber trees, 298.000 acres.
- Rubber trees, 358.000 acres.

Fertilizer consumption tabulations:

- Case A
- Case B
- Case C

Fertilizer Consumption Scheme

Crop: Oil palm trees, small holders

Application: According to typical scheme (assumed).

Total acreage: 8.000 acres, as existing in 1975.

Felling and replanting age: 20 years (assumed)

Ages of trees	0–1 year	1–2 year	2–3 year	3–4 year	5–20 year	0–20 year
Acreage distribution (assumed)	5%	5%	5%	5%	80%	Total
Fertilizer grades:	Annual fertilizer consumption, metric tons					
Ammonium sulphate	–	–	–	–	–	–
Urea	5,6	–	–	–	–	5,6
NPK (17-14-14)	–	11,2	–	–	–	11,2
NPK (15-15-15)	–	–	–	–	–	–
NPK (12-15-17)	–	–	17,2	–	–	17,2
NPK (12-15-18)	–	–	–	–	–	–
NPK (8-10-15)	–	–	–	–	–	–
Triple superphosphate	–	–	–	11,2	179,2	190,4
Rock phosphate	–	–	–	–	–	–
Muriate of potash	–	–	–	22,8	179,2	202,0
Kieserite	–	–	–	–	–	–

Fertilizer Consumption Scheme

Crop: Oil palm trees, industrial plantations.

Application: According to typical scheme.

Total acreage: 10.000 acres, as existing in 1975.

Felling and replanting age: 20 years (assumed).

Ages of trees	0–1 year	1–2 year	2–3 year	3–4 year	5–20 year	0–20 year
Acreage distribution (assumed)	5%	5%	5%	5%	80%	Total
Fertilizer grades:	Annual fertilizer consumption, metric tons					
Ammonium sulphate	–	–	–	–	–	–
Urea	7,0	–	–	–	–	7,0
NPK (17-14-14)	–	–	–	–	–	–
NPK (15-15-15)	–	–	–	–	–	–
NPK (13-15-17)	–	–	–	–	–	–
NPK (12-15-18)	–	–	–	–	–	–
NPK (8-10-15)	–	14,0	–	–	–	14,0
Triple superphosphate	–	–	11,5	14,0	224,0	249,5
Rock phosphate	–	–	–	–	–	–
Muriate of potash	–	–	21,5	28,5	224,0	274,0
Kieserite	–	–	–	–	–	–

Fertilizer Consumption Scheme

Crop: Oil palm trees, industrial plantations.

Application: According to typical scheme.

Total acreage: 51.100 acres, as projected at 1981

Felling and replanting age: 20 years (assumed).

Age of trees	0-1 year	1-2 year	2-3 year	3-4 year	5-20 year	0-20 year
Acreage distribution (assumed)	5%	5%	5%	5%	80%	Total
Fertilizer grades:	Annual fertilizer consumption, metric tons					
Ammonium sulphate	-	-	-	-	-	-
Urea	35,8	-	-	-	-	35,8
NPK (17-14-14)	-	-	-	-	-	-
NPK (15-15-15)	-	-	-	-	-	-
NPK (12-15-17)	-	-	-	-	-	-
NPK (12-15-18)	-	-	-	-	-	-
NPK (8-10-15)	-	71,6	-	-	-	71,6
Triple superphosphate	-	-	58,8	71,6	1.145	1.275
Rock phosphate	-	-	-	-	-	-
Muriate of potash	-	-	109,9	143,2	1.144	1.398
Kieserite	-	-	-	-	-	-

Fertilizer Consumption Scheme

Crop: Coconut trees

Application: According to typical scheme (assumed).

Total acreage: 21.500 acres, as projected at 1981

Felling and replanting age: 25 years (assumed).

Ages of trees	0–1 year	1–2 year	2–3 year	3–4 year	5–25 year	0–25 year
Acreage distribution (assumed)	4%	4%	4%	4%	84%	Total
Fertilizer grades:	Annual	fertilizer	consumption,	metric	tons	
Ammonium sulphate	–	–	–	–	–	–
Urea	24,9	12,4	–	–	–	37,3
NPK (17-14-14)	–	–	–	–	–	–
NPK (15-15-15)	–	–	–	–	–	–
NPK (12-15-17)	–	–	–	–	–	–
NPK (12-15-18)	–	–	–	–	–	–
NPK (8-10-15)	–	–	–	–	–	–
Triple superphosphate	–	–	24,9	24,9	–	49,8
Rock phosphate	–	–	–	–	–	–
Muriate of potash	–	24,9	49,8	99,6	1.878	2.053
Kieserite	–	24,9	24,9	24,9	939,1	1.014

Fertilizer Consumption Scheme

Crop: Coffee trees.

Application: According to typical scheme (assumed).

Total acreage: 51.000 acres, as existing in 1975.

Felling and replanting age: 15 years (assumed).

Ages of trees	0-1 year	1-2 year	2-3 year	3-15 year	0-15 year
Acreage distribution (assumed)	7%	7%	7%	79%	Total
Fertilizer grades:	Annual fertilizer consumption, metric tons				
Ammonium sulphate	96,4	285,6	-	-	382
Urea	-	-	-	-	-
NPK (17-14-14)	-	-	-	-	-
NPK (15-15-15)	-	-	-	-	-
NPK (12-15-17)	-	-	-	-	-
NPK (12-15-18)	-	-	860,4	12.933	13.793
NPK (8-10-15)	-	-	-	-	-
Triple superphosphate	-	-	-	-	-
Rock phosphate	-	-	-	-	-
Muriate of potash	-	-	-	-	-
Kieserite	-	-	-	-	-

Fertilizer Consumption Scheme

Crop: Coffee trees.

Application: According to typical scheme (assumed).

Total acreage: 75,200 acres, as projected at 1981

Felling and replanting age: 15 years (assumed).

Ages of trees	0-1 year	1-2 year	2-3 year	3-15 year	0-15 year
Acreage distribution (assumed)	7%	7%	7%	79%	Total
Fertilizer grades:	Annual	fertilizer	consumption,	metric	tons.
Ammonium sulphate	143,1	421,1	-	-	564
Urea	-	-	-	-	-
NPK (17-14-14)	-	-	-	-	-
NPK (15-15-15)	-	-	-	-	-
NPK (12-15-17)	-	-		-	-
NPK (12-15-18)	-	-	1.269	19.070	20 339
NPK (8-10-15)	-	-	-	-	-
Triple superphosphate	-	-	-	-	-
Rock phosphate	-	-	-	-	-
Muriate of potash	-	-	-	-	-
Kieserite	-	-	-	-	-

Fertilizer Consumption Scheme

Crop: Cocoa trees.

Application: According to typical scheme (assumed).

Total acreage: 45,000 acres, as existing in 1975.

Felling and replanting age: 20 years (assumed).

Ages of trees	0-1 year	1-2 year	2-3 year	3-4 year	4-20 year	0-20 year
Acreage distribution (assumed)	5%	5%	5%	5%	80%	Total
Fertilizer grades:	Annual fertilizer consumption, metric tons.					
Ammonium sulphate	-	55,1	55,1	-	-	110
Urea	-	-	-	-	-	-
NPK (17-14-14)	-	-	-	-	-	-
NPK (15-15-15)	-	-	-	-	-	-
NPK (12-15-17)	-	-	-	-	-	-
NPK (12-15-18)	-	-	-	220,5	4.924	[illegible].045
NPK (8-10-15)	-	-	-	-	-	-
Triple superphosphate	-	-	-	-	-	-
Rock phosphate	323,5	-	-	-	-	324
Muriate of potash	-	-	-	-	-	-
Kieserite	-	-	-	-	-	-

Fertilizer Consumption Scheme

Crop: Cocoa trees.

Application: According to typical scheme (assumed).

Total acreage: 73,000 acres, at projected at 1981.

Felling and replanting age: 20 years (assumed).

Ages of trees	0–1 year	1–2 year	2–3 year	3–4 year	4–20 year	0–20 year
Acreage distribution (assumed)	5%	5%	5%	5%	80%	Total
Fertilizer grades:	Annual fertilizer consumption, metric tons					
Ammonium sulphate	–	89,4	89,4	–	–	179
Urea	–	–	–	–	–	–
NPK (17-14-14)	–	–	–	–	–	–
NPK ([illegible]-15-15)	–	–	–	–	–	–
NPK (12-15-17)	–	–	–	–	–	–
NPK (12-15-18)	–	–	–	357,7	7.826	8.184
NPK (8-10-15)	–	–	–	–	–	–
Triple superphosphate	–	–	–	–	–	–
Rock phosphate	532,9	–	–	–	–	533
Muriate of potash	–	–	–	–	–	–
Kieserite	–	–	–	–	–	–

Fertilizer Consumption Scheme

Crop: Rubber trees.

Application: According to typical scheme (assumed).

Total acreage: 298,000 acres, as existing in 1975.

Felling and replanting age: 17 years (assumed).

Ages of trees	0-1 year	1-2 year	2-3 year	3-4 year	4-5 year	5-6 year	6-17 year	0-17 year
Acreage distribution (assumed)	6%	6%	6%	6%	6%	6%	64%	Total
Fertilizer grades:	Annual fertilizer consumption, metric tons							
Ammonium sulphate	-	-	-	-	-	-	-	-
Urea	-	-	-	-	-	-	-	-
NPK (17-14-14)	-	-	-	-	-	-	-	-
NPK (15-15-15)	523,8	1.216	1.062	1.366	1.593	1.822	21.857	29.449
NPK (12-15-17)	-	-	-	-	-	-	-	-
NPK (12-15-18)	-	-	-	-	-	-	-	-
NPK (8-10-15)	-	-	-	-	-	-	-	-
Triple superphosphate	-	-	-	-	-	-	-	-
Rock phosphate	684,8	382,6	191,4	152,0	-	-	-	1.411
Muriate of potash	-	-	-	-	-	-	-	-
Kieserite	150,2	304,0	266,4	343,3	382,6	418,4	5.116	6.981

Fertilizer Consumption Scheme

Crop: Rubber trees.

Application: Accroding to typical scheme (assumed)

Total acreage: 358,000 acres, as projected at 1981.

Felling and replanting age: 12 years (assumed).

Ages of trees	0-1 year	1-2 year	2-3 year	3-4 year	4-5 year	5-6 year	6-17 year	0-17 year
Acreage distribution (assumed)	6%	6%	6%	6%	6%	6%	64%	Total
Fertilizer grades:	Annual fertilizer consumption, metric tons							
Ammonium sulphate	-	-	-	-	-	-	-	-
Urea	-	-	-	-	-	-	-	-
NPK (17-14-14)	-	-	-	-	-	-	-	-
NPK (15-15-15)	640.1	1461	1276	1641	1.914	2.189	26.257	35.378
NPK (12-15-17)	-	-	-	-	-	-	-	-
NPK (12-15-18)	-	-	-	-	-	-	-	-
NPK (8-10-15)	-	-	-	-	-	-	-	-
Triple wuperphosphate	-	-	-	-	-	-	-	-
Rock phosphate	822,7	459,7	229,8	182,6	-	-	-	1.695
Muriate of potash	-	-	-	-	-	-	-	-
Kieserite	180,4	365,2	320,1	412,4	459,7	502,6	6.026	8.266

Fertilizer Consumption Tabulation

Case A: 1. Existing acreages as in 1975.

2. All rubber plantations fertilized at Firestone's typical application rates

3. No fertilization of the oil palm, coconut, coffee, and cocoa plantations and farms takes place and present

4. Fertilizer consumption of rice and other field crops excluded.

Plantations	Rubber	Oil palm	Coconut	Coffee	Cocoa	Total
Acreage, in 1.000 acres	298	18	0	51	45	412
Fertilizer grades:	Annual	fertilizer	consumption,	metric	tons	
Ammonium sulphate	-	-	-	-	-	-
Urea	-	-	-	-	-	-
NPK (17-14-14)	-	-	-	-	-	-
NPK (15-15-15)	29.449	-	-	-	-	29.449
NPK (12-15-17)	-	-	-	-	-	-
NPK (12-15-18)	-	-	-	-	-	-
NPK (3-10-15)	-	-	-	-	-	-
Triple superphosphate	-	-	-	-	-	-
Rock phosphate ($33\%\ P_2O_5$)	1.411	-	-	-	-	1.411
Muriate of potash ($60\%\ K_2O$)	-	-	-	-	-	-
Kieserite	6.981	-	-	-	-	6.981
Contents in total:						
N						4.417
P_2O_5						4.887
K_2O						4.417

Fertilizer Consumption Tabulation

Case B:
1. Existing acreages as in 1975.
2. All rubber plantations fertilized at Firestone's typical application rates.
3. All oil palm, coconut, coffee, and cocoa plantations and farms fertilized at LPMC's typical application rates.
4. Fertilizer consumption of rice and other field crops is excluded.

Plantations	Rubber	Oil palm	Coconut	Coffee	Cocoa	Total
Acreage, in 1.000 acres	298	18	0	51	45	412
Fertilizer grades:	Annual fertilizer consumption, metric tons					
Ammonium sulphate	-	-	-	332	110	492
Urea	-	13	-	-	-	13
NPK (17-14-14)	-	11	-	-	-	11
NPK (15-15-15)	29 449	-	-	-	-	29 449
NPK (12-15-17)	-	17	-	-	-	17
NPK (12-15-18)	-	-	-	13 793	5,045	18 838
NPK (3-10-15)	-	14	-	-	-	14
Triple superphosphate	-	440	-	-	-	440
Rock phosphate (33% P_2O_5)	1 411	-	-	-	32[illegible]	1 735
Muriate of potash (60% K_2O)	-	476	-	-	-	[illegible]6
Kieserite	6 981	-	-	-	-	6 981
Contents in total:						
N						6 792
P_2O_5						8 024
K_2O						8 090

Fertilizer Consumption Tabulation

Case C. 1. Acreages projected at 1981.

2. All rubber plantations fertilized at Firestone's typical application rates.

3. All oil palm, coconut, coffee and cocoa plantations and farms fertilized at LPMC's typical application rates.

4. Fertilizer consumption of rice and other field crops is excluded.

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Plantations	Rubber	Oil palm	Coconut	Coffee	Cocoa	Total
Acreages, in 1.000 acres	358	59,1	21,5	75,2	73	586,8
Fertilizer grades:	Annual fertilizer consumption, metric tons					
Ammonium sulphate	-	-	-	564	179	743
Urea	-	41	37	-	-	78
NPK (17-14-14)	-	11	-	-	-	11
NPK (15-15-15)	35.378	-	-	-	-	35.378
NPK (12-15-17)	-	17	-	-	-	17
NPK (12-15-18)	-	-	-	20.339	8.184	28.523
NPK (8-10-15)	-	72	-	-	-	72
Triple superphosphate	-	1.465	50	-	-	1.515
Rock phosphate (33% P_2O_5)	1.695	-	-	-	533	2.228
Muriate of potash (60% K_2O)	-	1.600	2.053	-	-	3.653
Kieserite	8.266	-	1.014	-	-	9.280
Contents in total:						
N						8.931
P_2O_5						11.021
K_2O						12.648

2.2.12 Forecast fertilizer consumption of rice and other field crops.

As mentioned previously, the Ministry of Agriculture envisages to distribute to the rice farmers during 1976 around 700-800 metric tons of fertilizers in total, which indeed is a very unsignificant quantity as compared to the consumption figures prevailing in developed countries.

The future consumption of fertilizers by the farmers will be greatly influenced by the suitability, cost, success, etc. of the fertilizers actually being sold. It is added that the suitability of the NPK compound fertilizer being actually sold to the rice farmers ought to be carefully checked and proved soonest possible.

Meanwhile, it seems reasonable to conclude that the consumption of fertilizers by the farmers will not reach any substantial quantity during the next years.

An important irrigated swamp rice development programme for next years is the Cestors project encompassing new 20.000 acres. All or part of these fields may be established on virgin land, which may not need much fertilization during the first few years. When fertilization may be started, this total area will need in the order of 565 metric tons of urea and 580 metric tons of triple superphosphate per each crop season, if fertilizers will be applied at the same rates of 13 kgs. of N and 13 kgs. of P_2O_5 per acre as typical for Thailand as previously described. Even if the application of urea would be tripled in accordance with the suggestions of Mr. Alan Carpenter as mentioned earlier, these quantities are very small as compared to the consumption figures of the vast, intensively cultivated farm lands of the developed countries.

Unlike Liberia, the countries, where fertilizers nowadays are in great demand and use, such as North America, Europe including European USSR., Middle East, India and Pakistan, Southeast Asia, China, and Japan, are densely populated and have cultivated the land continuously and incessantly during many decennia hundred, hundreds, thousand, or even thousands or years.

Therefore, in the sense that fertilizers are not in great need and large areas of arable land not yet under cultivation is at hand Liberia is a rich country. Liberia should use fertilizers only to the extent like in other countries-that it is profitable, i.e. the economic benefit in yield surpasses the cost of the fertilizers and their application.

The need of fertilizers ought to be judged from current fertilizer trials in the fields.

Any further accelaration of the consumption of fertilizers would be purposeless and a waste of money and efforts.

2.2.13 Prerequisites for success of fertilization.

A large scale application of fertilizers among the small plantation owners and farmers is an integrated and extremely completed process, which will require to be dealt with, organized, and co-ordinated in order to be a success, as follows:

- The fertilizers must be available in qualities to suit crops, soils and climate.
- A fertilizer center must be established to investigate the use of fertilizers on crops and soils, to instruct farmers in the use of fertilizers, to make field visits, soil tests, agronomy trials, demonstrations, etc. FAO/UNIDO can assist Liberia in establishing such a center. The same center may also advise on disease and pest control, crop selection, crop varieties, agricultural methods, etc.
- A marketing organization for instance LPMC must be established to purchase, distribute, and sell the fertilizers to the farmers at credit arrangements. Farmers will certainly not be willing to put their property of land on stake at purchase of fertilizer and failure of harvest due to bad weather and incidenses of diseases and pests. Central and local warehouses must be built and transportation facilities provided. Farmers must be able to shield the fertilizer bags, against rain, until the fertilizers are spread.
- The larger yields of the agricultural crops due to the introduction of fertilizers must be adapted to the national market, the national policy and the export markets. The proportion between various crops may have to be changed, and new and better crops may have to be applied. Farmers may need to be instructed by agronomists and field trials may have to be made as to the necessity of circulation of crops in the fields.

- To a certain extent the higher yields of crops may be converted into large production of domestic animal stock, milk, eggs, etc. Farmers will need advice and assistance from veterinarians, etc., in breeding of cattle, pigs, hen etc. Medical protection, etc. will have to be organized and financed. Import of quality breeding animals may be necessary.

- Machinery for better traction, plowing, harrowing, sowing, fertilizing, harvesting, threshing, milling, etc. will have to be provided and financed.

- Stables for domestic animals, if necessary storehouses for crops, fodder silos, etc. will need to be built and financed.

- Roads, trucks, railway and airplanes must be at disposal to bring the agricultural products to the markets, central stores, slaughtering, food porcessing, cold stores, etc.

- Slaughteries, dairies, canning factories, cold stores, cotton mills, grain silos, flour mills, etc., must be established, financed and managed.

- Wholesale, retail, and export must be organized and improved.

- Collaboration between farmers, fertilizer center, agronomists, veterinarians, fertilizer company, transporters, financing institutes, food processing factories, etc., must be co-ordinated under the authority of the Ministry of Agriculture.

- Farmers must organize and join in co-operatives to handle purchases, sales, processing of food, etc.

- Agricultural schools must be made available for the sons and daughters of farmers, and the most clever ones of the young people must have access to university education as agronomists, veterinarians, etc., possibly through scholarships. It is most beneficial and may even be necessary that agronomists have a practical training and knowledge in all details beside their university degree.

- First and foremost, the structure of prices of fertilizers, crops, domestic animals, processed food etc. must be secured to bring about a flow of goods through economical incentives and gains to all chain links in the process, such as farmers, transporters, factories, marketers, exporters, etc. The authorities must see to it that customs clearance, customs duties, taxes, etc., on machinery, seeds, muster cattle for breeding, etc., do not act against the whole process.

- In order that the latter condition can be fulfulled, the income of the population outside the agriculture must be increasing, or/and the export of agricultural products must be enlarging at beneficial prices, or/and the prices on agricultural products will have to be subsidized by the Government.

- A healthy and rich food supply is a must for the healthy growth and development of the young generation and creates more energy, happiness, self-reliance, and display of skill to the generation of adults. Free milk or even free healthy meals to schoolchildren each day is common practice in some countries.

2.3 The use of ammonium nitrate (33.5% N).

2.3.1 Exchem's exclusive concession on manufacture of explosives.

Exchem - West African Explosives and Chemicals Ltd. at Charlesville has an exclusive concession for the manufacture of explosives in Liberia in accordance with a concession agreement with the Ministry of Finance, Concession Secretariat.

Exchem is an affiliate of Canadian Industries Ltd. (CIL) which again is an affiliate of Imperial Chemical Industries Ltd. (ICI), England. Exchem - Canada and CIL have head offices in Montreal, Canada.

Consequently, Exchem is the only importer of ammonium nitrate (33,5% N) into Liberia, because AN needs mixing with other materials and preparation prior to and for the use as explosives.

Exchem has purchased and imported the AN from several foreign manufacturers in Norway, Sweden, West Germany, France, USA, Canada, etc. on the the basis of competitive bidding. Exchem is not restricted to buy the AN from CIL or ICI. In most cases other suppliers are cheaper and are chosen. Purchasing is made through Purchasing Department at Exchem-Canada, Montreal. The AN shall meet the specifications on AN as demanded by Exchem. Samples of AN from bidders and suppliers are subjected to prior tests by Laboratory Department of Exchem - Canada, Montreal.

Previously, the AN was bought on long term contracts with suppliers, but at the fluctuating conditions of the market the last years the AN is now being delivered under short term contracts.

CIL is presently constructing a 250.000 T/Y AN plant in Canada, mostly to supply the North American market on AN for explosives.

From the beginning of 1973 to the end of 1975 the AN price, c.i.f. Monrovia has nearly tripled according to Exchem.

The last deliveries of AN originate from Norsk Hydro, Norway.

The basic chemical for production of AN is ammonia. As a matter of fact a substantial part of the manufacturing cost of AN is due to the cost of the ammonia feedstock.

At the beginning of 1973 the world market price on ammonia delivered in bulk was 50-100 US$ per metric ton, but a sudden rise occurred in the world market price, which became and kept at 300-350 US$ per metric ton all during 1974 and the spring of 1975. However, then a drastic drop of the price took place. From the summer and through the automn of 1975 the world market price on ammonia devlivered in bulk has been down at 100-150 US$ per metric ton, ex-factory or f.o.b.

The freight and insurance cost of AN classified as an explosive is an essential element of the c.i.f. Monrovia price on AN and has increased during the automn of 1975. This has counteracted to some extent the fall in the ex-factory prices on AN due to the lower prices on ammonia according to Exchem. But during the last months of 1975 there has been a softening of the import prices of AN according to Exchem.

A good average c.i.f. Monrovia price for the automn of 1975 on the AN delivered by Norsk Hydro is Norwegian Crowns 1.300 per metric ton, corresponding to US$ 234 per metric ton at 0,18 US$ per Norwegian Crown according to Exchem.

In the Exchem plant, the AN is mixed and prepared in several explosives, as follows:

- AN and TNT
- AN and sodium nitrate
- AN and aluminium
- AN and fuel oil into slurries (30-60% FO content), and
- AN and fuel oil into ANFO dry mix (6% FO content)

The products are made according to the specific needs of the customers. Explosives are sold as a part of an entire package, consisting of know-how and consultation on rocks and exploitation methods, recommendations on explosives and pertaining commodities as needed in the specific cases, supply of the materials, explosive mixing and application in the quarries, etc.

Exchem also imports large quantities of dynamite, etc. Exchem is competitive and covers the whole market on explosives in the West African countries.

According to Exchem, they imported in the order of 12.000 metric tons of AN in total during 1975, and they estimate that around 9.000 - 9.500 metric tons of the total quantity was sold as final products in Liberia, while around 2.500 - 3.000 metric tons were reexported in the form of mixed products to the West African countries, in particular Mauretania.

Exchem points out that the market on explosives in West Africa is very fluctuating, as the consumption of explosives varies with the production in the mines, closing of old mines, opening of new mines, etc.

2.3.2 Specification of ammonium nitrate (33,5% N), low density grade for explosives.

The ammonium nitrate purchased from foreign manufacturers by Exchem through Exchem-Canada's Purchasing Department, Montreal is subjected to sample testing by Exchem-Canada's laboratory Department, Montreal and is required to comply with the following specification:

Chlorides	maximum 0,03% (as NH_4 Cl)
Nitrite	maximum 0,005% (as NH_4 NO_2)
Acidity or Alkalinity:	not more than 0,01% as HNO_3 or 0,02% as NH_3.
Sulphate	No positive reaction for sulphate.
Density	0,80-0,88 gr/cm^3

Fineness (Tyler Standard Screen Scale).

0% on mesh 6,
minimum 77% on mesh 14,
minimum 23% through mesh 14, of which
minimum 3% through mesh 28.

Organic coated

Non-volatile matters:	0,75-1,15%
Oil absorption	minimum 7,0%
Nitrogen %	-
Friability	10-65% through mesh 14
Moisture	maximum 0,15%

2.3.3 Safety regulations for handling of ammonium nitrate (33.5% N)

Exchem follows the US Coast Guard Regulations" during shipping, transhipping, unloading, transportation, handling, and storage of the ammonium nitrate being imported from abroad. These set of rules have been chosen in agreement with the Ministry of Finance, Concessions Secretariat.

According to this agreement, Exchem is not allowed to dock ammonium nitrate in Monrovia and Buchanan. The AN is imported in 1.000 tons lots in 50 kgs. bags. Each lot is transhipped from the freighter 1-1' mile from the sea coast near Monrovia into the feeder crafts owned by Farrell Lines Inc., which carry the bags along the coast and through Farmington River to the Sanfu Dock. There the bags are unloaded into the special trucks which take the bags to storage at Exchem's site at Cahrlesville. Maximum 2.000 - 2.500 tons of AN is stored in the storage at a time.

2.4 The use of ammonia.

Liquid ammonia is imported in pressure vessels from abroad, probably mostly from USA by the rubber plantations. The ammonia is dissolved in water into aqueous ammonia solution at the plantations.

Aqueous ammonia solution is added to the cups on the rubber trees by the tappers in order to prevent or limit coagulating from the juice. In the centrifuge and processing plant, the latex is added more aqueous ammonia solution and a phosphate compound for stabilization of the latex before its shipment.

The quantities of imported ammonia total 1.500 - 2.000 metric tons per year according to the import statistics.

2.5 References.

- Republic of Liberia, Ministry of Planning and Economic Affairs, statistics on External Trade of Liberia, Imports, 1972, 1973, 1974, etc.

  The Liberian Produce Marketing Corporation, Agricultural Development Division, Annual Report on Tree Crop Programme covering October 1974 - September 1975.

  Republic of Liberia, Ministry of Agriculture, Strenghtening Agriculture Research and Field Services, UNDP/FAO - LIR/73/013 Draft Terminal Report, Guideline for Rice Farming as a Development Objective for Liberia, Volumes I and II, by Alan Carpenter, Agronomist, June 1975.

- Republic of Liberia, Ministry of Agriculture- Ministry of Planning and Economic Affaris, National Rice Production Estimates, 1974.

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TERMINAL REPORT

REPORT PART 3

REVIEW OF FERTILIZERS AND THEIR RAW MATERIALS, MANUFACTURE, PROCUREMENT, SHIPMENT, DISTRIBUTION, AND APPLICATION, AND PREPARATORY STUDY OF A FERTILIZER BULK BLENDING AND BAGGING PLANT.

LIBERIA

(IS/LIR/74/012)

by

Karl Kjeldgaard,

Expert of the United Nations Industrial Development Organization acting as Executing Agency for the United Nations Development Programme

This report has not been cleared with the United Nations Industrial Development Organization which does not therefore necessarily share the views presented (1).

(1) To be omitted after clearance by UNIDO.

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ABBREVIATIONS

AN	Ammonium Nitrate
AS	Ammonium sulphate
N	Nitrogen
P	Phosphorus
K	Potassium
O	Oxygen
MTPD	Metric tons per day (24 hours)
STPD	Short tons per day (24 hours)
MTPY	Metric tons per year
STPY	Short tons per year
NPK (17-17-17)	Means a NPK compound fertilizer containing 17% or 170 kgs. of N per metric ton, 17% or 170 kgs. of P_2O_5 per metric ton and 17% or 170 kgs. of K_2O per metric ton.
DAP	Di-ammonium-phosphate
MAP	Mono-ammonium-phosphate.
KCL	Potassium chloride, equal to Muriate of potash

3.1 Fertilizers

3.1.1 Nutritional elements of plants.

Some fifteen elements are known to be essential for plant growth. Except for oxygen, carbon, and hydrogen, which are supplied mainly from air and water and converted by the plants through photosynthesis of carbon dioxide and water into carbohydrates and fats, etc., these elements are obtained through the plant roots from the organic and material substances in the soils.

The three elements having the greatest effect on plant growth are nitrogen (N), phosphorus (P), and potassium (K). All three elements are essential to plants, but nitrogen is the more important one.

Depending upon the characteristics of the soil these elements are slowly liberated as soluable chemical compounds from the organics and minerals of the soil. Part of the soluble components will remain chemisorbed by the soil and become available to the plant roots, and part of the liberated components will be depleted from the soil through the flow and action of the rainwater and be removed with the surface water and the ground water.

Virgin land where cultivation is initiated may be rich in the nutritional components and may yield satisfactory harvests during a series of years. During fallow conditions of land previously cultivated the gradual and slow liberation of the nutritional components will go on and the components will start to accumulate in the soil. After some years in fallow, cultivation of the land may be resumed for a limited number of years until a new fallow period will be necessary.

During incessant cultivation of land it is necessary to add the nutritional elements in the form of manure and chemical fertilizers to the soil in order to secure an adequate supply of the elements to meet the crop requirements in the agricultural production.

As the manure from livestock contains only a very reduced portion of the elements present in the fodder as gained from the cultivation of the land, the addition of manure will not be sufficient. Artificial fertilizers must be spread as well.

Primarily, nitrogen-containing fertilizers will be required. Few years after virgin or fallow conditions phosphorus-containing fertilizers will also be necessary. At the elapse of say 25 years of continous cultivation the addition of potassium-containing fertilizers may have an impact on the harvesting yields. Many soils contain relatively high amounts of potassium and may still not need the addition of potassium before the depletion has taken place after a prolonged crop production period.

Besides the three major elements, plants need the micronutrient elements such as magnesium, copper, manganese, boron, zinc, iron, etc. which may have to be added through fertilization or to cultivated soil. Certain tree crops need appreciable quantities of magnesium.

Regulation of the acidity of the soil may become feasible and necessary, and is carried out through spreading of marl, limestone, etc.

3.1.2 Fertilization

Fertilization should be carried out at rates which are economically feasible. The increased yields must more than compensate the cost of the fertilizers. Fertilization ought not be done beyond the rates where the costs of the fertilizer rate differentials surpass the yield increase differentials. Excessive fertilization may even decrease the yields of the crops. Some of the micronutrients which are essential in small concentrations may as a fact become toxic to the plants introduced in excess.

The optimal application of fertilizers will depend upon the soil characteristics, soil virginity, climatic conditions, crops, etc. Thus the optimal application rates may vary very much from one country or region to another.

Fertilizers are greatly needed in the developed countries, which are densely populated and where continuous cultivation has taken place during decennia or hundreds of years. Some of the developing countries like the Middle East countries, India, Indonesia, Red China, etc., where huge populations and intensive agriculture exist, are in great need of fertilizers. In developing countries with a scattered population and an abundancy of arable land the consumption of fertilizers may grow slowly as the population is increased and is urbanized.

On a world-wide scale, the fertilizer consumption in 1972/1973 was, as follows:

N	36,1 million metric tons
P_2O_5	22,6 million metric tons
K_2O	18,7 million metric tons
Total	77,4 million metric tons

3.1.3 Fertilizers Grades.

The most important fertilizer grades which are sold nowadays on the world market are, as follows:

N

- Liquid ammonia (82%N). Large quantities of liquid ammonia are used by the farmers in temperate climate zones in U.S.A. and Europe where the soil is cold and humid in the spring time, while the application of liquid ammonia is not feasible in subtropical and tropical climates due to excessive evaporation loss.

- Urea (46% N). Urea is the highest concentrated, nitrogeneous solid fertilizer which involves low transportation costs. It has a reliable fertilizer effect, and per ton of nitrogen it has the lowest manufacturing costs as compared to other nitrogenous fertilizers, when reference is made to the same construction and start-up time of plants. All the fertilizer plants built during the last 10 years around the world for conversion of liquid ammonia into a solid, straight nitrogeneous fertilizer have been based upon the urea route.

- (Ammonium nitrate (34% N), which is AN will 1 % coating agent is used entirely as a raw material for explosives, but is prohibited for the use as fertilizer because of explosion risk during storage, handling, and shipment. But AN is the main ingredient in the subsequent, diluted grade and in some NP or NPK compound fertilizers).

- Calnitro (26% N), which is AN with limestone powder in combined prills or granules.

- Ammonium sulphate (21% N). This is one of the oldest fertilizers which have been manufactured in large scale. It has excellent, low hygroscopic properties and is still in great use among farmers in many countries in spite of its low concentration of N. AS is advantageously used where the soil is deficient in sulphur. AS was a by-product in earlier town-gas plants based on coal.

- Other straight nitrogeneous fertilizers with even lower percentage of N are available on the world market, such as calcium nitrate, sodium nitrate (same as previous, natural Chilesalpeter, but is produced by manufacture to-day), etc.

P and N-P

- Rock phosphate (30-36 % P_2O_5). Since its phosphate content is insoluble and, thus, becomes only very slowly available to the plants, it is used merely for particular crops.

- Single superphosphate (20 % P_2O_5). Like the next grades it is rock phosphate which has been treated with sulphuric acid, so its phosphate content has become soluble and directly accessible to plants.

- Triple superphosphate (45 % P_2O_5).

- (Phosphoric acid (73 % P_2O_5) is not directly applied as fertilizer, but is shipped as a highly concentrated phosphorus source for manufacture of any of the next phosphate compounds).

- Di-ammonium-phosphate (18-21 % N, 46-50 % P_2O_5), named DAP.

- Mono-ammonium-phosphate (11-12 % N, 48-50 % P_2O_5), named MAP.

- Nitrophosphate.

K

- Muriate of potash =
  Potassium chloride (48-62% K_2O).

- Sulphate of Potash =
  Potassium sulphate (48-52% K_2O). This fertilizer is produced from potassium chloride and is used for chlorine sensitive crops, like potato, tobacco, tomato, citrus fruit trees, etc.

Binary and tertiary compounds- N-P, N-P-K, P-K.

- Further to the binary N-P compounds given above, a series of other binary and tertiary compounds or blends are available on the world markets. In particular the N-P-K compounds are getting a bigger share of the fertilizer market, as they imply easier, labour-saving, and cheaper application in the fields.

It is most important to distinguish between chemical blends and physical blends:

- In the manufacture of chemical blends the straight components are re-acted or mixed as solutions or sludges or melts with subsequent drying and prilling or granulation. Consequently, chemical blends are uniform as all fertilizer particles are identical in composition.

- Physical blends are mixtures of different fertilizer grades and they are made through blending of the granules of the fertilizer grades concerned. Although fertilizer grades of nearly uniform particle sizes are used for the blends, in practice the particles of the different compositions will vary. Consequently, physical blends must be treated with great care during handling, shipment, and application in order to avoid a seggregation into the basic components, as otherwise uneven and unsatisfactory fertilization of the fields may be implied.

Mg

- Kieserite, $MgSO_4 . x\ H_2O$ (26 % MgO).

3.2 Fertilizer Manufacture

3.2.1 Introduction

The establishment of a fertilizer manufacturing plant, which falls into the category of large scale and bulk chemical industry, presumes the fulfilment of certain main conditions, as follows:

- Raw materials must be available in adequate quantities at feasible and competitive prices. The raw materials may be either indigenous or imported.

- Utilities like electricity, water, etc. must be available at adequate and realiable rates at feasible and competitive prices. In developing countries, a fertilizer plant ought to have its own electric power station.

- Capital requirements are extremely high, which means that the operation of the plant must be reliable and constant and as near the design capacity as possible as otherwise even a feasible and modern plant may result in severe economical losses.

- The best and modern technology of the plant must be provided in order to secure its operation and competitiveness.

- The management, operation and maintenance personnel must be highly qualified, skilled, and experienced in order to safeguard a reliable operation, production, and maintenance of the plant.

- The fertilizer market must be adequate and able to accept and absorb the entire production of the plant at feasible and competitive sales prices.

- The costs of freight of raw materials and fertilizers must be reasonable and within acceptable limits with respect to the competition from other plants and importers and, of course, the world market in general.

- A fertilizer plant should not have a monopoly of the national market as this could lead to a serious economic burden on the farmers or the consumers of agricultural products.

3.2.2 Raw materials and process routes.

The raw materials and process routes needed for production of the fertilizer components containing nitrogen (N), phosphorus (P), and potassium (K), respectively are, as follows:

N

All nitrogeneous fertilizers are produced from ammonia as an intermediate product. The manufacturing cost of ammonia forms the greater part of the manufacturing cost of any other nitrogeneous fertilizer.

Ammonia is made from either one of the following alternative raw materials:

- Natural gas.
- Naphtha.
- Fuel oil (Bunker C).
- Refinery off-gas (if available in sufficient quantity).
- Lignite (coal)
- Electricity through electrolysis of water. This method is no longer used by the industry.

The modern process route for production of ammonia based upon hydrocarbons is desulphurization, steam reforming, secondary reforming, steam production from process waste heat, carbon monoxide conversion into carbon dioxide, carbon dioxide removal, methanization of carbon dioxide traces, high pressure compression, and ammonia synthesis.

In lignite based ammonia plants the lignite is gasified through reaction with oxygen or oxygen-enriched air and steam. The next process steps are steam production from process waste heat, desulphurization, carbon monoxide conversion into carbon dioxide, carbon dioxide removal, nitrogen wash for removal of carbon oxide traces and for nitrogen enrichment, high pressure compression, and ammonia synthesis. The oxygen and nitrogen is produced in an air separation plant. Lignite based plants have not been built during the last 10-15 years.

For production of urea, ammonia is reacted with carbon dioxide at high pressure. Carbon dioxide is a by-product of any ammonia plant. Therefore, a urea plant must by placed near and beside an ammonia plant.

Ammonium nitrate is made through reaction of ammonia with nitric acid. The nitric acid is formed in a separate unit by catalytic burning of ammonia with air. Thus, ammonia is the major raw material. Cheap linestone must be at disposal for admixture with the AN into calnitro.

Ammonium sulphate is produced from ammonia and sulphuric acid. The sulphuric acid is made in a separate unit on the basis of sulphur or pyrite as raw material. Previously, gypsum was sometimes used as a sulphate source, but this is now considered as an obsolete route.

P

Rock phosphate is the raw material of all phosphatic fertilizers. Rock phosphate is found in rich deposits in U.S.A., U.S.S.R., Morocco, etc.

In a few instances of tree crops, rock phosphate is applied directly as a fertilizer.

However, for all other crops, in particular rice, grains, corn, etc. the insoluble rock phosphate must be converted into water soluble phosphate, which can be easily and directly absorbed and made use of by the plants.

For this purpose, the rock phosphate is reacted in special process plants with sulphuric acid. The sulphuric acid is produced in a separate unit on the basis of sulphur or pyrite as a raw material.

The acidulated products will be either single or triple superphosphate or phosphoric acid.

Phosphoric acid will be neutralized with ammonia into mono - or di-ammonium-phosphate fertilizer.

Instead of sulphuric acid some rock phosphate treating plants use nitric acid for the manufacture of nitrophosphate as a combined fertilizer or nitrates and water soluble phosphates as individual fertilizers.

In certain instances the rock phosphate is reacted with both sulphuric acid and nitric acid in combination for production of particular fertilizers.

<u>K</u>

Muriate of potash and sulphate of potash are produced from potash - bearing minerals, such as sylvite, carnallite, etc. which are found in large underground deposits at many places of the world, for instance Western and Eastern Europe, U.S.A., Canada, some African countries.

The deposits vary much in concentration. The ore in Canada is highgrade and contains 26-28% K_2O. Whereas some of the low-grade Carlsberg, New Mexico ores contain only 12 - 14% K_2O.

The exploitation of a potash deposit is a large scale and high investment requiring operation, which comprises mining with sinking of shafts, underground recovery, and hoisting of ore, separation and disposal of waste, and further refining and concentration of the product. This manner, the freight cost of the product is lowered, and the purity and quality of the product becomes suitable fot its use as fertilizer.

A source of natural gas or fuel oil for the electric power plant and production of steam must be available for the potash mining operation, and water supply must be ample.

3.2.3 Modern design of ammonia plants

The modern design of ammonia plants makes use of the centrifugal compressor type for the high pressure compression and recycle of the synthesis gas instead of the reciprocating compressor type which is much more expensive, requires much more space and is much more costly and troublesome in maintenance.

The contrifugal compressor type for ammonia plants was not available until about 12-14 years ago and has been improved during the past years. Only a very restricted number of companies are specialized and capable in the design and manufacture of the said centrifugal compressor type. Previously, the reciprocating compressor type was applied nearly exclusively in ammonia plants.

The modern centrifugal compressor type is suitably driven by steam turbine which makes it possible to advance the exploitation of the waste heat in the ammonia plants through raising steam of adequately high pressure to the large steam turbine. This means a very substantial economy in the consumption of electricity in the ammonia plants as involved in comparison to the ammonia plants using the reciprocating compressor type which cannot be driven by a steam turbine but requires an electric motor.

However, for fundamental technical reasons the centrifugal compressor type can be used only in ammonia plants having a capacity not less than about 600 short tons of ammonia per stream day while smaller ammonia plants will still have to use the reciprocating compressor type.

One large ammonia plant unit will not use more personnel and workers than a smaller or small ammonia plant unit.

Therefore, besides the effect from the decreasing specific investment cost per ton of ammonia, a modern ammonia plant above the 600 TPD of ammonia capacity will have a substantially lower ammonia production cost for the above reasons as compared to smaller capacity ammonia plants.

Today, small ammonia plants with a capacity less than 600 MTPD of ammonia and necessarily applying the reciprocating compressor type would be installed only in a rare and highly specific cases, for instance where the ammonia plant in an old fertilizer or other petrochemical complex is the only unit being obsolete and have to be replaced, or where a very protected ammonia market is present, or where the ammonia is going to be used as process feedstock in a small petrochemical plant, etc.

3.2.4 Economics of Ammonia Plants

The investments and operating cost of an ammonia plant will depend strongly upon the selected process feedstock and fuel, plant size, plant design, and construction and start-up year. This dependency is demonstrated in the subsequent subchapters.

It can be deduced from the relationships given below that a large, say 1.000 MTPD ammonia plant based on cheap natural gas and constructed around 1970 - 1972 can produce ammonia at a total manufacturing cost, which is around **1/10-1/6** of the total manufacturing cost of a small say 100 STPD ammonia plant based on high cost naphtha and if constructed for start-up around 1978-1980.

3.2.4.1 Relative investments of ammonia plants versus raw materials.

Below are given on a rough basis the typical ratios between the overall investment figures of ammonia plants in dependence of the raw materials. The figures refer to the same plant capacity and same construction period.

Raw material	Investment %
Natural gas	100
Naphtha	100 - 115
Fuel oil (Bunker C)	130 - 140
Lignite	170 - 180

3.2.4.2 Relative operating cost of ammonia plants based on natural gas versus plant size.

Based upon the investment figures as valid in 1974 and using a total rate of 15 % for depreciation and interest, the following **approximate** dependence is valid between the operating cost and plant size of ammonia plants which are using natural gas as process feedstock and fuel:

Ammonia capacity	Total operating cost (Raw materials and utilities, labour, maintenance, and depreciation and interest)
Metric tons per 24 hours	per cent
1.000	approx. 100
600	110 - 120
400	135 - 150
200	155 - 170
100	180 - 200

The above figures assume that the plants being compared have been assigned after competitive bidding.

3.2.4.3 Energy consumption and cost per metric ton of ammonia

The specific energy consumption of an ammonia plant as relating to the lower heat value of the hydrocarbons used as process feedstock and fuel will vary within certain limits and will depend upon the individual process design of the plant. The process feedstock consumption per ton of ammonia will be nearly identical in all cases, while the specific consumption of fuel for the primary reformer is greatly influenced by the selected process design of the plant. In this way, the specific total LHV consumption of one plant may surpass another plant by as much as approximately 35 %.

Besides, the specific consumption of lower heat value of the hydrocarbon feedstock and fuel varies with the type of hydrocarbon raw material. Thus, ammonia plants designed for low heat consumption will use increasing amounts of heat whether the hydrocarbon is natural gas, naphtha, fuel oil, or lignite. In particular the fuel oil and lignite based plants have a relatively high consumption of lower heat value. Thus, a lignite based ammonia plant may need 20 - 30% more lower heat value input per ton of ammonia than a natural gas based ammonia plant.

As previously mentioned, the specific consumption of electricity is greatly dependent upon whether electric driven reciprocating compressors or a steam turbine driven centrifugal compressor are installed, which again is a question of the plant capacity. For instance, a 100 STPD ammonia plant with reciprocating compressors will consume as much electricity as a 1.000 MTPD ammonia plant.

The unit cost of energy will depend very much upon the type of hydrocarbon, geographic location, freight, availability of hydroelectric power, etc.

In the below tabulation a comparison on the specific energy consumption and cost is made between a small ammonia plant with reciprocating compressors and a relatively high consumption of naphtha and fuel oil and located in a country with high energy cost, and a modern large ammonia plant based upon natural gas at a price of US$ 1.00 per 10^3 SCF and a LHV of 1.045 BTU/SCF.

Energy Consumption per metric ton NH_3

100 STPD ammonia plant		Modern 1.000 MTPD ammonia plant	
Process feedstock:	LHV	Process feedstock:	LHV
Naphtha: 0,55mt =	$5,8 \times 10^6$ Kcal	Natural gas	$5,8 \times 10^6$ Kcal
Process fuel:	LHV	Process fuel:	LHV
Fuel oil No. 2: 0,50mt =	$5,1 \times 10^6$ Kcal	Natural gas	$2,2 \times 10^6 - 3,0 \times 10^6$ Kcal
LHV, total	$10,9 \times 10^6$ Kcal	LHV, total	$8,0 \times 10^6 - 8,8 \times 10^6$ Kcal
Electricity	794 KWh	Electricity	15,4-26,0KWh

Energy cost per metric ton NH_3

100 STDP ammonia plant.

US$

Naphtha

0,55mt a 216$ = 118,80

Fuel oil No. 2

0,50mt a 183$ = 91,50

Electricity

794 KWh a 0,055$ = 43,70

Total energy cost, 254,00

Modern 1.000 MTPD ammonia plant.

US$

Natural gas, total

$8,0 \times 10^6 - 8,8 \times 10^6$ Kcal $= 32,0 \times 10^6 - 35,0 \times 10^6$ Btu

at LHV = 1045 BTU/SCF =

$30,6 \times 10^3 - 33,4 \times 10^3$ SCF a $1,00/$10^3$SCF

= 30,60-33,40

Electricity

15,4-26,0KWh a 0,02$ = 0,31 - 0,50

Total energy cost, 30,90 - 33,90

3.2.4.1 Ammonia production cost versus start-up year of ammonia plants based on natural gas

For the reason of the steady escalation of equipment prices and construction expenditures the manufacturing cost of ammonia is a function of the construction and start-up time of the respective plant. During the last years, this influence has been important.

Along these lines it is estimated approximately that the production cost of ammonia plants having a capacity in the range of 600 - 1000 metric tons per 24 hours and using cheap natural gas as feedstock varies with the start-up year of the plants, as follows:

Start-up year	Total production cost of ammonia approximately (Raw materials and utilities, labour, maintenance, and depreciation and interest)
	US$ per metric ton
1972 and before	Less than 50
1972 - 1975	75 - 100
1975 - 1977	100- 150
1977-- 1980	150- 200

In the above estimates it has been assumed that the ammonia plants have been purchase under competitive bidding conditions.

3.2.5 Constructed fertilizer plants during the last 10 years and their raw materials.

The fertilizer factories which have been constructed around the world during the last 10 years have all been very big. The annual capacities of these factories have been within the range of 100.000 - 2.000.000 metric tons per year each.

In particular, the expansion of the ammonia industry has been enormous. Plants with capacities of 1.000 - 1.750 metric tons of ammonia per 24 hours of each plant unit have been built in a great number in U.S.A., Canada, Western Europe, Eastern Europe, U.S.S.R., Middle East, Iran India, Japan, Indonesia, Red China, Taiwan, Algeria, Central America, and South America.

Many of the fertilizer plants built in the course of the last 10 years for conversion of liquid ammonia into solid fertilizers have been based upon the urea process, which progressed in development and reached a reliable and competitive design around the middle of the 1960's.

The ammonia and urea plants established in this period have been placed either where natural gas is abundant and cheap or in great fertilizer consuming countries. In the later cases, fuel oil Bunker C has been applied as process feedstock if natural gas has not been available.

The ammonia plants have all been designed on basis of the advantageous large size ammonia technology developed and improved during 1960 - 1965 and utilize the cheapest available feedstock at the respective plant locations.

Countries where cheap and large deposits of natural gas is at hand have turned into important exporters of nitrogeneous fertilizers.

Naphtha was and is still used as feedstock in large ammonia plants built from the beginning to the middle/end of the 1960's in Western Europe, India, Japan, and Brazil. In the meantime, naphtha has increased disproportionately in price and become less abundant or even got scarce due to the increasing number of automobiles and because naphtha has no alternative in sufficient quantities as feedstock of some other petrochemical plants, like ethylene crackers, etc. Therefore, ammonia plants built after the end of the 1960's, where no natural gas is at disposal, have been based upon fuel oil Bunker C and not naphtha as previously. One exception is Red China, where automobiles are not found in a large number.

All phosphatic fertilizer factories built during the last series of years produce from rock phosphate as raw material intermediate products or fertilizers like phosphoric acid, mono-ammonium-phosphate (MAP), di-ammonium-phosphate (DAP), or NPK or NP or PK compounds. The previously used superphosphate route has become obsolete.

3.2.6 Formulation of NPK compound fertilizers

The manufacture of chemical or physical blends of NPK compound fertilizers is done through mixing of straight components each containing one or two of the constituents N, P, and K.

The mixing of a certain number of these fertilizer components will always involve a limitation of the NPK formulae which can be obtained. More freedom in the formulation is possible, if an inert material is added during the mixing.

The insert fillers are used in the mixtures by the manufacturers in order to arrive at formulations which are known by the farmers and may have been used for years as common practice. However, as a general rule neutral filler materials should not be used, as they only add to the costs, lower the concentration, and often, in case of physical blends, introduce additional segregation problems.

However, limestone powder used as inert filler may in some cases be valuable as a soil acidity regulator.

Withal, the agriculture should strive to use NPK grades with the N:P:K ratios as needed, but they ought to be purchased on basis of the cheapest price per metric ton of N+P+K content. This would probably in most cases be a relatively high concentrated NPK grade, which does not contain any unnecessary filler. For instance, NPK (19-19-19) might be cheaper than NPK (15-15-15) when the price comparison is made on the basis of the amount per metric ton N+P+K contents rather than metric ton of fertilizer.

The computation of formulaes is demonstrated through the following three examples of calculation.

Basis raw materials: (as example)

Urea (46%N)
DAP (18,2 - 46,8-0)
Muriate of potash (60 % K_2O)
Inert filler
Coating agent, 1% coat.

1. Example

Problem: What would be the N content of a NPK grade with 15 % P_2O_5 and 15% K_2O, but without inert filler.

Solution:

	Contents in 1 metric ton metric ton		N content Metric ton
Coating agent:	0,010		
Kcl: $\frac{0,150}{0,60}$ =	0,250		
DAP: $\frac{0,150}{0,468}$ =	0,321 x 0,182	=	0,058
Subtotal	0,581		
Urea (balance)	0,419 x 0,46	=	0,193
Total	1,000		0,251
Answer:	25,0 %		

2 Example.

Problem: A NPK (15-15-15) is wanted, and the addition of inert filler is allowed. How much inert filler will be needed.

Solution:

		Contents in 1 metric ton metric ton		N content Metric ton
Coating agent:		0,010		
Kcl:	$\frac{0,150}{0,60}$ =	0,250	Total N =	0,150
DAP:	$\frac{0,150}{0,468}$ =	0,321 x 0,182 =		0,058
Subtotal		0,581	Balance	0,092
Urea:	$\frac{0,092}{0,46}$	0,200		
Subtotal		0,781		
Inert filler (balance):		0,219		
Total		1,000		
Answer:		21,9% Inert filler		

3 Example.

Problem: What would be the NPK grade (x-x-x) with the ratios of N:P:K of 1: 1: 1, when no inert filler is permitted.

Solution:

		Contents in 1 metric ton metric ton.	N content Metric ton
Coating agent:		0,010	
Kcl:	$\frac{X}{0,60 \times 100}$ =	$\frac{X}{60}$	
DAP:	$\frac{X}{0,468 \times 100}$ =	$\frac{X}{46,8} \times 0,182$ =	$\frac{X \times 0,389}{100}$
Urea:	$\frac{1}{0,46} \left(\frac{X}{100} - \frac{X \times 0,389}{100} \right)$	$= X \times \frac{0,6[illegible]}{46}$	
		$= \frac{X}{75,3}$	
	Total	1,000	

$$0,99 = \frac{X}{60} + \frac{X}{46,8} + \frac{X}{75,3}$$

$$0,99 = X\ (0,0166 + 0,0213 + 0,0132)$$

$$0,99 = X\ \ 0,0511$$

$$X = 19,4$$

Answer: NPK (19,4 - 19,4 - 19,4)

3.3 Fertilizer procurement, shipment, storage, distribution And application.

3.3.1 Summary

The procurement of fertilizers from abroad and their distribution to the farmers and plantations is an integrated process which must be performed, organized and planned adequately in all steps as follows:

- The fertilizers must be purchased in proper qualities according to the demands and at best terms from competitive suppliers.
- Suitable arrangements of shipment to bring the fertilizers from abroad to Liberia must be made either by purchaser or suppliers.
- Central stores, intermediate stores, local stores and transportation vehicles must be provided in order to be able to pile up the fertilizers arrived from abroad and distribute them to the farmers and plantations in proper time ahead of the fertilizing season.
- The delivery and shipment of fertilizers from abroad will be scheduled to fit into an optimal structure of stores and transportation means in Liberia. The delivery, shipment, storage, and transportation should be selected to bring about the lowest overall cost. The structure of administration, stores and transportation vehicles should be designed on the basis of an analysis of logistics by specialized experts, before the fertilizer consumption becomes appreciable, in order to plan rightly and save in investments.
- The same stores and transportation vehicles for distribution of the fertilizers in the domestic area may be used after the fertilizing season and until a certain period before the next season for the agricultural produces having a time lag in storage and transportation requirements, and vice versa. Precautions against contamination of the agricultural produces by dust of fertilizers must be taken.

- The procurement and distribution of fertilizers ought to be carried out by a joint organization and as a co-operative effort and under the approval and control by the consumers of fertilizers. Probably, it will be most rational to combine and integrate the fertilizer enterprise with the Liberian Produce Marketing Corporation (LPMC), as far as this will be agreeable to the various fertilizer consumers.

- Nevertheless, the fertilizer import into Liberia ought to be maintained as a liberal trade and be free of customs or any other duties. This will secure the cheapest and best fertilizers and be in the best interest to the farmers and plantations and, thus, to the country.

- The same enterprise may import, distribute, and sell to the farmers and plantations other commodities, for instance:

- Tools and machinery.
- Seeds and seedlings.
- Herbicides, pesticides, and insecticides.
- Application of fertilizers.
- Application of herbicides, pesticides, and insecticides.

- The activities of the enterprise will have to be coordinated and should not compete with possible other Government corporation, but the enterprise ought not be favoured with concessions, duty freedom, etc. more or other than the private business.

- The enterprise should work close together with the fertilizer center proposed in chapter 2.2.13 of Report Part 2.

- If practicable, Liberia may coordinate its purchases and imports of fertilizers with other West African countries, like Sierra Leone under the Mano River agreement, in order to economise through purchase and shipment of larger lots.

- This sort of coordination between neighbouring countries for money saving, securing of supplies, improvement of techniques, etc. may apply to both other imported commodities and services, as follows:

    - Steel and iron products, building materials, and equipment machinery and equipment, etc.

    - Engineering services, know-how, etc.

3.3.2 Purchasing.

Fertilizers to be imported into Liberia for the domestic consumption of plantations and farmers may be bought on the basis of either ex factory prices or c.i.f. Monrovia prices, the latter prices including shipping and insurance during shipment. In the former cases the shipment and insurance must be paid separately by purchaser and be arranged in collaboration between purchaser and the supplier. The aspects of shipment are dealt with in the next chapter.

Fertilizer prices fluctuate on the world market according to the actual demands on the respective products. Those fluctuations can be very drastic. As an example, the ex factory prices on ammonia and urea were less than US $100 per metric ton in 1973 and kept at US $300-350 per metric ton during 1974 to the spring of 1975, while dropped to US $100-150 per metric ton during the summer and autumn of 1975.

The ex factory fertilizer prices normally allow a discount at the purchase of larger quantities. For instance, the price per metric ton of a lot of 1.000 metric tons will be a few per cent less than for a lot of 50-100 metric tons. Besides, regular purchases from the same manufacturer may allow an additional discount.

Bagged products are more expensive than the products in bulk, the different being the cost of bagging and bagging materials. The difference is in the order of US $ 10-20 per metric ton.

Purchases of both small and large lots of fertilizers ought to take place on basis of competitive bidding from several alternative suppliers.

Large scale buyers of fertilizers ought to keep in frequent touch with the exporting manufacturers and international dealers and brokers, communicate with them, obtain their price lists on a current basis, and receive bids from them, before a major purchase is being made.

Although plantations and farmers may prefer to use their traditional types of fertilizers because they are familiar with their application and benefits, it should be considered that the prices on the respective fertilizer qualities on the world market and from the various suppliers do not fluctuate simultaneously and to the same extent. This means that it may be advantageous to adjust the purchased types to the cheapest or a cheaper package of fertilizers.

Short term buying of fertilizer gives the purchaser the saving when the prices are low in the free world market, but involves the risk of large expenditures when the free world market prices are high.

Long term supply contracts may be preferable and beneficial to both a large scale purchaser and the supplier of fertilizers, because they safeguard the purchaser a reliable supply at reasonable and average prices, and they secure the supplier a safe sales outlet at a fixed profit. Most probably, a long term supply contract will have a clause on a certain price adjustment of the actual delivery prices to the prevailing free market prices for instance in function of an international commodity price index.

3.3.3 Fertilizer exporters and brokers.

Fertilizers are being exported from U.S.A. and several West European countries.

Countries like Poland, Romania, Spain from Huelva at Atlantic Sea in Southern part of Spain, Algeria, Morocco, Venezuela, Trinidad, etc. are also important exporters of fertilizers. Nigeria may become a future exporter of fertilizers.

Fertilizers may be bought through the import agents of foreign fertilizer houses or directly from the foreign manufacturers or through international fertilizer brokers, which may be owners of mines, manufacturers, and transporters as well.

A non-exclusive list of international fertilizer brokers and exporters is given below:

- Agricultural and Industrial Corporation,
  866 United Nation Plaza,
  New York, N.Y. 10017,
  U.S.A.
- Beker International Corporation,
  124 West Putnam Avenue,
  Greenwich, Connecticut 06830,
  U.S.A.
- International Minerals & Chemical Corporation (IMC),
  U.S.A.
- Kaiser Chemicals,
  U.S.A.
- Occidental Petroleum Corporation,
  (INTER ORE),
  10889 Wiltshire Boulevard,
  Los Angeles, California 90024,
  U.S.A.
- Nitrex A.G.,
  Bleicherweg 33,
  CH - 8027 Zurich,
  Switzerland

- Societe Complexport,
  12 Avenue de la G. de Armee,
  Paris,
  France.

Besides, reference is made to the individual large fertilizer manufacturers and exporters in Europe for instance in Belgium, England, France, Holland, Italy, Norway, Poland, Romania, Spain, West Germany, etc.

The manufacturers of fertilizers in Western Europe are members of the Europe Fertilizer Cartel where the decisions on available exports, prices, etc. are taken. Some of the broker associations given above are members of the cartel.

The names of fertilizer exporters in Africa and South America are, as follows:

- Cherifien des Phosphates
  Rabat,
  Morocco. (Phosphatic fertilizers)
- Federation Chemicals Ltd.,
  Trinidad. (Nitrogeneous fertilizers)
- Nitrogen -
  Venezolana del Nitrogeno, C.A.,
  Maracaibo,
  Venezuela. (Nitrogeneous fertilizers)
- Pemex, (?)
  Mexico.
- Sonatrach,
  Alger,
  Algeria. (Nitrogeneous fertilizers)

3.3.4 Shipment

Most reputated ship freighting companies are members of one or more conferences, and they carry freight at the tariffs and terms jointly agreed upon by the conference members.

Non-conference members usually are few and have small ships which drop in and out of harbours at irregular frequencies as their freight business dictates.

For Liberia two conferences are important:

- Continental-West African Conference-

  Cowac,
  dealing with the freight traffic between European Continent and West Africa.

- American West African Freight Conference, dealing with the freight traffic between North America and West Africa.

The basic pricing on freight is calculated, as follows:

- Unit price or tariff multiplied by weight in metric tons or by volume in m^3, whatever is highest: weight or volume figure.

- Unit price or tariff multiplied by weight in long ton or volume in 40 cu. ft., whatever is highest: weight or volume figure.

The unit tariff will depend upon the commodity code of the party, its packing, freight distance, harbours concerned, etc.

In principle ship owners sell and charge on basis of the space occupied by the stowed party if its density does not exceed 1,0 metric ton/m^3, which is equal to the specific bouyancy of sea water on the ship. This means that a party which can be stowed at a density of for instance 0,7 metric ton/m^3 cost as much in freight as a party of same volumetric occupancy but of 1,0 metric ton/m^3 density, provided that other cargo terms do not differ.

On the other hand, as ships are not allowed to be loaded to sink lower than the load line (Plimsoll mark) of the ship, a party with a density above 1,0 metric ton/m^3 will require that a free space corresponding to the density in excess of 1 metric ton/m^3 multiplied by volume of the party is reserved and cannot be stowed out of the hold of the ship, unless other parties of sufficient volumes and densities below 1,0 metric ton/m^3 are being freighted at the same time.

However, the total freight cost will depend upon several conditions, such as follows:

- Basic freight rate on basis of the conference tariff (see above)

  As an example:
  Phosphatic fertilizers at small consignments of 200 - 300 metric tons in bags to be sailed to Monrovia, Liberia are subject to the following tariffs (valid February 1976): (approximate figures)

  - From U.S.A. Gulf or East Coast
    U.S. $ 120 - 130 per long ton or 40 cu. ft.
  - From North European Continent
    U.S. $ 90 - 100 per metric ton or m^3
  - From Las Palmas, Canary Island
    US $ 25 per metric ton or m^3.
    (There are no conference tariffs on North Africa at the time being).

- Additional bunker surge charge, an extra to cover fuel cost increases around 13 % at February 1976.

- Congestion excess rates, to cover idle time when waiting at ports to get to quay, for instance at Lagos, Nigeria may be up to 70 %.

- Demurrage extra charge, to cover demurrage days during holidays, etc.

- Freight may be on:
  Free in and out and loading and unloading at expense of parcel owner, or

- Liner terms may apply, where ship owner pays all expenses (port charges, pilots, tug boats, dockage, etc.) from hook on to hook off the cargo. Harbour dues and handling charges may amount to about one or a few US $ per metric ton or m^3

- Big consignments, say 5.000 - 10.000 metric tons of fertilizers will result in a discount, which may be up to 25-30% of the basic tariff.

- Chartering of ship either:
  - Hatch or compartment charter, where parcel will fill one hatch or compartment of the ship, or
  - Regularily and stipulated parcel that is a certain amount each for instance 500-600 metric tons of fertilizers in bags a time,

  will involve lower freight rates and will depend upon the actual freight market.

Some saving in freight may be obtained if fertilizers are shipped in bulk instead of in bags. This is because the overall density of piled bags is lower due to the voids at the sides and ends of the bags than the bulk density, which, still, may not exceed 1 metric ton/m^3.

However, general cargo ships are not equipped for loading and unloading of materials in bulk. Therefore, if bulk shipment is considered, the parcel owner must arrange the loading and unloading of the ship. Loading of bulk shipments are frequently available at harbour terminals of fertilizer manufacturers and exporters, while the parcel owner must provide the unloading facilities and storage at the final determination of the ships, for instance the typical harbor unloading facilities, for bulk consignments would comprise, as follows:

- Capacity: 60-65 metric tons/hour,
- 1 - 2 cranes at quay,
- 1 - 2 hoppers at quay, and
- Trucks below the hoppers.

It goes without saying that the unloading and local transportation of fertilizers in bulk from the ships to the storage buildings must take place in dry weather in order to avoid humidification and caking of the fertilizers or even loss of fertilizers through dissolution and washing away by rain water. Therefore, freighting of fertilizers in bulk to Liberia will not be advisable during the rainy season, unless the proper precautions are taken.

The parcel owner would have to pay penalty to the ship owner if the stipulated unloading capacity could not be achieved.

Freight reduction may be possible through marriage of convenience with ships freighting export goods from Liberia to foreign countries on the return trip which otherwise uses to be a ballast voyage. The freight will be most favourable at least diversion of the ship from its normal return travel. The ships in mind will be the various freighters carrying iron ore, latex, logs, timber, plywood, etc. from Liberia.

As a matter of fact, it may be worth to consider jointly chartered vessel for freighting of the export of goods from Liberia and the import of large quantities of products to Liberia such as fertilizers, rice, steel, etc. The combination of freighting iron ore to Scandinavia and cement clinker back to Liberia is one such example.

In general, conference member ships give the best long term business.

Non-conference members ships can usually be advantageous only for a single or short term deal.

In the event that a non-conference member would offer favourable terms on freighting over a longer period, the conference members may upon request sue the conference to be allowed to lower its freight rates. This would normally be admitted by the conference, which may even be prepared to offer a low "fighting" rate, which would be disagreeable to most non-conference members to keep them out of the traditional freight market of the conference members. Only in case that a large, reputated ship owner may launch his ships in a new market still not being convered by a conference membership, it might be worthwhile to consider a long term business with a non-conference member.

3.3.5 Storage, transportation, and distribution.

At the beginning of each crop or growth season the fertilizers must be readily available and distributed in proper qualities and quantities according to the demands to the farmers and plantations at short notice as the weather conditions, sowing-time, growth of plants and trees, etc. dictate.

The fertilizers must be distributed to the farmers and plantations in waterproof bags being not heavier than 50 kgs., so the bags can be taken to the fields in humid weather, if required and be handled by one person.

The fertilizers imported from abroad during the months ahead of each fertilizing season must be piled up in the central stores of the harbour(s), intermediate stores and local stores.

The total capacity of all the stores must be sufficient to hold the demands of at least one fertilizing season.

The intermediate stores and local stores must be placed at main roads in the market area and the holding capacities of the respective storehouses must be provided and the storehouses filled up with bagged fertilizers in such a manner to permit the distribution and transportation to the farmers and plantations at the rates of demands with the use of a reasonable number and size of transportation vehicles.

In order to economize on the storage capacities and investments of the intermediate and local stores and transportation vehicles the farmers and plantations may be offered a price discount if they will accept and receive the fertilizer bags in advance of the season and keep the bags in their own barns or storehouses.

The transportation vehicles must be at disposal in adequate numbers and sizes to convey the fertilizer bags from the central store(s) via the intermediate stores via the local stores to the final destinations at the farmers and the plantations.

The cost of transportation from the local stores to the farmers and the plantations ought to be charged separately from the prices on the fertilizers. Possibly, some farmers and plantations may want to pick up the fertilizers at the local stores (or even the intermediate stores) in their own carriages or vehicles.

The fertilizers will arrive from abroad at the central store(s) in the harbour(s) according to the purchasing and shipping opportunities.

The purchasing and shipment from abroad may be scheduled in order to facilitate the transportation and distribution and optimize the investments and operating costs of the storehouses and transportation means in the domestic area.

The storehouses and transportation vehicles may be used after the fertilizing season and until a certain period in advance of the next season for other commodities with time lagged storage and transportation needs, for instance the harvested produces in bags, such as rice, coffee, and cocoa.

However, joint storehouses for fertilizers and the agricultural produces must only be established if it can and will be taken precautions against the risk of contamination of the agricultural produces usually bagged in penetrable jute bags by any dust of fertilizers. Even though fertilizers are kept in water-proof bags, such dust may occur due to defect bags or damage or breakage of the bags during the handling.

Before or as soon as the fertilizer consumption of Liberia reaches a substantial amount, an analysis of logistics should be made, preferably by specialized experts, on the scheduled import, storing in central, intermediate, and local stores, and transportation and distribution of the fertilizers. Simultaneously, this analysis should be integrated with a similar analysis of logistics of the agricultural produces.

Such analyses would make it possible to plan and optimize the investments, construction and provision, organization of personnel and workers, and operating costs of the stores and transportation vehicles.

3.3.6 Application.

The right times for application of fertilizers are determined by the weather conditions, sowing-time, crops or trees concerned, growth of plants and trees, etc.

The type of fertilizers will depend upon the crops or trees, soil conditions, spreading costs, etc.

Fertilizers in solid particles (crystals, granules or prills) are spread either by hand or mechanically by spreading machinery.

Manual spreading by farmers with adequate practice and care is fully satisfactory and is of course the cheapest way in a developing country. Besides, this method makes it easily possible to spread at certain intervals after the sowing time if this will be beneficial and practicable to the growing plants.

In developed countries where labour in the farms is scarce and expensive, fertilizer spreading is done mechanically. To a great extent NPK compound fertilizers, in so far as they are needed, are applied and spread in one operation in order to save and simplify the time of spreading. Because of the high labour cost this may happen even if a delayed or split fertilization might render somewhat larger crop yields.

Harrow injection of liquid ammonia from pressure tanks is extensively applied in the developed countries with temperated climate as ammonia is the cheapest nitrogeneous fertilizer in terms of US$ per ton of nitrogen content, as it shows a reliable effect, and as the spreading method is economical and useful.

Furthermore, mechanical spraying or harrow injection of fertilizers in the form of aqueous solutions is widely used in some developed countries, like U.S.A.

3.4 NPK compound fertilizer bulk blending and bagging plant.

3.4.1 Summary

NPK compound fertilizers as produced in fertilizer chemical plants normally are more expensive than most combinations of straight fertilizers, for instance urea, IMP, and muriate of potash, when the cost comparison is referring to the same contents in kgs or tons of N, P_2O_5, and K_2O.

Therefore, the establishment of a fertilizer bulk blending and bagging plant in the marketing area makes it possible to purchase and import straight fertilizers in bulk and blend them in the desired ratios so the fertilizer customers of the plant among the farmers and plantations will benefit from the saving in the import prices.

Suitably, the plant may be operated as a co-operative enterprise to be consumer oriented or owned or under the approval and control by the farmers and plantations in order to maintain and protect their interest in the plant.

As apparent from Report Part 2, the plantations are and will be the major consumers of NPK compounds or blends in Liberia. Whereas, the farmers will hardly need this type of fertilizers to any appreciable extent over the next many years for the field crops. The farmers will need straight type fertilizers for the fields, while NPK compounds or blends for their tree crops. The farmers will be able to benefit through the large lot purchases and shipment of the straight fertilizers in bulk by the bulk blending and bagging plant which will bag and sell straight fertilizers as well in keeping with the requirements of the farmers.

By means of a bulk blending plant individual mixtures or recipes of the N, P_2O_5, and K_2O constituents possibly with any admixtures of micronutrients and/or Kieserite and/or rock phosphate and/or pesticides-herbicides can be formulated, fit and produced according to the desires and demands of the farmers and plantations in terms of crops, trees, soil conditions, etc.

The straight fertilizers to be procured as feedstock to the physical bulk blending plant must be chemically compatible, as otherwise unsatisfactory mixtures with high hygroscopic and caking properties might result.

The import, unloading, transportation, and storage of bulk fertilizers must take place under dry conditions and consequently must be fit into the dry season of the year.

Besides, the straight fertilizers must match in size so that the risk of segregation and destruction of the homogeneity of the blends during the subsequent handling, transportation, and application at the fields and plantations will be minimized.

Nevertheless, the risk of segregation and heterogeneity of the bulk blended products will still exist. This means that particular precautions must be taken during handling, transportation and application of the blended products in bags or in bulk, so they will not become uneven and thus unacceptable to the farmers and plantations.

Consequently, a bulk blending plant must be situated within the marketing area possibly away from harbour(s) and with limited distances to the farmers and plantations. Handling and transportation must be lenient and without vibrations, and the application must occur at care.

The bulk blended plant must be operated under qualified supervision and technical management. Formulaes of blends will have to be made by experts.

The economy in the procurement and shipment of the straight fertilizers in bulk must exceed over the achievable import prices on the ready chemical compounds in bags with at least the variable and fixed operating cost of the bulk blending and bagging plant (in the order of US $ 15-30 per metric ton) plus the unevitably higher cost of unloading, storage, transportation, and distribution in the domestic area of the blends over the imported compounds.

Fertilizer bulk blending and bagging plants can be delivered by several, alternative and reputated contractors and equipment suppliers. The fixed assets will be in the order of US$ 0,5 - 0,6 million for a 30.000-50.000 metric tons annual capacity plant. Delivery and construction period may last 6-12 months depending upon local conditions and contractual terms with contractor. In the design of a bulk blending and bagging plant the local and market requirements must be taken into account in details and in full.

The operating personnel and operators of a bulk blending and bagging plant will amount to around 25 full time people and during the fertilizing season another around 40 part time labourers. These numbers do not include the administrative and marketing personnel.

As the consumption of bulk blended mixtures may increase after the installation and over the capacity of a first blending plant, another plant of similar design and capacity should be installed at another center location of the market in order to decrease the transportation distances of the blends and thus the risk of segregation.

Irrespective of the provision of a bulk fertilizer blending plant in Liberia, the fertilizer import ought to be maintained as a liberal trade and be free of customs or any other duties as pointed out in chapter 3.3.1. At any rate, fertilizer blending or for that matter any other fertilizer manufacturing process should not be granted as an exclusive or protected concession to any co-operative or company or corporation in Liberia as this would be against the interest of the farmers and plantations in general.

3.4.2 Technology and investments of fertilizer bulk blending and bagging plant and necessary precautions.

The technology and investments of a fertilizer bulk blending and bagging plant are described in details in the UNIDO Monograph No. 8 (see references).

The fixed assets are given in the monograph for two variants, as follows: (excl. land and housing of personnel and workers)

- Variant A.
  Capacity: 30.000 metric tons per year
  Estimated total fixed assets:
  Approximately US $ 0,5 million.

- Variant B.
  Capacity: 50.000 metric tons per year.
  Estimated total fixed assets:
  Approximately US $ 0,6 million.

Working capital required to cover inventories, accounts receivable and other liquid assets is estimated, as follows:

- Variant A.
  Approximately US $ 0,5 million

- Variant B.
  Approximately U.S. $ 0,8 million.

Thus, the total investments will be:

- Variant A.
  Approximately US $ 1,0 million

- Variant B.
  Approximately US $ 1,4 million

Particular attention shall be paid to the following aspects and problems related to the raw materials, operation, and end-products of a fertilizer bulk blending plants as described in the monograph:

- Selection of fertilizer materials for bulk blending must be careful, because not all materials on the world market are chemically compatible. The monograph points out, as follows:

  - If ammonium nitrate, triple superphosphate and single superphosphate are kept out of the plant, there should be no problems with incompatibility. Referring to chapter 2.2.8 of Report part 2 it is stressed that nitrate fertilizers are not suitable for swamp rice.

  - The conclusion is that the raw materials blended in the plant should be limited to urea, DAP, MAP, and KCl, except that agronomic consideration might necessitate the use of AS or KS, or both, in certian blends. In Liberia rock phosphate and Kieserite may be convenient to add to the blends, if the size match can be fulfilled (see below). Reference is made to chapter 2.2.11 of Report Part 2.

- The shipment of the bulk fertilizer raw materials to Liberia, their unloading in the harbour(s) and transportation and storage in the bulk blending plant must take place under dry weather conditions so that any humidification and caking of the fertilizers or even loss of fertilizers through dissolution and washing away by rain water is avoided. Consequently, the whole import, unloading, transportation and storage operation must be timed and adjusted to the dry weather season in Liberia.

- Segregation or unmixing of bulk blended products must be counteracted during handling, transportation, and application. If precautions are not taken against this risk, the homogeneity of the bulk blended fertilizer will be destructed, and the farmers and plantations may risk to spread fertilizers of irregular and varied composition to the fields and trees, which of course would be unacceptable. Due to the risk of this problem, the following precautions must observed:

    - The raw materials must match in particle size according to strict requirements on the supplies.

    - The bulk blending plant must be of a satisfactory design and must be operated correctly and under supervision of qualified personnel.

    - The plant should preferably be set up in areas of fertilizer consumption rather than at the ports of importation of the raw materials, and the transportation of the bulk blended products either in bulk or bags to the farmers and plantations ought to be lenient and free of vibrations and be limited to short distances. Thus, bulk blended products are not suitable for export and transportation over long distances.

    - Spreading of bulk blended products ought not be done by centrifugal broadcasters.

- As a passing remark it is noted that urea with 0,8 - 1, 0 % biuret as by-product shall not be applied for pineapple, citrus fruits, and urea solution spraying of certain crops, where biuret above 0,3 % is not acceptable. This question should be checked in details with specialized agronomists as far as urea as straight type or in blended type fertilizers will have to be applied for any of the above purposes.

The list of contents of the UNIDO Monograph No. 8 is given below:

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IX. Equipment for "doubling" bags 17
X. Assembly drawing of volumetric bagger 18
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3.4.3 Selecting straight fertilizer materials in least-cost analysis.

The selection of the straight fertilizer materials and possible fillers must be made on the basis of an overall survey and least-cost analysis of ex factory costs and availability, shipment and handling costs, and requirements of farmers and plantations.

The least-cost analysis should be carried out by experts at the possible use of modern calculating and/or computer techniques.
These techniques may be available from:

- TVA,
  Tennessee Valley Authority,
  Muscle Shoals, Alabama 35660,
  U.S.A

  IFDC,
  International Fertilizer Development Center,
  402 First Federal Building,
  Florence, Alabama 35630,
  U.S.A.

The calculating or computing techniques are described in the following articles:

- Normal L. Hargett, Selecting Materials in Least-Cost Analysis, TVA National Fertilizer Development Center, Distribution Economics Section, Tennessee Valley Authority, Muscle Shoals, Alabama 35660, U.S.A.

3.4.4 Utility costs.

Apart from the straight fertilizers, bagging materials, and a negligible consumption of gasoline for the shovel trucks, the only utility consumed is electricity, which at US $ 0,055 per KWh corresponds to:

- Variant A.

  Total power required: 69 KW

  Production capacity: 7 metric tons/hour

  Electricity cost: US $ 0,54/metric ton

- Variant B.

  Total power required: 71 KW

  Production capacity : 12 metric tons/hour

  Electricity cost: US $0,33/metric ton.

3.4.5 Salaries of personnel and workers.

The subsequent personnel and workers and total salaries per year will be valid in Liberia:

Personnel and workers Number and categories	Annual salaries, US $ Total of each category
1 Agronomist and marketing manager	30.000
1 Plant manager	24.000
1 Production supervisor	8.400
1 Materials handling supervisor	6.000
6 Operators	7.100
1 Maintenance man	2.500
8 Labourers	6.400
40 Part time labourers	8.000
4 Security people	2.900
Total, excl. administrative personnel	95.300

3.4.6. Variable and fixed costs of fertilizer bulk blending and bagging, exclusive materials costs.

The variable and fixed costs of a fertilizer bulk blending and bagging plant, exclusive the materials cost will be, as follows:

- Variant A

  Capacity: 30.000 metric tons per year

Annual production	Cost
30.000 MTPY	US $ 18,32/metric ton
22.500 MTPU	US $ 20,98/metric ton
15.000 MTPY	US $ 26,04/metric ton

- Variant B

  Capacity: 50.000 metric tons per year

Annual production	Cost
50.000 MTPY	US $ 16,00/metric ton
37.500 MTPY	US $ 17,88/metric ton
25.000 MTPY	US $ 22,30/metric ton

The specific cost figures are calculated in the attached tabulations Nos. 1 and 2.

The figures correspond to the equipment price basis and Liberian salary conditions of 1975/1976.

Tabulation No. 1

VARIANT A
VARIABLE AND FIXED COST EXCLUSIVE MATERIALS COST CALCULATION

Capacity : 30.000 MTPY

Fixed assets : estimated US $ 0,5 million

Working capital: estimated US $ 0,5 million

Stream factor, %	100	75	50
Annual production, MTPY	30.000	22.500	15 .000
Cost per metric ton:	US$	US$	US$
Electricity	0,54	0,54	0,54
Gasoline	-	-	-
Bagging materials	10,00	10,00	10,00
Salaries:			
US $ 95.300 per year	3,18	4,33	6,35
Maintenance:			
2,5 % on fixed assets	0,42	0,56	0,83
Straight line depreciation over 10 years:			
10 % on fixed assets	1,67	2,22	3,33
Average interest,			
4,0 % on fixed assets	0,67	0,89	1,33
Interest,			
10,0 % working capital	1,67	2,22	3,33
Insurance cost,			
1,0 % on fixed assets	0,17	0,22	0,33
Total	18,32	20,98	26,04

Tabulation No. 2

VARIANT B

VARIABLE AND FIXED COST

EXCLUSIVE MATERIALS COST

CALCULATION

Capacity	:	50.000 MPT
Fixed assets	:	estimated US $ 0,6 million
Working capital	:	estimated US $ 0,8 million

Stream factor, %	100	75	50
Annual production, MTPY	50.000	37.500	25.000
Cost per metric ton:	US $	US $	US $
Electricity	0,33	0,33	0,33
Gasoline	—	—	—
Bagging Materials	10,00	10,00	10,00
Salaries:			
US $ 95.300 per year	1,91	2,54	3,81
Maintenance:			
2,5 % on fixed assets	0,36	0,48	0,72
Straight line depreciation over 10 years:			
10 % on fixed assets	1,20	1,60	2,40
Average interest,			
4 % on fixed assets	0,48	0,64	1,60
Interest,			
10,0 % on working capital	1,60	2,13	3,20
Insurance cost,			
1,0 % on fixed assets	0,12	0,16	0,24
Total	16,00	17,88	22,30

3.4.7 Contractors and equipment suppliers

The following list gives a number of reputated contractors and equipment suppliers of fertilizer bulk blending and bagging plants:

- Fertilizer Engineering and
  Equipment Co. (FEECO),
  Green Bay, Wiscousin,
  U. S. A.

- The A.J. Sackett and Sons Co.,

  Baltimore, Maryland,
  U. S. A.

- Steadman Foundry and
  Machine Co., Inc.,
  Aurora, Indiana,
  U. S. A.

- Chartin Construction Co.,
  Como, Texas,
  U. S. A.

- Nisho - Iwai,
  Tokyo,
  Japan.

- Voest,
  Linz,
  Austria.

- Basse Sambre - Eri,
  Belgium.

3.4.8 Helpful hints to potential investor.

A potential investor who inquires of vendors for information on a bulk blending and bagging facility should make the request as complete as possible. Typical information needed is as follows:

(1) How will materials be received and what rate?
(2) What kind and how much bulk material is to be stored?
(3) How much bag storage is needed?
(4) The bagging rate desired, type of bags and method of closure.
(5) What type of season is expected and what rate of output is expected?
(6) Is bulk product to be shipped?
(7) Is it planned to store bulk product?
(8) The desired type of building construction and any available details about specific location.
(9) Any information concerning the production of specialty materials such as those containing micronutrients or pesticides-herbicides.
(10) How will bagged product be handled and shipped?
(11) Any information that may be pertinent such as road access, availability of labor and rates, etc. should be helpful.
(12) Weather conditions through the year, i.e. maximum, minimum, and average rainfall of each month and maximum, minimum, and average of temperature and humidity of atmospheric air of each month through a few consecutive years at envisaged plant location.

This will allow the vendor to make a more accurate quote and to make specific recommendations for achieving a well-designed and operated facility.

3.5 References.

- UNIDO Monograph No. 6 Fertilizer Industry, UNIDO Monographs on Industrial Development, Serial No. ID/40/6, Sales No. E 69 II.B. 39, Vol. 6, United Nations Publication, United Nations, New York, 1969.

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- Norman L. Hargett, Selecting Materials in Least-Cost Analysis, TVA National Fertilizer Development Center, Distribution Economics Section, Tennessee Valley Authority, Muscle Shoals, Alabama 35660, U. S. A.

- Frank P. Achorn and Hubert L. Balay,
Plant Experiences in Adding Pesticides,
Micro-and Secondary Nutrients to Bulk Blends,
Process and Product Improvement Section,
TVA National Fertilizer Development Center,
Tennessee Valley Authority,
Muscle Shoals, Alabama 35660,
U. S. A.

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- Ditto, Part II. Nitrogen No. 81
January/February 1973.

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TERMINAL REPORT
REPORT PART 4.

FEASIBILITY STUDY AND ASSESSMENT OF A CHEMICAL COMPLEX, CONSISTING OF AN AMMONIA PLANT, A NITRIC ACID AND AMMONIUM NITRATE PLANT, AND A NPK COMPOUND BLENDING AND GRANULATION PLANT AS PROPOSED BY N-REN CORPORATION.

LIBERIA

(IS/LIR/74/012)

by

Karl Kjeldgaard,
expert of the United Nations Industrial Development
Organization acting as Executing Agency for
the United Nations Development Programme

This report has not been cleared with the United Nations Industrial Development Organization which does not therefore necessarily share the views presented (1).

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(1) To be omitted after clearance by UNIDO

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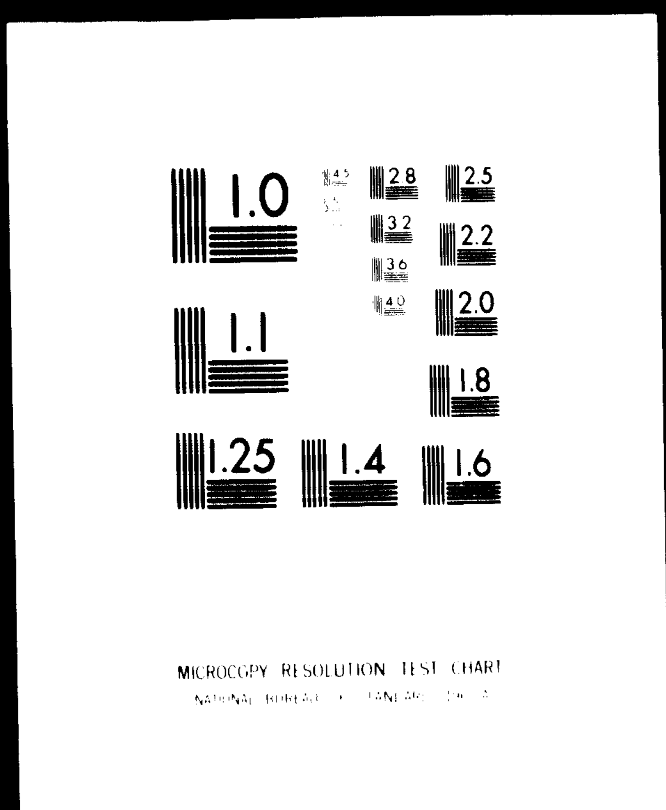

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ABBREVIATIONS

AN	Ammonium nitrate
AS	Ammonium sulphate
N	Nitrogen
P	Phosphorus
K	Potassium
O	Oxygen
MTPD	Metric tons per day (24 hours)
STPD	Short tons per day (24 hours)
MTPY	Metric tons per year
STPY	Short tons per year
NPK (17-17-17)	Means a NPK compound fertilizer containing 17% or 170 kgs. of N per metric ton, 17% or 170 Kgs. of P_2O_5 per metric ton and 17% or 170 Kgs. of K_2O per metric ton.
DAP	Di-ammonium-phosphate
MAP	Mono-ammonium-phosphate.
KCl	Potassium chloride, equal to Muriate of potash

4.1 Introduction

In the present report a feasibility study and assessment is described and detailed of a proposed chemical complex, consisting of an ammonia plant, a nitric acid and ammonium nitrate plant, a NPK compound blending and granulation plant, and related off-sites inside and outside the battery limit of the complex.

This chemical complex has been proposed and offered for construction in Liberia to the Government of Liberia by N-Ren Corporation. The proposal has been submitted and quoted in a proposal book with the following title:

> "Project Study and Technical Proposal for
> Agrochemical Complex
> for
> The Republic of Liberia.
> September 1974
> Sales No. 9 1374."

The complex is proposed to produce the following end-products:

- Ammonia,
  For sale to the Liberian rubber plantations for stabilizing of latex solution.
  Nominal rate: 3.000 short tons per year
- Ammonium nitrate (33,5% N)
  For sale to the explosive manufacturing industry in Liberia, which covers the market on explosives in all West Africa.
  Nominal rate: 28.000 short tons per year.

- NPK compound fertilizers,
  For sale to the agriculture in Liberia and neighbouring countries.
  Nominal rate: 100.000 short tons per year.

Furthermore, in this report is evaluated a revised proposal of February 1976 from N-Ren Corporation. This proposal has been submitted to President William R. Tolbert by N-Ren International Ltd., Bermuda by letter of 12th March 1976.

In the revised proposal, the same end-products as above are foreseen.

The phosphatic raw material to be imported has been changed from di-ammonium - phosphate (DAP) in the previous proposal to the cheaper mono-ammonium - phosphate (MAP) which contains relatively less ammonia.

The revised proposal comprises two alternatives:

Alternative A: As in the previous proposal, a process plant for production of ammonia on basis of naphtha and fuel oil No.2 is foreseen. Besides, this alternative includes a nitric acid plant, and a complex plant for production of ammonium nitrate (33, 5% N) and NPK fertilizer.

Alternative B: This alternative is based upon import of ammonia and has a large ammonia storage tank, but includes no ammonia plant. The other production units are the same as in alternative A.

The nominal production rates of the revised proposal are, as follows:

Ammonia for sale.
Nominal rate: 3.000 short tons per year.

Ammonium nitrate (33, 5% N).
Nominal rate: 25.000 short tons per year.

NPK fertilizers.
Nominal rate: 100.400 short tons per year.

4.2 Summary

The feasibility study and assessment of the fertilizer factory as proposed by N-Ren Corporation can be summarized, as follows:

1. A fertilizer plant in Liberia will have to depend upon either imported petroleum or imported ammonia, and, besides, imported phosphatic and potassic raw materials. Liberia does not dispose of any indigenous raw materials for the manufacture of fertilizers and ammonium nitrate (33.5% N).

2. Although the proposed plant has relatively a very small capacity as compared to the modern size fertilizer plants, which have been built during the last 10 years around the world, the domestic market of Liberia, as it is to-day and it may still be during the next few years, will be able to consume merely approximately 60-70% of the annual production of ammonium nitrate (33,5% N) and in the order of 15-35% of the annual production of NPK fertilizers.

3. The annual production at a stream factor of 80% as typical for developing countries will total approximately 18.000 metric tons of ammonium nitrate (33,5% N) and approximately 73.000 metric tons of NPK fertilizers.

4. The domestic consumer in Liberia of the ammonium nitrate (33,5% N) would be entirely Exchem-West African Explosive and Chemicals Ltd. at Charlesville, which possesses the exclusive rights on explosives manufacturing, blending and preparation in Liberia, and which covers practically all the market on explosives in the West African countries. The consumption of explosives is a function of the production of the mining industry, the construction of roads, etc. in the marketing areas.

5. In Liberia the present and future consumers of NPK fertilizers are and will be the tree plantations, in particular the rubber plantations and other plantations operated by the concessions. The plantations may prefer NPK fertilizers admixed with micronutrients and Kieserite. The N-Ren proposal does not include, but could probably be supplemented with the extra equipment for such admixture. At any rate, it would be necessary to check carefully with the concessions whether the NPK grades to be manufactured in a Liberian factory would be acceptable and suitable for their purposes.

6. In case of field crops, such as rice it is not feasible at present and probably for a number of years to apply to the Liberian soil potassium (K), which is one of the three constituents of NPK fertilizers.

In swamp rice fields the nitrate content or 50% of the N constituent of the NPK fertilizers of the proposed plant will be lost to the atmosphere, before the plants can make use of it.

Therefore, NPK fertilizers are not economic and suitable for the fields in Liberia. The same may be valid in some other African countries.

7. At any rate, any production of Liberian factory in excess of the domestic market would need to be exported to other African countries, where a serious competition from the international exporters having much lower manufacturing costs due to modern and large sized technology and indigenous raw materials would have to be faced.

Since most African countries consume small amounts of fertilizers, the excess fertilizer production would have to be sold to several countries.

With respect to AN (33,5%) the surplus production could only be sold outside the West African region to the other African countries, which do dispose of their own explosive manufacturing, blending, and preparation facilities.

Reference is made to chapter 4.13.

Besides, the export of ammonium nitrate (33,5% N), which is classified as an explosive, would require the construction of a new ocean harbour with stores complying with "the US Coast Guard Regulations" which may not permit this harbour to be used for other commodities and ships. Please note that Exchem at Charlesville is not allowed to land their import of AN (33,5% N) in the Monrovia and Buchanan harbours.

8. The prices quoted in the revised N-Ren proposal are appreciably higher than those in the previous proposal, even though the extent of supplies of both alternatives A and B of the revised proposal are less as compared to the previous proposal. The increased prices can be explained by the drastic inflation on capital goods from 1974 to 1976.

9. The apparent profits of a Liberian factory as demonstrated in the previous and revised N-Ren proposal are entirely [redacted] unrealistic.

   The reasons of this are that N-Ren have based their fictive estimates on hypotetical and extremely low raw material prices which cannot be obtained to-day in Liberia, and because they consider the factory to be able to operate continuously at design capacity all through the year corresponding to a stream factory of 100%. Undoubtedly, the raw material prices will increase during the next years, and even a stream factor of 80% is optimistic in a developing country.

On the subject of raw material prices reference is made to tabulation No. 11 of chapter 4.7.

In the revised proposal straight-line depreciation over 14 years of only 85 % of the investments has been anticipated by N-Ren instead of a period of 10 years and 100% of the investments as it ought to.

It is noted that the raw material costs make out the major part of the manufacturing costs of the end-products. A less, but still important part is formed by the depreciation and interest on the investments.

Furthermore, N-Ren does not account adequately for the cost of maintenance and repair of the factory during operation, shutdowns, and annual overhauls.

Besides, N-Ren has not made any allowances for harbour fees and local transportation of raw materials and end-products or any depreciation and interest on the additional capital to be financed and paid by the Government of Liberia for site preparation, indigenous supplies and construction works, auxiliary equipment, ex battery limit installations and provisions, harbour facilities etc. Reference is made to chapter 4.12.

10. The revised N-Ren proposal includes the battery limit process plants and facilities and expatriate services, but excludes the indigenous building materials, civil engineering works, and salaries of local personnel and workers.

The investments and financing of the N-Ren supplies and services are, as follows:

	Alternative A Million US $	Alternative B Million US $
Investments, working capital and pre-operating interest	55,9	49,3
Financing		
Equity		
N-Ren Corporation's shares	4,3 (8%)	3,8 (8%)
Government of Liberia's shares	10,0 (18%)	8,8 (18%)
Long term debt Supplier's loan	41,6 (74%)	36,7 (74%)
Total	55,9(100%)	49,3(100%)

The long term debt or loan is required by N-Ren Corporation to be 100% surety quaranteed by the Government of Liberia. Repayments on the long term loan and payments of accrued interest will start 6 months after commissioning of the plant, irrespective of the plant will be operating or not.

Therefore, the commitment of the Government of Liberia as related to the N-Ren supplies and expatriate services, but exclusive of additional commitments would be:

	Alternative A Million US $	Alternative B Million US $
Paid up Government of Liberia's shares	10,0	8,8
Repayments on long term debt	41,6	36,7
Payments of accrued interest	14,4	12,4
Total	66,0	57,9

There can be no doubt at all, that the plant and services as offered by N-Ren Corporation are much more expensive and includes a fat profit to N-Ren Corporation as compared to bidding on competitive terms.

Thus, the modest capital retained in the factory as N-Ren shares corresponding to 8% of the above investments would surely be a part only of the extra profit secured by N-Ren Corporation under the contract terms as offered and to be paid and guaranteed by the Government of Liberia.

The guarantees, warrantees, and liability as offered by N-Ren Corporation are very unsatisfactory, narrow and of little legal value. Besides, N-Ren is grouped into a series of Belgian, U.S.A. and Bermuda corporations which means that any legal action later on against N-Ren probably would be bound to fail.

Nevertheless, the modest share capital retained by N-Ren Corporation would entitle this company to a 30 % ownership of the Liberian factory.

11. The annual deficit of a Liberian fertilizer factory has been calculated on the following basis:

- Prevailing ex-Liberian refinery prices on naphtha and fuel oil No.2. without any allowance for additional fractionating cost to fulfil the naptha specification required by N-Ren Corporation.

- Prevailing c.i.f. Monrovia prices on imported phosphatic and potassic raw materials.

- Electricity cost as prevailing in Monrovia for large industrial consumers, while other utility costs as foreseen by N-Ren Corporation.

- Straight-run depreciation over 10 years and 3,7 % p.a. average interest on battery limit investments and expatriate services of above item 10 exclusive electric power station.

- 10 % p.a. interest on working capital.

- Maintenance cost at 2,5% p.a. on the battery limit investments and expatriate services of above item 10, excluding electric power station.

- A stream factor of 80%.

- Ex factory prices on end-products equal to prevailing cif. Monrovia prices on imported fertilizers and AN.

- Labour and staff costs as foreseen by N-Ren Corporation.

- US $ 200 per metric ton of imported ammonia for Alternative B.

The annual deficits as calculated are, as follows:

	Annual deficit
Alternative A	US $ 6,3 million
Alternative B	US $ 3,3 million

At an imported price of US $ 220 per metric ton on ammonia as figured by N-Ren Corporation, the annual deficit of alternative B would increase by US $ 0,5 million to US $ 3,8 million.

Evidently, the ex factory prices which can be obtained from the exported end-products will be substantially lower than the c.i.f. Monrovia prices on these products imported from abroad at to-day's level. A discount of say US $ 25 per metric ton to cover loading, freight, insurance, and unloading costs and import agents' fees on a yearly quantity of for instance 70.000 metric tons would make the above annual deficits to increase by US 3.5 million.

Moreover, the above annual deficits do not include any allowances for harbour fees and local transportation of imported raw materials and exported products or any depreciation and interest or other charges related to the large extra investments of the Government as explained under the subsequent items 12 and 13.

12. Further to the investments on N-Ren Corporation's battery limit supplies and expatriate services of above item 10, the Government of Liberia would be obliged to furnish, pay, and finance, as follows:

- Price escalation on N-Ren Corporation's battery limit supplies and expatriate services during the delivery and construction period. These amounts would probably have to be paid cash and could very well reach the order of US $ 5-10 million or more.
- Additional fractionating equipment at Liberia Refining Company.
- Site of plant and site preparation.

- Auxiliary equipment, indigenous building materials, and civil engineering works at battery limit plant.
- Ex battery limit installations, harbour facilities in existing harbour, new harbour for AN export, etc.
- Housing of personnel and workers.
- Stores, transportation, distribution, and farmers' credits for the domestic fertilizer market.
- Consultants and staff during contract period to control the interest of Government of Liberia.
- Training and employment of plant staff and workers during final construction period.
- Supply of raw materials of factory.
- Repair of factory and loss of production due to possible maloperation during the first start-up and operation years.

Seemingly, the N-Ren Corporation does not permit the Government of Liberia to convert any of the above investments into share capital. At any rate, these investments could only be recovered through sky-high fertilizer prices in the domestic market which would imply any import of fertilizers to be prohibited for many years.

Reference is made to above item 7 and chapter 4.12.

13. Referring to chapter 4.9.5 the Government of Liberia would be asked and would have to pay to ICI/Kellogg a large license fee on their naphtha reforming process as soon as the Liberian factory would start to produce. This claim presupposes that the ICI/Kellogg patents on said process are in force in Liberia.

14. The technical references on the Ammopac units of N-Ren Corporation must be checked carefully through visits by neutral experts to existing units in operation before signing of any contract. In particular, it would be imperative to control the technical references of N-Ren Corporation on naphtha reforming.

15. All supplies on raw materials would have to be secured on a long term delivery, freight and price basis before any signing of contract.

16. A Liberian fertilizer factory would give employment possibilities for around 100 Liberian nationals and no more.

17. The plant units offered by N-Ren Corporation would hardly meet the environmental protection standards now being in force in most industrial countries.

18. Liberia Refining Company has no access to any crude petroleum to be able to produce a naphtha with the high naphthenic contents as specified by N-Ren.

It is stressed that any deviation of the naphtha actually to be supplied to the fertilizer factory from the naphtha specified by N-Ren may form a legal escape by N-Ren from any liability on the naphtha reforming process of the Ammopac ammonia plant.

4.4 Financial and contractual terms of [illegible]-Man proposal of September 1974

4.4.1 Price (As valid by September -October 1974)

	1.000 US $
- Cost of plant and facilities	36.200
- Working capital and preoperating expenses	1.810
- Pre-operating interest	2.805
Total	40.815 US $

4.4.2 Financing

		1.000 US $
- Share Capital		
Liberian Government and investors (70%), to be fully paid shortly after signing of contract with N-Ren Corporation	7.602	
N-Ren Corporation (30%)	3.258	10.860
- Loan to be provided by N-Ren Corporation from either suppliers' credit or buyers' credit through international bankers against Liberian Government guarantees, and repaid in 5 equal installments during 5 years at 10% p.a. interest		29.955
Total		40.815

4.4.3 Payment to N-Ren Corporation and subcontractors at cash terms

		1.000 US $
Full price	40.815	
Minus N-Ren Corporation's equity share (30% of share capital and 9% of full price)	3.258	37.557

4.4.4 Liberian Government's guarantees, payments, legislation, and liability as envisaged by N-Ren Corporation

	1.000 US $
- Payment of 70 of share capital, shortly after signing of contract with N-Ren Corporation	7.602
- Surety guarantee on payment of loan - Surety guarantee on accrued interest on loan	29.995

- Antidumping legislation and customs duty to secure high fertilizer prices in Liberia and protect fertilizer plant against external competition and import.

- According to the proposal, N-Ren will assist Lib-Ren in the establishment of its marketing organization, moving products to retail outlets, selecting, training, and organizing fertilizer distribution systems and developing long range market forecasts to allow proper financial planning. In practice, this means the fixation and regulation of the market prices on fertilizers in Liberia to be high enough to cover the manufacturing costs and financial obligations of the plant.

- Moreover, during the years of early operation and the establishing of increased usage of fertilizers in Liberia N-Ren if required will guarantee the off-take of surplus produced in the plant. Most probable, this clause only promises that N-Ren will sell any surplus of products on the free world market at free world market prices, including a sales provenue to N-Ren. Because the plant will operate at an extremely high operation cost, this promise is empty as it does not secure any financial backing from sales to the free world market. In fact, this clause could very well prove to be very disadvantageous as it may oblige the plant to sell its surplus production to the free world market upon any commitments by N-Ren at a loss and at the expense of the Liberian customers.

- N-Ren requires in the proposal that the Liberian Government allocates extra capital for the establishment of some form of farmers' credit facility which will enable farmers to pay for the fertilizer out of the proceeds of their sale of the agricultural products. The capital required for this purpose may correspond to the market price in Liberia of fertilizers consumed during 6 - 12 months.

- Any necessary improvement of plant beyond N-Ren's narrow liability (see later) will have to be borne by Government of Liberia.

4.4.5 Management of Plant

The N-Ren proposal claims:

- General Manager of company shall be an expatriate with appropriate industry experience.

- A technical management contract will be given to construct and operate the company for a period of at least seven years.

- The initial plant manager and superintendents of maintenance and operations will be selected from American or European experienced personnel.

The above claims would mean that the Liberian Government and investors would have no saying at all as to the technical management of the company during the first seven years of construction and operation.

4.4.6 N-Ren Corporation and subcontractors' narrow warranties and liability

The following paragraphs in the N-Ren proposal are important to perceive, and they are extremely unusual and outrageous according to the normal practice in the international contracting business:

- No allowance will be granted for any repairs or alterations made by the Liberian Government and investors (purchaser) without N-Ren's written consent.

- Equipment and accessories designed and manufactured by third parties (i.e. all N-Ren's subcontractors and suppliers) are guaranteed only by N-Ren to the extent of the original manufacturer's guarantee to N-Ren.

- The liability of N-Ren (except as to the warranty of title and the liability respecting any performance guarantee) arising out of the sale and installation of said apparatus or its use, whether on warranties or otherwise, shall not in any case exceed the cost of repairing or replacing defective parts as aforesaid, and upon the expiration of the said one year, all such liability shall terminate.

- The utilities consumption figures stated herein are estimated figures. Final figures will be developed after final equipment selection is made and manufacturer's guaranteed utilities consumption figures received.

In the above clauses, N-Ren seemingly does not retreat from a normal performance guarantee which means a guarantee on the design capacity or production of end-products in tons per 24 hours. The performance guarantee is usually tested during a few days' operation period.

N-Ren does not give any guarantee on consumption figures in advance of signing the agreement. The lack of this important guarantee on well-defined terms must be regarded to be unacceptable to any purchaser.

It is emphasized that N-Ren is not an equipment and machinery manufacturer. N-Ren most probably is the owner of the complete engineering packages of the process design, instrumentation, detailed mechanical design of equipment, etc. for the process plants as offered. All equipment offered by N-Ren will have to be purchased from specialized manufacturers, who will have to comply with N-Ren's engineering specifications and drawings. Engineering etc. of piping, lay-out, buildings, etc. may be subcontracted by N-Ren to other subcontracting firms.

This means that the manufacturers and the subcontractors can only guarantee and be liable for their specific equipment or tasks and cannot assume any general guarantees and liability for the N-Ren overall design.

Therefore, a limitation of N-Ren's guarantees and liability to the extent of the guarantees and liability of third parties would be entirely unacceptable to any purchaser.

Just as unacceptable would it be to accept that N-Ren's liability should not in any case exceed the cost of repairing or replacing defective parts of the apparatus as suggested by N-Ren.

On the contractual terms proposed by N-Ren the performanee guarantees given in the N-Ren proposal have no or very little legal and financial baekground. Besides, the performance guarantees must eomprise both eapaeity and consumption figures, the latter of which are given only on an estimated basis.

Thus, in the event that the plant proposed by N-Ren would show a poor performance, the liability and guarantees proposed by N-Ren eould very easily and quickly be exhausted, before the plant might be properly improved. Subsequently, because of their great surety guarantee and 70% equity share the Liberian Government and investors would have to pay at their own expense the delivery and installation of any additional or new equipment and machinery as required to bring the plant into reliable and constant operation at desired capacity.

Consequently, before any eontract could be eoncluded with N-Ren, N-Ren must agree upon a full set of normal guarantees on performanee capaeities, consumption figures, eompleteness of plant, mechanical reliability of all equipment and machinery within the first 12 months of operation, etc. within a total liability which would comprise of a reasonable portion of the contract price.

With reference to the particular history of the N-Ren Corporation, it is evident that N-Ren would not be disposed and financially strong enough to comply with such an extention of the guarantee and liabilities, although they are normal in the international contracting business.

4.4.7 N-Ren's Ownership of Plant

- It is recalled that the contractual and financing terms proposed by N-Ren imply that N-Ren would remain the owner of 30% of the plant at any time and at any event and that the Liberian majority group would have to respect the rights under Liberian laws of the N-Ren minority shareholding.

4.5 Technical evaluation of N-Ren proposal of September 1974

4.5.1 Process units, capacities, and production rates

The N-Ren proposal comprises the following process units:

- One Ammopac ammonia plant.
  Capacity: 100 short tons of ammonia/24 hours.

  Yearly production at 100 % stream factor:

  34.044 short tons of ammonia (calculated as 100% NH_3).

  Stream days per year: 340 (100% stream factor).

  Process feedstock: Naphtha
  Fuel : Fuel oil No. 2.

- One nitric acid plant.

  Capacity:
  180 short tons of nitric acid (100%) /24 hours,
  acid strength min. 56%.

  Yearly production at 100% stream factor:
  55.874 short tons of nitric acid (100 % basis).

  Stream days per year: 310 (100 % stream factor).

  Process feedstock:
  16.315 short tons of ammonia (as 100 %)/year.

- One ammonium nitrate plant.
  Capacity of ammonium nitrate prills:
  100 short tons of ammonium nitrate prills/24 hours.

  Yearly production of prills at 100% stream factor:

  28.000 short tons of prills.

  Stream days per year: 280 (100% stream factor).
  Process feedstocks for prills.
  6.244 short tons of ammonia (as 100%)/year
  22.764 short tons of nitric acid (as 100%)/year

Additional capacity and production of ammonium mitrate solution for N-P-K plant at 100% stream factor:

8.485 short tons of ammonia (as 100%)/year
33.110 short tons of nitric acid (as 100%)/year.

- One N-P-K blending and granulation plant.

Capacity: 300 short tons of 17-17-17 compound fertilizer/ 24 hours, with capability to produce other grades

Stream days per year: 280 (assumed).

Yearly production of N-P-K prills at 100% stream factor:

17-17-17 grade.
40.000 short tons
Process feedstocks:
2.680 short tons of ammonia (as 100%)/year.
10.880 short tons of nitric acid (as 100%)/year.
15.160 short tons of DAP (18,2-46,8-0)/year.
11.840 short tons of muriate of potash (60% K_2O)/year.

16-8-24 grade.

30.000 short tons.

Process feedstocks:

2.550 short tons of ammonia (as 100%)/year
9.750 short tons of nitric acid (as 100%)/year.
5.370 short tons of DAP (18,2-46,8-0)/year.
12.540 short tons of muriate of potash (60% K_2O)/year.

23-11,5-11,5 grade

15.000 short tons.

Process feedstocks:

1.755 short tons of ammonia (as 100%)/year.
6.720 short tons of nitric acid (as 100%)/year.
3.690 short tons of DAP (18,2-46,8-0)/year.
2.880 short tons of muriate of potash (60% K_2O)/year.

19,1 -9,6- 19,2 grade

15.000 short tons.

Process feedstocks:

1.500 short tons of ammonia (as 100%)/year.
5,760 short tons of nitric acid (as 100%)/year.
3.180 short tons of DAP (18,2-46,8-0)/year.
4.935 short tons of muriate of potash (60% K_2O)/year.

4.5.2 End-product quantities for sale (yearly basis):

The N-Ren proposal envisages the following quantities of end-products per sale on a yearly basis:

Liquid ammonia	3.000 short tons
Ammonium nitrate prills	28.000 short tons
N-P-K compound fertilizers:	
17-17-17 grade	40.000 short tons
16--8-24 grade	30.000 short tons
23-11,5-11,5 grade	15.000 short tons
19,1-9,6-19,2 grade	15.000 short tons

Part of the process feedstock for production of the N-P-K fertilizers is ammonia and nitric acid. Nitric acid is again produced in the plant on basis of ammonia.

The N-Ren proposal foresees that the ammonia plant will be able to operate at design capacity through 340 days per annum corresponding to a stream factor of 100%. The above quantities of end-products have been based upon this assumption, which however is not correct. In a developing country a stream of more than 80% can hardly be obtained, which implies that no more than 80% of all the quantities listed above would be available for sale on a yearly scale.

4.5.3 End-product and intermediate product specifications.

The N-Ren proposal is based upon the following product specifications:

Ammonia, liquid

NH_3	minimum	99,5%	by weight
Oil	maximum	5 ppm	by weight
Water	maximum	0,5%	by weight

Temperature at loading station: not given
Pressure at loading station: not given

Nitric acid

HNO_3	minimum	56%	by weight
HNO_2	maximum	0,1%	by weight

Ammonium nitrate prills:

Alternative qualities: High or low density product.

Nitrogen:	33,5%
Water:	not given
Free acid:	not given
Nitrite:	not given
Coating agent:	not given
Particle size:	not given

N-P-K granules.

Nominal grades:	17-17-17
	16-8-24
	23-11,5-11,5
	20-10-20

Particle size:

90% less 6 and plus 14 mesh Tyler
90% plus 20 mesh Tyler.

4.5.4 Raw material quantities and specifications.

The N-Ren proposal requires the following raw materials as available to the plant.

Ammonia plant.

Naphtha: as process feedstock.
Yearly quantity:
Expected 18.724 short tons for
34.044 short tons of ammonia
(as 100%) at a specific consumption
of 0,55 ton/ton

Specification:
Straight-run naphtha

API Gravity	minimum	62,10°
Gross heating value	minimum	20.500 BTU/lb
Distillation range:		
IBP	minimum	131°F
90% V:	maximum	212°F
FBP:	maximum	239°F
PONA analysis:		
Paraffins:	48,2 %.V	48,2 %.V
Olefins	maximum	0,3 %.V
Naphthenes		47,0% .V
Aromatics	maximum	4,5% V
		100,0% V
Sulphur:	maximum	0,03 % by weight

Fuel oil: as fuel

Yearly quantity:

Expected 17.022 short tons for
34.044 short tons of ammonia (as 100%)
at a specific consumption of 0,50 ton/ton.

Specification:

Type: Equivalent to No.2 fuel oil.

Ammonium nitrate plant

Coating agent

Yearly quantity:

Expected 280 short tons for
28.000 short tons of AN prills at 1% coating.

Specification: not given, but probably the same as for N-P-K-fertiliser (see below)

Bags

N-P-K Plant

Di-Ammonium Phosphate (DAP): as feedstock

Yearly quantity: 27.400 short tons for production of 100.000 short tons of N-P-K grades in portions given above.

Specification:

Ammonia content:	18,2% by weight (dry)
P_2O_5 content:	46,8% by weight (dry)
Particle size:	not given

Potassium chloride

(Muriate of Potash): as feedstock.
Yearly quantity: 32.195 short tons for production of 100.000 short tons of N-P-K grades in portions given above

Specification:

Type:	Standard
K_2O content:	minimum 60% by weight

Particle size:

100% minus 16 mesh Tyler (1 ml.)
min. 50% minus 32 mesh Tyler (0,5 ml.)

Coating agent.
Yearly quantity: 1.000 short tons for 100.000 short tons of N-P-K fertilizers at 1% coating

Specification:

Type:	Diatomaceous earth or fine limestone with addition of a 2% surfactant.
Size:	Substantially minus 325 mesh
Moisture:	Maximum 3%

Surfactant. (if required for coating agent).

Yearly quantity:	20 short tons for 1.000 tons coating agent at 2% surfactant.
Type:	Petro Ag.
Purity:	Minimum 95% Methyl Naphthalene Sodium Sulfonate.
Moisture:	Maximum 2,5%

Fuel oil: Fuel for spherodizer furnace

Type: Bunker C.

Gross heating value: minimum 18.000 BTU/lb.

Bags

Electrical power plant. (Included as own utility of plant in N-Ren proposal)

Diesel oil: as fuel of Diesel generators (2x6.000 HP units).

Yearly quantity: not given or apparant in N-Ren proposal.

Package boiler. (Included in N-Ren proposal)

Fuel oil: Bunker C oil

Yearly quantity: not given or apparent from N-Ren proposal.

4.5.5 Process plant description and specification

4.5.5.1 General

1. The N-Ren proposal does not submit any process flow diagrams, operating conditions, etc. which means that the process design is not defined in accurate data and cannot be checked adequately.

2. The N-Ren proposal does not submit any engineering flow diagrams and utility diagrams which means that the adequacy of piping instrumentation, process control, mechanical safety control, automatric analyses, utilities, etc. are not defined in beforehand and cannot be checked.

3. The N-Ren proposal does not include any detailed plot plan and proposed equipment and piping lay-out drawings, which means that the arrangement of equipment, piping, buildings, storages, etc. is not defined and cannot be checked in beforehand.

4. The N-Ren proposal does not submit any electrical diagram which means that the electrical system is not defined in details and cannot be checked in beforehand.

5. The N-Ren proposal does not indicate any codes and standards as assumed for the design, engineering manufacturing, construction, etc of the plant which leaves quite some uncertainty on the adequacy of these items.

6. In accordance with the N-Ren proposal the list of equipment for the process plants seems to be generally inclusive.

7. The equipment specifications of the list of equipment of the N-Ren proposal does not state any dimensions, any detailed design features and data, any individual expected and guaranteed performance data, any makes or names of manufacturers, etc. This involves that the equipment cannot be evaluated in sufficient details.

8. Although the N-Ren list of equipment is stated to be generally inclusive, the N-Ren proposal ought to indicate clearly that it shall be the responsibility of N-Ren to deliver all equipment as needed for the adequate design, construction, and operation of the plant according to general engineering standards, even though the equipment list might not be complete in the first place. If there would be any exceptions in the delivery liability, they ought to be pointed out by N-Ren in advance of signing any agreement.

4.5.5.2 Ammonia Plant

A modern ammonia plant of first class design and based upon either natural gas or naphtha as process feedstock comprises the following sequence of processes (other ammonia plants are based on fuel oil and have a different process scheme).

- Feedstock hydrocarbon desulphurization.
- Primary steam-hydrocarbon reforming at approximately 35 Kg/cm^2g.
- Secondary reforming and addition of process air from centrifugal air compressor driven by steam trubine.
- High degree of waste heat utilization for raising of high presure steam (approximately 100 Kg/cm^2g.)
- High temperature Co shift conversion.
- Low temperature Co shift conversion.
- Hot potassium carbonate wash for Co_2 removal. At plants with very low price natural gas as feedstock, a MEA wash may be used instead, resulting in lower investment, but higher steam consumption, and, thus, higher consumption of fuel.
- Methanation of residual Co and Co_2.
- Water or air cooling of synthesis gas.
- High pressure steam turbine driven centrifugal compressor for synthesis gas compression and recirculation.
- Ammonia synthesis at approximately 250-350 Kg/cm^2g. pressure. Primary condensation by water or air cooling and secondary condensation by refrigerant ammonia cooling with centrifugal refrigerant ammonia compressors driven by steam turbines.

A study of the N-Ren proposal shows the following departures from the modern ammonia process route:

1) Primary reforming of steam-naphtha takes place at an inlet pressure of 15-16 Kg/cm^2g, and simultaneous addition of a portion of the process air to the primary reformer.

2) Secondary reforming and addition of the remaining portion of process air.

3) Quenching by injection of process condensate is applied at exit of secondary reformer, between the high and low temperature Co shift conversion beds, and at inlet to the MEA reboiler.

4) MEA - Girbotol wash is used instead of a hot potassium carbonate wash for Co_2 removal.

5) Reciprocating multiservice compressor driven by electrical motor is foreseen for synthesis gas pressure, synthesis gas recirculation, process air, and refrigerant ammonia.

These departure from modern process route imply as follows:

- Substantially cheaper equipment. This advantage is however by far outruled by the higher specific investments and the use of reciprocating compressor in the small size plant compared to a large plant.

- Substantially higher consumption of fuel and electricity because of the low reforming pressure, the low utilization of waste heat, the application of MEA wash rather than a hot potassium carbonate wash, and the installation of a reciprocating multiservice compressor driven by electric motor. (see report Part III, Page 3.18)
- The design and operation of the primary reformer of the N-Ren proposal may not be satisfactorily reliable. At any rate, N-Ren should be asked to prove safisfactory operation in similar existing plants with the same raw materials. It is emphasized that the primary reformer is a very important process unit in an ammonia plant and a high investment item.

- The addition of a portion of the process air to the primary reformer is partly because N-Ren cannot use a promoted or special naphtha reforming catalyst against the ICI/Kellogg naphtha reforming patents. For the same reason, N-Ren has specified a very light naphtha quality, as the plant may not be able to handle a normal naphtha quality.

4.5.5.3 Nitric acid plant

The nitric acid plant of the N-Ren proposal has a normal nitric acid process concept and contains the usual kind of equipment for such a plant.

However, the overall nitrogen efficiency based upon the nitrogen content of the ammonia and of the nitric acid produced is given **to be at design production rate 92.5% as applicable to high pressure (8 atm.) as in N-Ren proposal. This figure is unacceptably low; in a modern residual pressure (3 atm., 8 atm.) and well operated plant the nitrogen efficincy is as high as 95 - 97%.**

The N-Ren proposal does not specify the guaranteed maximum limit and concentration of nitrogen exides in the effluent stack gas. This limit and the height of the stack would be subject to the Liberian authorities dealing with environmental protection.

4.5.5.4 Ammonium nitrate plant

The ammonium nitrate plant proposed by N-Ren follows a normal design concept of this category of process plants.

The AN plant consist of a section for vaporization of ammonia and ammonium nitrate neutralization and sections for evaporation of ammonium nitrate solution and prilling, drying, cooling, coating, conveying, storage, and bagging.

In the former section the ammonium nitrate solution for the N-P-K compound granulation plant is prepared as well.

The coating, storage, bagging, handling, shipment, etc. of the ammonium nitrate explosive material will be subject to the Liberian safety regulations on explosives. A check of the compliance of the N-Ren proposal plant to the Liberian safety regulations on explosives has not been carried out so far. The N-Ren proposal foresees the AN explosive (33,5% N) shipped in 50 kgs. bags.

4.5.5.5 N-P-K blending and granulation plant

The N-P-K plant of the N-Ren proposal carries out the following steps:

- Mixing of ammonium nitrate solution (arriving from the AN plant) with the DAP and KCL raw materials into a slurry.
- Drying and granulation of the slurry into prills.
- Cooling of prills
- Coating of prills.
- Conveying, storage, and bagging.

The N-P-K fertilizer is foreseen shipped in 50 kgs. bags.

According to the N-Ren proposal maximum 2% of the respective N,P_2O_5 and K_2O ingredients fed to the plant will be lost as dust into the atmospheric air. On a yearly basis this makes a lot of dust, which is an undesirable loss of valuable materials and which may cause an unacceptable pollution of the environments. Correspondingly, the overall yields on N,P_2O_5, and K_2O of 93%, 97%, and 97%, respectively as stated in the N-Ren proposal are too low.

4.5.5.6 Catalysts, spare parts, etc.

The N-Ren proposal does not state the following important items:

- Initial charge catalysts.
- Spare charge catalysts.
- Tower packings (initial charges plus spare charges).
- Chemicals, like MEA, etc.
- Lube oil and grease.
- Spare parts (critical items plus normal consumption during one year of operation).

Out of the above items only the initial charges of catalysts and chemicals are included in the N-Ren proposal price.

4.5.5.7 Utility units

The N-Ren proposal includes the following utility units:

- Circulating cooling water system.
- Fire water system.
- Boiler feed water treatment system and pumps.
- One package boiler
- Electric power station, comprising two 6.000 HP Diesel generators.
- Yard lighting and building lighting.
- Electric power switchgear, transformers, distribution system and motor control centers.
- Instrument air system.
- Plant air system.
- Truck scale, payloaders, fork lift trucks, and pallets.

Not included or not stated in the proposal, although needed

- Water supply of fresh water for cooling water make-up, fire water system, and boiler feed water make-up is supposed in the proposal to be made by PUA directly to the plant site. Normal operation make-up water rate is given at approximately 700 US gallons per minute.

- One extra package boiler may be recommendable depending upon steam balance of plant not submitted by N-Ren.

- Telephone system.

- Micro-wave call and communication system

- Laboratory equipment

- Mechanical, electrical, and instrument workshops.

- Erection equipment and tools (are not stated, but must be assumed to be included).

4.5.5.8 storage facilities and capacities

The N-Ren proposal envisages the following storage facilities and capacities for raw materials, intermediate products, and end-products:

- One naphtha storage tank (naphtha for process feedstock of ammonia plant).

  Capacity: 2 days' surge.

- One fuel oil storage tank (fuel oil No. 2 for primary reformer furnace).

  Capacity: 2 days' surge.

- One Diesel oil storage tank (Diesel oil for Diesel motor-driven electricity generators).

  Capacity: not given.

- Four ammonia horizontal storage cylinder tanks.

  Capacity: 50 tons is given, it is not given whether this is for all tanks or for each one.

- One nitric acid storage tank.

  Capacity: Approximately 48.750 gallons.

- One raw material storage building for DAP and KCL.

  Capacity: 5.000 short tons of DAP, and 5.000 short tons of KCL.

- One NPK finished products bulk storage building.

  Capacity: 1.500 short tons of each of four grades.
- One AN product bulk storage building. Cap. 4.000 short tons.
- One bagging and bagged storage building.

  Capacity: 1000 metric tons of products in bags, plus 60 days' empty bag storage.

Not included or not stated in N-Ren proposal

- One raw water storage tank.
- One treated water storage tank.
- One fuel oil storage tank (fuel oil, Bunker C for spherodizer furnace and package boiler.

4.5.5.9 Buildings

The N-Ren proposal includes the following buildings and items (storage buildings are given above):

- One compressor building.
- One boiler and utilities building.
- One administration building.
- One change house and locker room.
- One maintenance and warehouse building, including laboratory

- Fencing
- Inside roadways
- Inside parking areas.

The N-Ren proposal ought to add to what extent building materials are part of the delivery of N-Ren, and which are excluded.

4.6 Availability and prices of naphtha and fuel oils from Liberia Refining Company.

The following information has been received during discussions with Mr. P.N. Duggan, Manager of Technical Services, Liberia RE-fining Company on the 31st December 1975 and 19th January 1976 at dhe offices of the oil refinery at Gardnersville.

Naphtha.

The present oil refinery is able to produce and sell a straight-run naphtha either as raw naphtha or as predesulphurized naphtha, as follows:

Situation by January 1976	Raw naphtha		Predesulphurized naphtha
Type		Straight-run	
Total sulphur content, %	0.037		0,007
Price, ex refinery US$/metric ton	216,10		227,40
Total capacity, metric tons/24 hours	350	or	300
Quantity already committed to other purposes or other clients, metric tons/24 hours		200	
Available for sale, metric tons/24 hours	150	or	50-100

Specification	Raw naphtha	Predesulphurized naphtha
API Gravity	71,0°	65,0°
Gross heating value, minimum BTU/lb.	—	—
Distillation range:		
IBP, °F	98	140
90% V, °F	268	282
FBP, °F	318	346
PONA analysis:		
Paraffins, % V	78,1	—
Olefins, % V	0,2	—
Naphthenes, % V	14,8	—
Aromatics, % V	6,9	—

The raw naphtha has a sulphur content slightly above the maximum limit specified by N-Ren.

However, the naphtha specified by N-Ren is a considerably lighter naphtha and does neither contain the lighter nor the heavier compounds as the naphtha qualities actually being available from Liberia Refining Company.

The light naphtha specified by N-Ren could only be delivered by Liberia Refining Company after installation of new fractionating equipment at a large investment, which would result in a considerable increase of the price of the naphtha as compared to the prices given above.

With respect to PONA analysis there is a substantial difference between the figures specified by N-Ren and the figures of the naphtha available from Liberia Refining Company.

There is no doubt that the raw naphtha quality now being at disposal from Liberia Refining Company would cause operational troubles in the ammonia plant proposed by N-Ren.

LRC has no access to any crude petroleum to be able to produce a naphtha with the high naphthenic contents as specified by N-Ren.

Fuel oils.

The present oil refinery is capable to produce and sell fuel oil in two qualities, namely Diesel gas oil and fuel oil Bunker C, as follows:

	Diesel gas oil	Fuel oil Bunker C
Sulphur content, %	1,05	4,0
Price, ex refinery, US$/metric ton	183,30	127,80
Total capacity, metric tons/24 hours	---	1,000.00
Sale already committed to other clients, metric tons/24 hours	---	800.00
Available for sale, metric tons/24 hours	---	200.00
Specification		
API Gravity	36,1°	18, 3°
Lower heating value, BTU/lb	---	---
Distillation range:		
IBP, °F	418	---
90 % V, °F	700	---
FBP, °F	760	---

N-Ren specifies the fuel oil for the primary reformer of the ammonia plant to be equivalent to Number 2 fuel oil, which is a fuel oil slightly heavier than the Diesel gas oil as available from Liberia Refining Company, but much lighter than Bunker C fuel oil.

Liberia Refining Company cannot deliver Number 2 fuel oil from its present operation and would have to supply Diesel gas oil in its place.

4.7 Economic Evaluation of N-Ren Proposal of September 1974

4.7.1 Introduction

In the present chapter an economic evaluation of the N-Ren proposal it carried out on basis of the summary investment figures of October 1974 as given in the proposal and on actually prevailing prices on raw materials.

The detailed procedure of the evaluation and its findings are described below.

4.7.2 Investments

A summary breakdown of the investment and working capital figures as quoted in the N-Ren proposal is given in the attached tabulation No. 1.

In the attached tabulation No. 2 a detailed breakdown of the investments and working capital into the respective amounts of the various process plants, including for each process the related part of the amounts pertaining to the common facilities such as cooling water system, boiler feed water preparation unit, fire water system, electrical distribution and lighting system instrument air and plant air system, buildings, tanks, and storages. The detailed breakdown has not been submited by N-Ren but is estimated based on typical figures of similar plants.

It is pointed out that the investment figures given by N-Ren refer to October 1974, and that the costs of delivery and construction of fertilizer plants have escalated drastically in the meantime.

4.7.3 Raw material and utility prices

The actually prevailing prices in Liberia or CIF Monrovia on raw materials, such as raw naphtha, fuel oil No. 2, Bunker C fuel oil, DAP, and KCl as they have been used in the present economic evaluation of the N-Ren proposal are given in the attached tabulation No, 5.

It is emphasized that the prices on these raw materials have a great impact on the cost prices of the respective products of the plant.

The corresponding prices on raw materials as figured by N-Ren are much lower.

In the N-Ren proposal no consumption figures are given for the electricity plant, which means that the cost of the electricity as it may be produced in the quoted electric power station cannot be calculated at the present stage. A substantial burden in this cost will be the cost of the Diesel gas oil consumed by the Diesel motors driving the electric generators.

Consequently, in the subsequent cost price calculations on the fertilizer products an electricity price as charged to large industrial consumers by Liberia Electricity Corporation has been assumed. This price is more than double as big as the electricity price used in the cost estimates of the N-Ren proposal book.

A comparison between the two sets of raw material and electricity prices is stated in the attached tabulation No. 11.

All other raw materials, utilities etc. such as cooling water, boiler feed water, steam, coating agents, catalysts, chemicals, lube oil and bagging materials have in the present economic evaluation been assumed at the prices as specified in the N-Ren proposal. It is mentioned that none of these materials, utilities, etc. involves an appreciable cost in the manufacturing processes of the plant.

It is pointed out that all the unit costs, which are mentioned have been revised in the present chapter from the N-Ren proposal, have been calculated from U.S.$ per metric ton.

4.7.4 Labour and staff.

The salaries and wages of labour and staff are normally not an essential part of the manufacturing costs of plants producing chemicals in large quantities.

Therefore, in the present economic evaluation the same labour crews and staff and their salaries and wages as in the N-Ren proposal have been applied directly.

In the attached cost price calculations the salaries and wages have been divided with the actual production per year of the respective plants in order to arrive at the cost per metric ton of product.

The projected general administrative staff salaries and their estimated distribution on the respective plants are given in the attached tabulations Nos. 3 and 4.

4.7.5 Stream days, stream factor, and annual production.

The daily design capacities of the process plants have been based on the following stream days per year:

- Ammonia plant 340 days
- Nitric acid plant 310 days
- Ammonium Nitrate plant 280 days
- NPK blending and granulation plant not given, but assumed 280 days.

The design stream days of the NPK blending and granulation plant is not stated in the N-Ren proposal, but can hardly be larger than 28o days as in the case of the ammonium nitrate plant, as the feedstock of ammonium nitrate solution of the NPK plant is prepared in the AN plant, and no large solution tank is foreseen.

The daily design capacity of the NPK plant is 300 short tons of compound fertilizer when the grade (17-17-17) is being produced according to the N-Ren proposal. However, the annual total production of all products is given by N-Ren to be 100,000 short tons, which means that the average daily production through the 280 days would be 357 short tons equal to 324 metric tons of the NPK blending and granulation plant.

On the other hand, the above discrepancy in the daily capacity figures could mean that N-Ren has made a mistake and designed the NPK blending and granulation plant too small.

Meanwhile, N-Ren has in its determination of the yearly production figures and in its manufacturing cost estimates considered, that the process plants will be able to perform at the daily design capacities continuously through all the design stream days each year as given above, corresponding to a stream factor of 100%. This will not be possible. In a developing country, where the operating and maintenance personnel and workers do not have many years of experience and where upsets in the supply of raw materials and utilities and in the transportation and consumption of fertilizers may occur, it will hardly be possible to achieve at a stream factor of more than 80% or less corresponding be not more than 80% or less of the annual design production.

In the plant proposed by N-Ren the actual stream factor might even be substantially lower than 80% during the first years of operation, because the primary reformers of the ammonia plant may be of a delicate design and may cause frequent shut downs due to operational and mechanical troubles.

Nevertheless, in the present economic evaluation a stream factor of 80% has been arbitrarily forseen corresponding to annual production figures at 80% of the N-Ren figures, and the fixed costs per metric tons of each product are increased accordingly.

The annual production figures assumed in the present economic evaluation are summarized in the attached tabulation no. 13.

4.7.6. Maintenance

The annual maintenance costs have been envisaged at 2,5% of the investment figures for delivery and construction of the respective plants. This is a conservative estimation. In reality, the maintenance costs may very well be higher.

In the N-Ren proposal maintenance costs, including the cost of annual overhaul and repair works have not been duly considered.

Even though the maintenance costs are important, they are merely a small portion of the total manufacturing costs.

4.7.7 Insurance

The insurance costs per year have been taken directely from the N-Ren proposal at 0.95% of the investment figures for delivery and construction of the respective plants.

Depending upon the insurance coverage as desired, the percent rate may be higher, say 2% in the reality.

4.7.8 Capital costs.

An average interest of 4.8% p.a. accrued once a year on the total investments have been envisaged for the ammonia plant and the nitric acid plant, while an average interest of 4.2% p.a. accrued once a year on the total investments have been forseen for the ammonium nitrate plant and the NPK blending and granulation plant.

Straight-line depreciation over 10years of the total investments have been supposed.

Interest on working capital has been figured at a rate of 10% p.a. accrued once a year.

4.7.9 Cost price calculation.

The cost price calculations as carried out are apparent from the attached tabulations nos. 6,7,8, and 9a, b, and c. A summary of the calculated cost prices is given in the attached tabulation No. 10.

4.7.10 Market prices on end-products.

In the attached tabulation No. 12 it is given a comparison on the market prices on the end-products as figured in the N-Ren proposal and as assumed to prevail presently on a CIF Monrovia basis.

As apparent from the tabulation the market prices at actual conditions and purchasing through competitive bidding on ammonia and ammonium nitrate have been taken at the same prices as in the N-Ren proposal. Possibly, even lower prices may be obtained at the time being. The figure on ammonia should be understood as delivery and shipment in purchaser's own pressure vessels.

The presently assumed prices on NPK fertilizer have been found by prorating the market prices on NPK (17-17-17) as given in the N-Ren proposal to 17/15 of the quoted CIF Monrovia price on NPK (15-15-15) given in the attached tabulation No. 5 and revising the other NPK market prices of the N-Ren proposal in the same propportion as the NPK (17-17-17) price. It goes without saying that the market prices calculated in this way should be considered only as approximate and typical figures. Possibly, even lower prices may be obtained through conpetitive bidding on large lots.

The actually prevailing market prices found in the above manner have been used in the subsequent calculation of the annual sales revenues.

4.7.11 Annual manufacturing costs, annual sales Revenues, and annual deficit.

Ih the attached tabulation no. 14 there are calculated the annual manufacturing costs, the annual sales revenues and the annual deficit at a stream factor of 80%.

As apparent the annual deficit would amount to U. S. $9.3 million. In fact, the deficit would be appreciably higher for the following reasons:

- Raw naphtha price will be higher than forseen in the present calculations.
- A large price escalation of the investment on delivery and construction of the plant from the price basis of October 1974 of the N-Ren proposal and until today, and further escalation until the plant construction could be terminated will take place. No price escalation is considered in the present calculations, as the escalation rate cannot be known so far.
- The stream factor may actually prove to be lower than the 80% applied in the present calculations.

The important difference in the economic evaluation between the present calculations and the N-Ren proposal are mainly due to the following points:

- N-Ren has calculated on the basis on raw material prices which are much too low as compared to today's price level in Liberia or CIF Monrovia.
- N-Ren has foreseen a stream factor of 100% which cannot be achieved in a developing country.
- N-Ren has not considered duly the maintenance cost of the plant.

- N-Ren has figured the market and sales prices on the NPK fertilizer to be slightly higher than the actual level. As the world market situation on fertilizer is now there is no reason to expect a big rise in the prices on ammonia, ammonium nitrate and NPK fertilizers during the next few years.

It is noted that the ammonia plant of the N-Ren proposal is in particular uneconomic.

Compared to modern large ammonia plants the N-Ren ammonia plant has a chockingly high manufacturing cost of ammonia for the following main reasons:

- The investment cost per metric ton of ammonia capacity is very high, about 4 times higher than in a modern large ammonia plant, when referring to the same price basis date.

- The N-Ren plant consumes about 25 - 35% more lower heat value of the hydrocarbon process feedstock and fuel than a modern large ammonia plant.

- The N-Ren ammonia plant must due to its small size use reciprocating compressers driven by electric motors rather than a steam turbine driven centrifugal compressor as installed in modern large ammonia plants. Thus, the N-Ren ammonia plant with 100 STPD ammonia capacity consumes about the same amount of electricity as a modern large ammonia plant of 1,000 MTPD ammonia capacity.

- The high costs of hydrocarbon and electricity in Liberia, in particular in comparison with countries where natural gas is abundant and cheap, like Algeria, Nigeria, etc.

It is emphasized that the actual annual deficit of a Liberian fertilizer plant would be substantially bigger than the calculated amount of U.S. $9.3 million, firstly because of the loss of interest and earnings of the additional obligations and investments of the Government of Liberia as listed in the subsequent chapter 4.12, and secondly because the large portion of the annual production, which will be in excess of the domestic consumption and will have to be exported will need to be sold at lower ex factory prices than the CIF Monrovia prices of imported fertilizer into Liberia from competitors. On the latter subject, reference is made to the subsequent chapters 4.13.

Tabulation No. 1

INVESTMENT AND WORKING CAPITAL
N-REN PROPOSAL
Price Basis: October 1974

Summary Breakdown of Investments and Working Capital

	Investments Million U.S. $	Working Capital Million U.S. $
Cost of plant and facilities N-Ren Proposal	36,2	-
Working capital and pre-operating expenses		-
N-Ren proposal US $1,8 million:		
Estimated breakdown:		
Catalysts, lube oil, spare parts, and other pre-operating expenses *	0,8	-
Working capital	-	1,0
Pre-operating interest	2,8	-
Total	39,8	1,0

* It may not be true that these items are included in the N-Ren figure.

Tabulation No. 2

INVESTMENT AND WORKING CAPITAL
N-REN PROPOSAL
Price Basis: October 1974

Detailed breakdown of investments and working capital

	Proportion	Investments Plant facilities, Pre-operating expenses	Investments Pre-operating interest	Working Capital
	%	US $million	US $million	US $million
	Estimated			
Ammonia plant and facilities including tanks for naphtha, fuel oil No. 2 and ammonia, and catalysts lube oil, spare parts	43	14,3	1,075	0,387
Nitric acid plant and facilities including nitric acid storage tank, catalyst, lube oil, spare parts	31	10,3	0,775	0,279
Ammonium nitrate plant and facilities, including AN storage and bagging, lube oil, spare parts	13	4,3	0,325	0,117
NPK blending and granulation plant and facilities, including NPK storage and bagging, DAP and KCI storages, lube oil, spare parts	13	4,3	0,325	0,117
Sub-total	estimated 100	33,2	2,5	0,9
Electricity plant and facilities including Diesel oil tank, lube oil, spare parts	estimated	3,8	0,3	0,1
Total		37,0	2,8	1,0

Tabulation No. 3

PROJECTED GENERAL ADMINISTRATIVE EXPENSES
N-REN PROPOSAL
Salary Basis: October 1974

Projected Salaries of Staff	1,000 US $	
Staff		
- Expatriates:		
- plant manager	40	
- production manager	35	
- maintenance manager	35	
- chief chemist	28	
	138	
social charges, 25%, including housing	35	173
- Local Staff		
- 20 administrative employees	125	
- social charges, 25%	31	156
Administrative Overhead		
- 40% on staff salaries		136
Total		465

Tabulation No. 4

PROJECTED GENERAL ADMINISTRATIVE EXPENSES
N-REN PROPOSAL
Salary Basis: October 1974

Estimated distribution of projected salaries of staff on respective plants

	Proportion estimated %	Salary distribution 1,000 US $
- Ammonia Plant	32	148,8
- Nitric acid Plant	20	93
- Ammonium Nitrate Plant	24	111,6
- NPK blending and granulation plant	24	111,6
Total	100	465

The number and salaries of staff in charge of the electricity plant have been disregarded, as the salary amount involved will be very minor in comparison to all other salaries and as some of the duties in connection with the electricity plant may be solved as part-time job by personnel dealing also with other plants.

Tabulation No. 5

MARKET PRICES ON RAW MATERIALS
AND ELECTRICITY AND FERTILIZERS
Price Basis: January-February 1976

	Prices quoted by Liberia Refining Company, ex-refinery and on, US $/metric ton
- Raw straight-run naphtha, maximum 0,04% sulphur	216,10
- Raw straight-run naphtha, predesulphurized maximum 0,01% sulphur	227,40
The raw naphtha quality as specified and required by N-Ren will be more expensive and is presently not available from the oil refinery.	
- Diesel gas oil, to be used for fuel oil No. 2 as specified and required by N-Ren	183,30
- Bunker C fuel oil	127,80

	Price of Liberia Electricity Corporation, Monrovia US $ per kWh
- Electricity to large industrial consumer with own transformer	0,055

Tabulation No. 5 cont'd

	Prices, CIF Monrovia, quoted by ULRC, Monrovia for 50-100 metric ton lots shipped from BASF, West Germany, US $ per metric ton
- Mono-ammonium-phosphate (13-52-0) in 50 kgs bags	231,00 (208)
- Di-ammonium-phosphate (21-53-0), in 160 kgs net steel drums	509,87 (459)
- Muriate of potash (60% K_2O) in 50 kgs bags	153,77 (139)
- Sulphate of potash (50% K_2O) in 50 kgs bags	195,37
- NPK (15-15-15), in 50 kgs bags	179,00

The above prices within the brackets for DAP and KCL and MAP have been used in the cost price calculations of tabulation No. 9 of chapter 4.7 and tabulation No. 20 of chapter 4.11 to account for shipment of large lots in bulk from abroad. They are taken at ten percent lower than the quoted prices.

COST PRICE CALCULATION
AMMONIA PLANT

Investments:

1. Delivery and construction: estim. US 14,300.000 (price basis: October 1974)
2. Price escalation: to be added later
3. Pre-operating interest: estim. US 1.075.000
4. Total excluding price escalation: US 15.375.000

Working capital: estim. US 387.000

Daily Capacity: 100 STPD ammonia. Stream factor: assumed 80%

Production: 90.7 MTPD x 340 days x 0,80 = 24.670 MTPY

Item	Unit/m. ton	Cost/Unit U.S.	Cost/m. ton U.S.	Sub-total U.S.
Raw Materials				
Naphtha	0,55 m. ton	216,10/m.ton*	118,86	
Fuel oil No. 2	0,50 m. ton	183,30/m.ton	91,65	210,51
Other Materials				
Catalysts			0,70	
Lube oils, chemicals			0,60	1,30
Utilities				
Electricity	794 kWh	0,055/kWh	43,67	
Cooling water (circulating)	350 m^3	0,004/m^3	1,20	
Boiler feed water	1 m^3	0,33/m^3	0,33	45,20
Labour and Staff				
Supervisor	1man/3shifts	3,00/manhour	1,07	
Operators	3men/3shifts	2,00/manhour	2,13	
Maintenance labour	1man/3shifts 3men/day	2,00/manhour	1,42	
		Cost per Year		
Overhead (40% On labour)			1,85	
Staff and 40% overhead	-	148.300	6,04	12,51
Maintenance	2.5% on inv.1	357,500	14,49	14,49
Capital Costs				
Average inter. on inv.	4.8% on inv.4	738.000	29,91	
Depreciation on inv.	10% on inv. 4	1.537.500	62,32	
Inter. on work. cap.	10% on w. cap.	38,700	1,57	93,80
Insurance cost	0,95% on inv. 1	135.850	5,51	5.51
Total cost price per metric ton NH_3, excluding cost of price escalation* cost of the light naphtha as specified by N-Ren will be higher				383,32

Tabulation No. 7

COST PRICE CALCULATION
NITRIC ACID PLANT

Investments:

1. Delivery and construction: estimated US $ 10.300.000(price basis: October 1974)
2. Price escalation: to be added later
3. Pre-operating interest: estimated US $ 775.000
4. Total excluding price escalation: estimated US $ 11.075.000

Working Capital: estimated US $ 279.000

Daily Capacity: 180 STPD HNO_3 (100%) Stream factor: assumed 80%

Production: 163,3 MTPD x 310 days x 0,80 = 40.498 MTPY

Item	Unit/m.ton U.S. $	Cost/Unit U.S. $	Cost/m. ton U.S. $	Sub-total U.S. $
Raw Material				
Ammonia	0,292 m.ton	383,32/m. ton	111,93	111.93
Other Material				
Catalyst	0,0054 Troy oz	310/Troy oz	1,68	1,68
Utilities				
Electricity	110 kWh	0,055/kWh	6,05	
Cooling water (circulating)	111 m^3	0,004/m^3	0,44	
Boiler feed water	0,69 m^3	0,04/m^3	0,03	6,52
Labour and Staff				
Supervisor	1man/3shifts	3,00/manhour	0,65	
Operator	1man/3shifts	2,00/manhour	0,43	
Maintenance labour	1man/3shifts 1man/day	2,00/manhour	0,58	
Overhead (40% on labour)			0,66	
		Cost per Year		
Staff and Overhead		93.000	2,30	4.62
Maintenance	2.5% on inv.1	257.500	6,36	6.36
Capital Costs				
Average inter. on inv.	4.8% on inv.4	531.600	13,13	
Depreciation on inv.	10% on inv. 4	1.107.500	27,35	
Interest on work. cap.	10% on W. cap.	27.900	0,69	41,17
Insurance Costs	0.95% on inv. 1	97.850	2,42	2,42
Total cost price per metric ton HNO_3 (100%) excluding cost of price escalation				174,70

COST PRICE CALCULATION
AMMONIUM NITRATE PLANT

Tabulation No. 8

Investments:

1. Delivery and construction: estim. US $4.300.000 (price basis October 1974)
2. Price escalation: to be added later
3. Pre-operating interest: estim. US $ 325.000
4. Total excluding price escalation: US $4.625.000

Working capital: estim. US $ 117.000

Daily Capacity: 100 STPD AN (33,5% N). Stream factor: assumed 80%

Production: 90,7 MTPD x 280 days x 0,80 = 20.317 MTPY

Item	Unit/m. ton	Cost/Unit US	Cost/m. ton US	Sub-total US
Raw Materials				
Ammonia	0,223 m. ton	383,32/m.ton	85,48	
Nitric acid, 56% (100%)	0,813 m. ton	174,70/m.ton	142,03	
Coating agent	0,010 m. ton	44,10/m.ton	0,44	227,95
Other Materials				
Lube oil, chemicals			0,11	
Bagging Materials			7,72	7,83
Utilities				
Electricity	41 kWh	0,055/kWh	2,26	
Steam	0,6 m. ton	1,44/m. ton	0,86	3,12
Labour and staff				
Supervisor	1man/3shifts	3,00/manhour	1,30	
Operators	3men/3shifts	2,00/manhour	2,59	
Maintenance labour	1man/3shifts 2men/day	2,00/manhour	1,44	
Bagging & shipping crew	2men/day	2,00/manhour	0,58	
Helpers	8men/day	1,50/manhour	1,73	
Overhead (40% on labour)			3.06	
		Cost per year		
Staff and Overhead		111.600	5,49	16,19
Maintenance	2.5% on inv.4	107.500	5,29	5,29
Capital Costs				
Average inter. on inv.	4.2% on inv.4	194.250	9,56	-
Depreciation on inv.	10% on inv.4	462.500	22,76	
Interest on Work. Cap.	10% on W. Cap.	10,700	0,58	32,90
Insurance Cost	0,95% on inv.1	40,850	2,01	2,01
Total cost price per metric ton AN (33,5% N), excluding cost of price escalation				295,29

COST PRICE CALCULATION

Tabulation No. 9a

NPK COMPOUND BLENDING AND GRANULATION PLANT PRODUCTION COST EXCLUDING RAW MATERIALS

Investments:

1. Delivery and construction: estimated US \$ 4.300.000(price basis: October 1974)
2. Price escalation: to be added later
3. Pre-operating interest: estimated US \$ 325.000
4. Total excluding price escalation estimated US \$ 4.625.000

Working Capital: estimated US \$ 117.000

Daily capacity: 300 STPD NPK (17-17-17). Stream factor: assumed 80%
357 STPD NPK (average). Stream factor: assumed 80%

Production: 324,0 MTPD x 280 days x 0,80 = 72.576 MTPY (average)
(100,000 x 080 = 80.000 STPY = 72.576 MTPY)

Item	Unit/m. ton	Cost/Unit U.S. \$	Cost/m. ton U.S. \$	Sub-total U.S. \$
Raw materials				
See next pages				
Other Materials				
Lube oil, chemicals			0,11	
Bagging Materials			7,72	7,83
Utilities				
Electricity	44 kWh	0,055/kWh	2,42	
BunkerC fuel oil	0,037 m. ton	127,80/m.ton	4,73	
Steam	0,018 m. ton	88,00/m.ton	1,58	8,73
Labour and Staff				
Supervisor	1man/3shifts	3,00/manhour	0,36	
Operators	4men/3shifts	2,00/manhour	0,97	
Maintenance labour	1man/3shifts 3men/day	2,00/manhour	0,48	
Bagging and shipping crew	3men/day	2,00/manhour	0,24	
Helpers	8men/day	1,50/manhour	0,48	
Overhead (40% on labour)			1,01	
		Cost per Year		
Staff and overhead		111.600	1,54	5,08
Maintenance	2.5% on inv.4	107.500	1,48	1,48
Capital Costs				
Average inter. on inv.	4.2% on inv.4	194.250	2,68	
Depreciation on inv.	10% on inv. 4	462.500	6,37	
Interest on work. cap.	10% on W. Cap.	11.700	0.16	9,21
Insurance cost	0,95% on inv.1	40.850	0,56	0,56
Production cost excluding raw materials and cost of price escalation				32,89

Tabulation No. 9b

COST PRICE CALCULATION
NPK COMPOUND BLENDING AND GRANULATION PLANT
Compounds Proposed By N-Ren

Item	Unit/m. ton	Cost/Unit U. S. $	Cost/m. ton U.S. $	Sub-total U.S.$
NPK (17-17-17)				
Raw Materials				
Ammonia	0,067 m.ton	383,32/m. ton	25,68	
Nitric acid, 56% (100%)	0,272 m.ton	174,70/m. ton	47,52	
Di-amm.-phosphate (18,2-46,8-0)	0,379 m.ton	459/m.ton	173,96	
Muriate of potash(60% K_2O)	0,296 m.ton	139/m.ton	41,14	
Coating agent	0,010 m.ton	44/m.ton	0,44	288,74
Other production costs			32,89	32,89
Total cost price per m. ton NPK (17-17-17) excl. cost of price escalation.				321,63
NPK (16-8-24)				
Raw Materials				
Ammonia	0,085 m.ton	383,32/m. ton	32,58	
Nitric acid, 56%(100%)	0,325 m.ton	174.70/m. ton	56,78	
Di-amm.-phosphate (18,2-46,8-0)	0,179 m.ton	459/m.ton	82,16	
Muriate of potash(60%K_2O)	0,418 m.ton	139/m.ton	58,10	
Coating agent	0,010 m.ton	44/m.ton	0,44	230,06
Other production costs			32,89	32,89
Total cost price per ton NPK (16-8-24) excl. cost of price escalation				262,95

COST PRICE CALCULATION
NPK COMPOUND BLENDING AND GRANULATION PLANT
Compounds proposed by N-Ren

Item	Unit/m. ton	Cost/Unit U. S. $	Cost/m. ton U. S. $	Sub-total US $
NPK (23-11,5-11,5)				
Raw Materials				
Ammonia	0,117m. ton	383,32/m.ton	44,[illegible]	-
Nitric acid ,56% (100%)	0,448m. ton	174,70/m.ton	76,[illegible]	
Di-amm.-phosphate (18,2-46,8-0)	0,246m. ton	459,/m. ton	112,[illegible]	
Muriate of potash (60%K_2O)	0,192m. ton	139,/m. ton	26,69	-
Coating agent	0,010m. ton	44,/m. ton	0,44	263,16
Other production costs			32,89	32,89
Total cost price per metric ton of NPK (23-11,5-11,5) excluding cost of price escalation				296,05
NPK (19,1-9,6-19,2)				
Raw Materials				
Ammonia	0,100m. ton	383,32/m.ton	38,33	
Nitric acid ,56% (100%)	0,384m. ton	174,70/m.ton	67,08	
Di-amm.-phosphate (18,2-46,8-0)	0,212m. ton	459/m.ton	97,31	
Muriate of potash (60%K_2O)	0,329m. ton	139/m. ton	45,73	
Coating agent	0,010m. ton	44/m. ton	[illegible],44	248,89
Other production costs			32,89	32,89
Total cost price per metric ton NPK (19,1-9,6-19,2) excluding cost of price escalation				281,78

Tabulation No. 10

COST PRICE CALCULATION
SUMMARY

Total cost prices per metric ton excluding cost of price escalation on delivery and construction of plant.

	US $
- Ammonia (tabulation No. 6)	383,32
- Nitric acid, 56% strength (100% basis) (tabulation No. 7)	174,70
- Ammonium nitrate (33,5% N) (tabulation No. 8)	295,29
- NPK Compounds (tabulation No. 9a, b, c)	
- grade (17-17-17)	321,63
- grade (16-8-24)	262,95
- grade (23-11,5-11,5)	296,05
- grade (19,1-9,6-19,2)	281,78

COMPARISON ON MARKET PRICES, RAW MATERIALS AND ELECTRICITY

	Prices assumed in N-Ren proposal US $/metric ton	Actually prevailing prices tabulation Nos 5 & 9 US $/metric ton
Raw straight-run naphtha	110,23	More than 216.10 (if available)
Fuel oil No. 2 (Diesel oil)	88,18	183,30
Bunker C fuel oil	88,18	127,80
	US $/kWh	US $/kWh
Electricity	0,021	0,055
	US $/metric ton	US $/metric ton
Mono-ammonium-phosphate (11-48-0)	133,00	208,00 (231,00)
Di-ammonium-phosphate (18,2-46,8-9)	275,52	459,00 (509,87)
Muriate of potash (60% k_2O)	110,23	139,00 (153,77)
Ammonia (Alternative B revised proposal	220,45	assumed 200,00

The figures within the brackets in right column have been quoted according to tabulation No. 5, but in the cost price calculations of tabulation No. 9 ten percent lower prices were used to account for shipment of large lots in bulk from abroad.

Tabulation No. 12

COMPARISON ON MARKET PRICES
ON END-PRODUCTS

	Prices assumed in N-Ren proposal in Liberia US $/metric ton	estimated actually prevailing import prices in Liberia (CIF Monrovia) US $/metric ton
Ammonia	220,46	same
Ammonium Nitrate (33,5% N)	209,44	same
NPK Compound Fertilizers		
Grade (17-17-17)	240,30	202,79
Grade (16-8-24)	225,97	190,70
Grade (23-11,5-11,5)	214,95	181,40
Grade (19,1-9.6-19,2)	233,69	197,21

Tabulation No. 13

ANNUAL PRODUCTION FIGURES

(80% stream factor)

Ammonia for sale	
3.000 x 0,80 = 2.400 short tons =	2,177 metric tons
Ammonium Nitrate (33,5% N)	
28.000 x 0,80 = 22.400 short tons =	20.317 metric tons
NPK Compound Fertilizers	
Grade (17-17-17)	
40.000 x 0,80 = 32.000 short tons =	29.030 metric tons
Grade (16-8-24)	
30.000 x 0,80 = 24.000 short tons =	21.773 metric tons
Grade (23-11,5-11,5)	
15.000 x 0,80 = 12.000 short tons =	10.886 metric tons
Grade (19,1-9,6-19,2)	
15.000 x 0,80 = 12.000 short tons =	10.886 metric tons

Tabulation No. 14

ANNUAL MANUFACTURING COSTS
(excluding cost of price escalation of delivery and construction of plant

&

ANNUAL SALES REVENUES

&

ANNUAL DEFICIT
(80% stream factor)

Annual Manufacturing Costs

			U.S. $
Ammonia	2.177 metric tons @ US $ 383,32	=	834.500*
AN (33,5% N)	20.317 metric tons @ US $ 295,29	=	5,999.400
NPK (17-17-17)	29.030 metric tons @ US $ 321,63	=	9.336.900
NPK (16-8-24)	21.773 metric tons @ US $ 262.95	=	5.725.200
NPK (23-11,5-11,5)	10.886 metric tons @ US $ 296,05	=	3.222.800
NPK (19,1-9,6-19,2)	10,886 metric tons @ US $ 281,78	=	3.067.500
Total		=	28.186.300

Annual Sales Revenues

Ammonia	2.177 metric tons @ US $ 220,46	=	479.900
AN (33,5% N)	20.317 metric tons @ US $ 209,44	=	4.255.200
NPK (17-17-17)	29.030 metric tons @ US $ 202,79	=	5.887.000
NPK (16-8-24)	21.773 metric tons @ US $ 190,70	=	4.152.100
NPK (23-11,5-11,5)	10.886 metric tons @ US $ 181,40	=	1.974.700
NPK (19,1-9,6-19,2)	10.886 metric tons @ US $ 197,21	=	2.146.800
Total		=	18.895.700

Annual Deficit = 9.290.600

* Cost of the light naphtha as specified by N-Ren will increase cost of end-products

4.8, 4.9, 4.10, and 4.11 N-Ren proposal of February 1976

4.8 Minutes of Meeting in Ministry of Agriculture on 18th March 1976.

Participants:

Hon. Louis A. Russ, Minister of Agriculture

Mr. Joshua Cooper, Director, Planning Division, Ministry of Agriculture

Mr. Hilary B. Wilson Sr., General Manager, LDC

Mr. W.C.N. Howard II, Project Manager, LDC

Mr. William T. Diggs, Manager, Project Research and Evaluation Department, LDC

Mr. Browne, Administrative Officer, N-Ren Corporation

Mr. M. Woods, Lawyer, A.B. Tolbert Law Firm

Mr. J. Fogstad, UNIDO Senior Expert, Consultant to LDC

Mr. Karl Kjeldgaard, UNIDO Senior Expert, Consultant to LDC

N-Ren International Ltd., Bermuda had by letter of 12th March 1976 signed by Mr. Martin A. Train, Vice President and addressed to President William R. Tolbert presented a revised proposal of February 1976 on a fertilizer complex from N-Ren Corporation, Cincinnati, Ohio, U.S.A. to the Government of Liberia.

Minister Louis A. Russ had invited two delegates of N-Ren Corporation, Bruxelles, Belgium Mr. Browne, Administrative Officer and Mr. Provine Technical Officer who had arrived Monrovia to a meeting in the Ministry of Agriculture for a preliminary discussion.

Mr. Browne started the meeting by excusing to Minister Russ that regretfully Mr. Provine had had to leave Liberia the evening before in an urgent matter and therefore could not be present at the meeting. Mr. Browne pointed out to Minister Russ that he was not a Technical expert and was not able to answer any technical questions.

Minister Russ handed over the revised proposal as received to LDC as Mr. Browne had no other copy available than his own.

Mr. Browne said that the revised proposal contained two alternatives:

Alternative A: Corresponds to previous proposal with some changes.

1 - 100 STPD Ammopac ammonia plant.
1 - 180 STPD nitric acid plant.
1 - 400 STPD ammonium nitrate and NPK fertilizer complex plant for campaign operation.

Alternative B:

1 - 10.000 ST ammonia storage for import of ammonia.
No Ammopac unit
Other plants as above

Mr. Browne was asked about the industrial references of N-Ren Corporation on the Ammopac ammonia plant design. Mr. Browne explained that N-Ren Corporation owns in joint venture with the U.S. company Cargill six Ammopac units each identical and with a capacity of 100 short tons of ammonia per 24 hours and with natural gas process feedstock and fuel, as follows:

4 Ammopac plants in operation at
Company: Cherokee Nitrogen
Location: Prior, Oklahoma, USA

2 Ammopac plants in operation at
Company: Surprisingly, Mr. Browne did not know the name
Location: Plain View, Texas, USA.

Mr. Browne said that he had visited the plants both in Prior, Oklahoma and in Plain View, Texas during 1972.

Mr. Browne said that Mr. Hamilton, the President and owner of N-Ren Corporation possesses 40% of the share capital of the joint venture, while the remaining 60% is in the hands of Cargill. Mr. Browne did not tell how Cargill had obtained their shares and how much or little they had paid for the shares. As Mr. Browne repeatedly stressed that he was not a technical expert and knew no details, Mr. Browne was not asked how the operation performance and how big the annual ammonia production of the six Ammopac plants of the joint venture actually is.

It shall be mentioned that contrary to the above Ammopac plants in USA all based on natural gas, the Ammopac unit proposed by N-Ren Corporation to Liberia is based upon naphtha. Besides, that the naphtha reforming process is technically a more difficult operation than natural gas operation, and that the naphtha reforming process has during a series of years been covered by the world-wide ICI/Kellogg patents. Provided that these patents are still in force, ammonia plants with naphtha reforming cannot be operated without payment of a large license fee to ICI/Kellogg.

Mr. Browne was, therefore, asked whether N-Ren Corporation could refer to any other Ammopac units in operation, in particular on basis on naphtha. Mr. Browne said that no other Ammopac units existed in operation than the six units in USA.

Mr. Browne said that N-Ren Corporation lately has sold small fertilizer plants all comprising Ammopac units based on naphtha to Sudan, Kenya, and Senegal.

Mr. Browne stated that the plant for Senegal comprises two 100 short ton/day Ammopac units and a urea unit. Mr. Browne was asked why N-Ren for Senegal would not deliver one 200 short ton/day ammonia unit, as even this capacity would be very small compared to modern ammonia plants. Mr. Browne answered that N-Ren Corporation base their offers on standard design and engineering packages as available in their files, and that they have not and are not prepared to work out any other ammonia plant design than the 100 STPD Ammopac package.

Mr. Browne was asked how many people were employed with N-Ren Corporation, whether the order is 10, 100, or several hundreds. Mr. Browne stated that he had no idea on this subject. On the other hand, Mr. Browne stated earlier during the meeting that he had been associated with the N-Ren Corporation since 1972.

Mr. Browne was questioned whether N-Ren Corporation would sub-contract the general engineering, purchasing, inspection of workshops, forwarding, erection, construction, etc. to other sub-contractors under a possible agreement with Liberia. He answered no, N-Ren Corporation would not. If so, N-Ren Corporation would need a staff of several hundred of highly qualified and experienced engineers.

Mr. Browne was asked about the names of the banks which would finance the construction of a possible plant by N-Ren Corporation. M. Browne replied that the financing scheme proposed by N-Ren Corporation was entirely based upon suppliers' credit and that no bank credits would be necessary. This is indeed entirely strange.

Mr. Browne was told that the prices on raw materials are entered in the manufacturing cost estimates in the N-Ren proposal were surprisingly low as compared to the prevailing prices of today. Mr. Browne stated that N-Ren Corporation on basis of international price statistics had assessed the average raw material prices and fertilizer prices over the next twenty years and used these average prices in their manufacturing cost estimates.

Mr. Browne was questioned whether he would be able to submit to-day's prices on the raw materials, since N-Ren Corporation diligently had been capable to assess the average prices over the next twenty years. Mr. Browne replied that how could anyone tell what the prices would be in the two years. Mr. Browne was corrected that he was asked to give today's prices and not the prices in two years. Mr. Browne said, he had no ideas. Furthermore, Mr. Browne was asked whether he would expect the raw material prices of today to be higher or lower than the average prices over the next twenty years. Mr. Browne replied: I have no idea.

Mr. Browne explained that he had recently checked with the Plant Manager of Liberia Refinery Company that the Refinery after installation of extra equipment would be able to deliver the naphtha and fuel oil No. 2 as specified in the N-Ren proposal. Mr. Browne was asked whether he had checked with Liberia Refinery Company what their ex refinery prices on the two raw materials would be. Mr. Browne stated that he had not checked this.

Mr. Browne was told that the capacities on ammonium nitrate and NPK fertilizers of the N-Ren proposal were far beyond what Liberia would be able to consume during the next number of years. Mr. Browne confirmed as stated in the N-Ren proposal that the N-Ren Corporation would be prepared to assist in selling the excess production on the export market. Mr. Browne was asked whether he was in a position to tell the detailed lines and conditions of N-Ren Corporation for assistance in the export sales. Mr. Browne said that he could tell nothing on this subject.

By a slip of the tongue Mr. Browne had earlier during the meeting told that the USA fertilizer broker INTER ORE (same as Occidental Petroleum Corporation) would handle the export sales of the forthcoming N-Ren fertilizer plant in Sudan. As this is their business INTER ORE will need a substantial brokerage fee and be covered for any road transportation, loading, unloading, harbour, freight, and insurance costs. Mr. Browne was asked whether N-Ren Corporation had INTER ORE in mind to deal with the possible export sales from Liberia. Mr. Browne answered that he could tell nothing.

4.9 Financial and contractual terms of N-Ren proposal of February 1976

The financial and contractual terms of the revised proposal must be assumed to be the same as in the previous proposal, except as follows:

4.9.1 Price basis and price escalation

In N-Ren International Ltd.'s letter of 12th March 1976 is quoted:

" Firm price basis as specified in the proposal and we are prepared to maintain such prices for a period of sixty (60) days to allow you and your staff to assess this proposal".

In common trade usage the term "firm price" means that the offered price will remain firm during the whole delivery and construction period.

Obviously, this is not what N-Ren Corporation have in mind. They only mean a firm price unitl signature of agreement provided this would happen prior to 12th May 1976, and that such an agreement would contain a clause for escalation of prices during the delivery and construction period in addition to the offered price. Most probably, N-Ren Corporation may demand the price escalation to be paid cash by the Government of Liberia.

4.9.2 Investments, working capital, financing and interest

Investments, working capital and financing schemes of the two alternatives of the revised N-Ren proposal are given in the attached tabulation No. 15.

It is apparent that the investments and working capital of alternative A amount to US $ 55.388.000 in total (exclusive of price escalation during the delivery and construction period) against US $40.815.000 of the previous proposal. It is noted, as explained later, that the scope of deliveries of alternative A is less than in the previous proposal.

The corresponding total investments and working capital of Alternative B amount US $49.315.000 (exclusive price escalation during the delivery and construction period).

The financing of the investments and working capital will be through debt financing and share capital. Part of the share capital will be owned by N-Ren Corporation through a corresponding discount in the payment of the capital cost, while the remaining share capital will have to be paid up by the Government of Liberia.

The debt financing will be through credits obtained under various European export credit programs, normal commercial credits and contractor's notes.

The debt or loan has to be repaid through 14 uniform, semi-annual payments, beginning 6 months after the commissioning of the plant. Simultaneous with the semi-annual repayments of the principal, the accrued interest must be paid in addition.

It shall be pointed out that commissioning in contracting agreements often means when the construction of the plant and trial-runs of compressors have terminated. It does not necessarily imply that the plant will start-up and full production will be initiated. As a matter of fact, this may be delayed, in particular in developing countries, by many months.

The composite interest rate and fees of the loan will be 9% p.a. accrued semi-annually.

Each of the 14 semi-annual loan repayments will be US $ $2.972.000 for alternative A and US $2,623.000 for alternative B. In addition, for alternative A the semi-annual interest charges to be paid will be US $2.246.000 at first instalment and gradually decrease to US $133.000 at last instalment, while for alternative B they will be US $1.652.000 at first instalment and decrease to US $118.000 at last installment.

In the attached tabulation No. 15 is summarized the commitment of the Government of Liberia on repayments of loan and accrued interest in case of a contract. In addition, the Government of Liberia will have to pay the escalation of prices cash upon presentation of bills. Besides, the Government of Liberia will need to pay and render the tasks and obligations of chapter 4.12.

Alternatively, according to the M-Ren International Ltd. letter of 12th March 1976 the financing of the long term debt could be supplied directly to the Liberian Company by European Government utilizing the export credit insurance programs which are available.

Tabulation NO. 15

INVESTMENTS, WORKING CAPITAL, PRE-OPERATING INTEREST AND FINANCING

	Alternative A US $	Alternative B US $
Investments, working capital, and pre-operating interest:		
Capital cost of plants and facilities	47.600.000	42.000.000
Pre-operating costs	1.500.000	1.500.000
Subtotal	49.100.000	43.500.000
Pre-operating interest	3.528.000	3.115.000
Subtotal	52.628.000	46.615.000
Working capital	3.260.000	2.700.000
Total	55.888.000	49.315.000
Financing		
Equity capital : (25,6%)		
Shares of N-Ren Corporation (30%)	4.284.000	3.780.000
Shares of Government of Liberia (70%)	9.996.000	8.820.000
Total shares (100%)	14.280.000	12.600.000
Total suppliers' loans (74,4%)	41.608.000	36.715.000
Total (100%)	55.888.000	49.315.000
Commitment of Government of Liberia		
Government shares	9.996.000	8.820.000
Total suppliers' loans	41.608.000	36.715.000
Accrued interest on loans	14.409.000	12.390.000
Total, excluding price escalation	66.013.000	57.925.000

4.9.3 Surety guarantee by Government of Liberia

In the N-Ren International Ltd's letter of 12th March 1976 is quoted:

" In order to obtain the financing for this project it will be necessary for Government of Liberia to guarantee the financial portion of the contract price".

4.9.4 N-Ren Corporation's unsatisfactory guarantee and narrow warranties and liabilities.

Like the previous proposal the revised proposal does not give any guaranteed consumption figures as it ought to. The revised proposal lists the expected requirements on naphtha and fuel oil No. 2 for alternative A, which figures are 2,7% and 4.8% lower than the consumption figures used by N-Ren Corporation in their manufacturing cost estimates. But none of these two sets of consumption figures are guaranteed by N-Ren Corporation.

In the revised proposal N-Ren Corporation has not improved the narrow and unacceptable warranties and liability on their behalf.

4.9.5 Naphtha reforming patent infringement

It is emphasized that the naphtha reforming process of alternative A of the revised proposal is a direct violation of the world-wide ICI/Kellogg patents on said patents.

Prior to signing of any contract with N-Ren Corporation it must be checked very carefully whether these patents are still in force and apply to Liberia. If so, the Government of Liberia would be sued unavoidably to pay a large fee to ICI/Kellogg for patent infringement.

At any rate, N-Ren Corporation should be liable to reimburse any such patent infringeme : payment.

The suppliers of the naphtha reforming catalyst must be named by N-Ren Corporation.

If the ICI/Kellogg patents are still in rule ICI/Kellogg, however, cannot for legal reasons and will not present their claim on payment of license fee on their pat nt rights, before the Liberian factory will be in actual operation after the construction and start-up.

4.10 Technical evaluation of N-Ren proposal of February 1976

4.10.1 Process units, capacities and production rates .

The revised N-Ren proposal consists as follows:

Alternative A.

- One Ammopac ammonia plant, similar as previous proposal.
- One nitric acid plant, similar as previous proposal.
- One complex ammonium nitrate and NPK production plant. This plant has been changed from previous proposal and contains less and modified equipment. The prilling section for AN of the previous proposal has been entirely withdrawn. Instead, AN will be produced as granules in equipment which will be common for AN and NPK. The common equipment will comprise AN solution preparation and storage tank, granulator, dryers, bagging, etc.

  Capacity: 400 short tons of either production per 24 hours. At a time the plant will produce either AN or NPK. The products will be produced on a campaign basis. The operation campaign will be on the basis that the product grade changes would be made no more than at two weeks intervals.

  Yearly production at 100% stream factor:

  AN: 25.000 short tons (against 28.000 short tons in previous proposal, as the phosphatic raw material has been changed to MAP in revised proposal from DAP in previous and thus contains less ammonia in proportion to P_2O_5) .

  NPK: As previous proposal

Alternative B.

This alternative contains no Ammopac ammonia plant. Instead ammonia will be imported. A 10.000 short ton atmospheric pressure liquid ammonia terminal and storage, including refrigeration compressors has been foreseen.

The pier or harbour for the tank ship is not included. The rest of the process units of this alternative are identical to the other process units of alternative A.

4.10.2 End-product specificati ns.

Ammonium nitrate:

Grade: Low density

Particles: Granules

Further specification is not apparent from the revised proposal.

NPK Grade: Assumed as previous proposal.

4.10.3 Raw materials specifications.

The following modifications have been introduced in the revised proposal:

Naphtha:

The sulphur content has been reduced to maximum 100 ppm equal to 0,01% by weight from 0,03% in the previous proposal. This means that the naphtha must be delivered predesulphurized from the oil refinery to the plant, implying a higher naphtha price. Otherwise, the naphtha quality has been maintained from the previous proposal.

Phosphate raw material:

The phosphate raw material to be imported for production of the NPK grades has been changed to:

Mono-ammonium-phosphate (11-48-0)

In the previous proposal (di-ammonium phosphate (18,2-46,8-0) was foreseen instead.

4.10.4 Raw material supplies.

It goes without saying that the suppliers and supplies of all the main raw materials such as naphtha, fuel oil No. 2, Bunker C fuel oil, ammonia, mono-ammonium-phosphate (11-48-0), muriate of potash (60% K_2O), coating agent, and bagging materials must be secured at long term delivery, freight, and price agreements before signing of any contract with the contractor.

4.10.5 Climatic and other conditions as design basis.

In the revised proposal certain climatic conditions are given as basis for design of the quoted equipment.

These conditions must be checked and detailed before any signing of a contract.

The maximum relative humidity as envisaged by N-Ren Corporation at 69% seems very low to Liberian conditions. Probably, the cooling water tower installations will have to be enlarged considerably and be more expensive as compared to the previous and revised proposals.

Besides, the make-up water analysis as assumed by N-Ren Corporation for the design of the boiler feed water preparation system and for the operation of the cooling water system must be checked very carefully prior to signing of any contract.

4.10.6 Design codes.

The design codes as assumed by N-Ren Corporation are given in broad terms in the revised proposal, but they must be given in details and be checked by the Liberian authorities prior to any signing of a contract.

4.10.7 Off-site facilities

Alternative A.

Essentially, the scope of deliveries under alternatives A of the revised proposal seems to be, apart from minor modifications, to be the same as in the previous proposal.

As previously mentioned, the adequacy of the cooling water towers and the boiler feed water preparation unit must be checked carefully on basis on the prevailing conditions in Liberia before signing of any contract.

An electric power station is still included in the bid as it ought to be.

The electric generator sets in the revised proposal have gas turbine engines, but it must be assumed that the raw materials will be diesel gas oil or fuel oil No. 2. This must be checked carefully before signing of any contract.

Alternative B.

In spite of the fact that this alternative does not include any ammonia plant, it comprises the cooling tower installation, water recovery boiler, boiler feed water preparation system, electric power station and instrument and plant air system at the same specifications and capacities as alternative A.

This is indeed very strange as the need of the liquid ammonia terminal, storage, and refrigerating compressors on these facilities evidently are lower than for a complete ammonia plant. This question must be checked cautiously and in details before signing of any contract.

On the other hand, the specifications of alternative B do not list any raw materials and bulk storage buildings or any bagging and bagged storage building as these buildings are required for this alternative like alternative A where they are specified. It must be assumed that the omission of these buildings from alternative B must be due to a typing error. This point should, of course, be checked carefully before signing of any contract.

With respect to the atmospheric pressure liquid ammonia terminal, storage and refrigerating compressors the adequacy must be checked carefully and be strictly in accordance with the possibilities for import of ammonia before signing of any contract. Also, the adequacy of these installations under the climatic conditions of Liberia must be checked before signing of any contract. It is noted that the capacity figures given in the present specification do not all agree.

4.11 Economic evaluation of N-Ren proposal of February 1976

4.11.1 Investments.

The investment figures of alternatives A and B are subtracted the estimated cost of the electric power station for the calculation of the cost price of the products, as no consumption figures for the electric power station are given in the revised proposal. They were neither stated in the previous proposal.

For the cost price calculations, the figures on investment, pre-operating interest, and working capital as listed in the attached tabulation No. 16 will be used.

4.11.2 Raw material and utility prices.

Raw material and utility prices have been used in the economic evaluation of the revised proposal along the same lines as explained in chapter 4.7.3.

With respect to alternative B an import price of US $ 200,00 per metric ton on ammonia has been anticipated rather than US $ 200,00 per short ton equal to US $ 220,45 per metric ton as applied in the N-Ren proposal. The operating cost of the ammonia terminal and atmospheric storage tank has not been taken into account. The discount of US $20,45 per metric ton as used in the present evaluation means an annual amount of US $ 0.5 million in favour of alternative B of the revised proposal.

4.11.3 Labour and staff.

Same calculating principles as outlined in chapter 4.7.4 and in the revised proposal will be applied for the cost price calculations.

4.11.4 Stream days, stream factor, and annual production.

Same stream factor of 80% as in the chapter 4.7.5 will be used in the cost price calculations.

The annual production figures at a stream factor of 80% are given in the attached tabulation No. 25.

4.11.5 Maintenance.

Same calculation principles as given in chapter 4.7.6 will be used.

4.11.6 Insurance.

As in chapter 4.7.7

4.11.7 Capital cost.

An average interest of 3,7% p.a. accrued once a year has been used in the cost price calculations. This average interest over 10 years corresponds to the 9% p.a. interest rate accrued semi-annually over 7 years which will be charged on the long term debt according to the revised proposal.

Straight-line depreciation over 10 years of the total investments is applied in the cost price calculations for the revised proposal as in the cost price calculations for the previous proposal.

It is pointed out that N-Ren Corporation in the revised proposal has envisaged straight line depreciation over 14 years of 85% only of the investments, whereas they used straight-line depreciation over 10 years of 100% of the investments in the previous proposal.

Interest rate on working capital has been maintained at 10% p.a. accrued once a year as in chapter 4.7.8

4.11.8 Cost price calculations.

Confer the attached tabulation Nos. 17, 18, 19, 20a, b, and c, 21, 22, 23, 24.

4.11.9 Market prices on end-products.

As in chapter 4.7.10.

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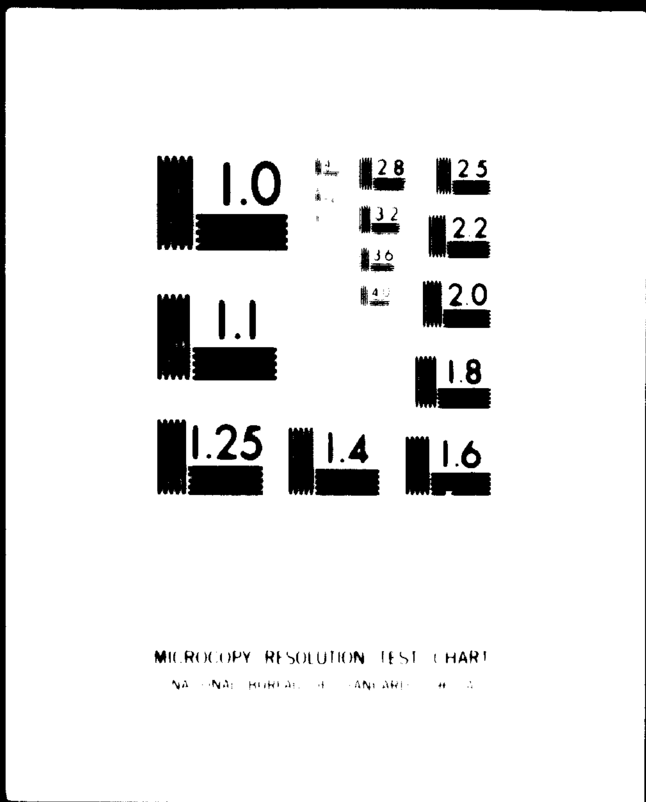

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4.11.10 Annual manufacturing costs, annual sales revenues, and annual deficit.

The attached tabulations Nos. 26 and 27 give the annual manufacturing costs, the annual sales revenues, and annual deficit at a stream of 80%.

As it can be seen from these tabulations, the annual deficit would be US $ 6,3 million for alternative A and US $ 3,3 million for Alternative B of the revised proposal.

The smaller deficit of alternative B of the revised proposal as compared to the previous proposal, even though this had a lower capital cost due to its earlier price basis, is mainly because of the use of the cheaper mono-ammonium-phosphate in replacement of di-ammonium-phosphate envisaged in the previous proposal as phosphatic raw material.

As regards the annual deficit, the same remarks as stated in chapter 4.7.11 are applicable. In particular, it shall be repeated that the above amounts do not include all the losses, which would be much more serious and larger for a Liberian fertilizer factory.

Tabulation No. 16

INVESTMENTS AND WORKING CAPITAL
N-REN PROPOSAL OF FEBRUARY 1976
Price Basis: March 1976

	Alternative A US $	Alternative B US $
Total Complex		
Investments and pre-operating costs	49.100.000	43.500.000
Pre-operating interest	3.528.000	3.115.000
Working capital	3.260.000	2.700.000
Total	55.888.000	49.315.000
Electric power station (estimated)		
Investments and pre-operating costs	5.000.000	5.000.000
Pre-operating interest	400.000	400.000
Working capital	100.000	100.000
Total	5.500.000	5.500.000
All process plants and other battery limit facilities (balance)		
Investments and pre-operating costs	44.100.000	38.500.000
Pre-operating interest	3.128.000	2.715.000
Working capital	3.160.000	2.600.000
Total	50.388.000	43.815.000

VARIABLE COST PRICE CALCULATION
AMMONIA PLANT

Daily Capacity: 100 STPD ammonia. Stream factor: assumed 80%
Production: 90,7 MTPD x 340 days x 0,80 = 24.670 MTPY

Item	Unit/m. ton	Cost/Unit U.S. $	Cost/m.ton U.S. $	Sub-total US $
ALTERNATIVE A				
Raw materials				
Naphtha	0,55m. ton	227,40/m.ton*	125,07	-
Fuel oil No. 2	0,50m. ton	183,30/m.ton	91,65	216,72
Other materials				
Catalysts			[illegible]	-
Lube oil & chemicals			[illegible]	1,30
Utilities				
Electricity	794 kWh	0,055/kWh	43,67	-
Cooling water (circulating)	350 m^3	0,004/m^3	1,20	-
Boiler feed water	1,5 m^3	0,33/m^3	[illegible]	45,36
Labour and staff				
Supervisor	1 man/3 shifts	3,00/manhour	1,07	-
Operators	3 men/3 shifts	2,00/manhour	2,13	-
Maintenance labour	2 men/3 shifts 3 men/day	2,00/manhour	1,42	-
Overhead (40% on labour)			1,35	-
		Cost per Year		
Staff and 40% overhead		148,800	6,04	12,51
Variable cost price				275,89

* Cost of light naphtha as specified by N-Ren will be higher

Tabulation No. 18

VARIABLE COST PRICE CALCULATION
NITRATE ACID PLANT

Daily Capacity: 180 STPD HNO_3 (100%), stream factor: assumed 80%

Production: 163,3 MTPD x 310 days x 0,80 = 40.498 MTPY

Item	Unit/m. ton	Cost/Unit U.S. $	Cost/m. ton U.S. $	Sub-total U.S. $
ALTERNATIVE A:				
Raw material				
Ammonia	0,292 m. ton	275,89/m. ton	80,56	80,56
Other material				
Catalyst	0,0054 Troy oz	310,00/Troy oz	1,68	1,68
Utilities				
Electricity	5 kWh	0,055/kWh	0,28	
Naphtha as fuel	0,016 m. ton	227,40/m. ton	3,64	-
Cooling water (circulating)	$111 m^3$	$0,004/m^3$	0,44	
Boiler feed water	0,70 m. ton	$0,33/m^3$	0,23	4,59
Labour and staff				
Supervisor	1 man/3 shifts	3,00/manhour	0,65	
Operator	1 man/3 shifts	2,00/manhour	0,43	-
Maintenance labour	1 man/3 shifts 1 man/day	2,00/manhour	0,58	
Overhead (40% on labour)		-	0,66	
		Cost per Year		
Staff and Overhead		93.000	2,30	4,62
Variable cost price				91.45
ALTERNATIVE B				
Raw Material				
Ammonia imported	0,292 m. ton	200,00/ m. ton	58,40	58,40
Other Variable Costs(as above)				10,89
Variable cost price				69,29

Tabulation No. 19

VARIABLE COST PRICE CALCULATION AMMONIUM NITRATE PRODUCTION

Daily Capacity: 400 STPD (33,5% N). Stream Factor: Assumed 80%

Production: 362,8 MTPD x (280 days x 0,22) x 0,80 = 18.144 MTPY

Item	Unit/m. ton	Cost/Unit U.S. $	Cost/m. ton U. S. $	Sub-total U.S.$
Alternative A.				
Raw materials				
Ammonia	0,223 m.ton	275,89/m. ton	61,52	
Nitric acid, 56% (100%)	0,813 m.ton	91,45/m. ton	74,35	
Coating agent	0,010 m.ton	44,10/m. ton	0,44	136,31
Other Materials				
Lube oil, chemicals			0,11	
Bagging materials			7,72	7,83
Utilities				
Electricity	41 kWh	0,055/kWh	2,26	
Steam	0,6 m. ton	1,44/m.ton	0,86	3,12
Labour and staff				
Supervisor	1man/3shifts	3,00/manhour	0,32	
Operators	4men/3shifts	2,00/manhour	0,86	
Maintenance Labour	1man/3shifts 3men/day	2,00/manhour	0,43	
Bagging & ship. crew	3men/day	2,00/manhour	0,22	
Helpers	8men/day	1,50/manhour	1,29	
Overhead (40% on labour)			1,25	
		Cost per year		
Staff and overhead		223.200	2,45	6,82
Variable cost price				154,08
Alternative B.				
Raw materials				
Ammonia	0,223 m.ton	200,00/m. ton	44,60	
Nitric acid	0,813 m.ton	69,29/m. ton	56,33	
Coating agent	0,010 m.ton	44,10/m. ton	0,44	101,37
Other variable costs (as above)			17,77	17,77
Variable cost price				119,14

VARIABLE COST PRICE CALCULATION
NPK PRODUCTION

4. 98
Tabulation No.20a

Daily capacity: 400 STPD (as 17-17-17). Stream factor: assumed 80%
461,3 STPD (average). Stream factor: assumed 80%

Production: 418,5 MTPD x (280 days x 0,73) x 0,80 = 72,867 MTPD (average)
(100.400 x 0,80 = 80.320 STPY = 72.867 MTPD)

Item	Unit/m. ton U.S. $	Cost/Unit U.S. $	Cost/m. ton U.S. $	Sub-total U.S.$
Alternative A, Grade (17-17-17)				
Ammonia	0,081 m.ton	275,89/m. ton	22,35	
Nitric acid, 56% (100%)	0,313 m.ton	91,45/m. ton	28,62	
Mono-amm.-phosphate (11-48-0)	0,361 m.ton	208,00/m. ton	75,09	
Muriate of potash(60%K_2O)	0,289 m.ton	139,00/m. ton	40,17	
Coating agent	0,010 m.ton	44,00/m. ton	0,44	166,67
Other materials				
Lube oil, chemicals			0,11	
Bagging materials			7,72	7,83
Utilities				
Electricity	44 kWh	0,055/kWh	2,42	
Bunker C fuel oil	0,037 m.ton	127,80/m. ton	4,73	
Steam	0,018 m.ton	88,00/m. ton	1,58	8,73
Labour and staff				
Supervisor	1man/3shifts	3,00/manhour	0,28	
Operators	4men/3shifts	2,00/manhour	0,75	
Maintenance labour	1man/3shifts 3men/day	2,00/manhour	0,38	
Bagging and ship. crew	3men/day	2,00/manhour	0,19	
Helpers	8men/day	1,50/manhour	1,12	
Overhead (40% on labour)			1,09	
		Cost per year		
Staff and overhead		223,200	2,45	6,26
Variable cost price				189,49

VARIABLE COST PRICE CALCULATION NPK PRODUCTION   Tabula. No. 20b

Item	Unit/m. ton	Cost/Unit U.S. $	Cost/m. ton U.S. $	Sub-total U.S. $
Alternative A.				
Grade (16-8-24)				
Raw materials				
Ammonia	0,088 m.ton	275,8[illegible]/m. ton	24,28	
Nitric acid, 56% (100%)	0,339 m.ton	91,45/m. ton	31,00	
Mono-amm.-phosphate (11-48-0)	0,170 m.ton	208,00/m. ton	35,26	
Muriate of potash(60% K_2O)	0,408 m.ton	139,00/m. ton	56,71	
Coating agent	0,010 m.ton	44,00/m. ton	0,44	147,79
Other variable costs (as above)			22,82	22,82
Variable cost price				170,61
Grade (23-11,5-11,5)				
Raw materials				
Ammonia	0,127 m.ton	275,8[illegible]/m. ton	35,04	
Nitric acid, 56% (100%)	0,489 m.ton	91,45/m. ton	44,72	
Mono-amm.-phosphate (11-48-0)	0,234 m.ton	208,00/m. ton	48,67	
Muriate of potash(60% K_2O)	0,187 m.ton	139,00/m. ton	25,99	
Coating agent	0,010 m.ton	44,00/m. ton	0,44	154,86
Other variable costs (as above)			22,82	22,82
Variable cost price				177,68
Grade (18-9-18)				
Raw materials				
Ammonia	0,100 m.ton	275,[illegible]/m. ton	27,59	
Nitric acid 56%(100%)	0,391 m.ton	91,[illegible]/m. ton	35,76	
Mono-amm.-phosphate (11-48-0)	0,197 m.ton	208,00/m. ton	40,98	
Muriate of potash(60% K_2O)	0,314 m.ton	139,00/m. ton	43,65	
Coating agent	0,010 m.ton	44,[illegible]/m. ton	0,44	148,42
Other variable costs (as above)			22,82	22,82
Variable cost price				171,24

Tabulation No. 20c

VARIABLE COST PRICE CALCULATION
NPK PRODUCTION

Item	Unit/m. ton	Cost/Unit U.S. $	Cost/m. ton U.S. $	Sub-total U.S. $
ALTERNATIVE B				
Grade (17-17-17)				
Raw materials				
Ammonia	0,081 m. ton	200,00/m. ton	16,[illegible]	
Nitric acid ,56% (100%)	0,313 m. ton	69,29/m. ton	21,69	
Other raw materials (see above)			115,70	153,59
Other variable cost (see above)			22,82	22,82
Variable cost price				176,41
Grade (16-8-24)				
Raw Materials				
Ammonia	0,088 m. ton	200,00/m. ton	17,60	
Nitric acid ,56% (100%)	0,339 m. ton	69,29/m. ton	23,49	
Other raw materials (see above)			92,51	133,60
Other variable cost (see above)			22,82	22,82
Variable cost price				156,42
Grade (23-11,5-11,5)				
Raw Materials				
Ammonia	0,127 m. ton	200,00/m. ton	25,40	
Nitric acid ,56% (100%)	0,489 m. ton	69,29/m. ton	33,88	
Other raw materials (see above)			75,10	134,38
Other variable costs (see above)			22,82	22,82
Variable cost price				157,20
Grade (13-9-18)				
Raw materials				
Ammonia	0,100 m. ton	200,00/m. ton	20,00	
Nitric acid ,56% (100%)	0,391 m. ton	69,29/m. ton	27,09	
Other raw materials (see above)			85,07	132,16
Other variable costs (see above)			22,82	22,82
Variable cost price				154,98

Tabulation No. 21

FIXED COST PRICE CALCULATION
ALTERNATIVE I
Total Plant, excluding electric power station

Investments (Price basis March 1976)

1. Delivery and construction: US $ 44.100.000
2. Price escalation: To be added later
3. Pre-operating interest: US $ 3.128.000
4. Total, excluding price escalation: US $ 47.228.000

Working Capital: US $ 3.160.000

Production:

AN (33,5% N)	18.144 MTPY	
NPK	72.867 MTPY	
Total	91.011 MTPY	

Item	Charge	Cost/year US $	Cost/m. ton US $	Subtotal US $
Maintenance	2,5% on inv. 1	1.102.500	12,11	12,11
Capital Costs				
Average int. on inv.	3,7% on inv. 4	1.747.500	19,20	-
Depreciation on inv.	10% on inv. 4	4.722.800	51,89	.
Interest on Work. Cap.	10% on W. cap.	316.000	3,47	74,56
Insurance Cost	0,95% on inv.1	419.000	4,60	4,60
Fixed cost price, excluding escalation				91,27

Tabulation No. 22

FIXED COST PRICE CALCULATION
ALTERNATIVE B
Total Plant excluding electric power station

Investments: (price basis March 1976)

1. Delivery and construction: US $ 38.500.000
2. Price escalation : To be added later
3. Pre-operating interest: US $ 2.715.000
4. Total, excluding price escalation US $ 41.215.000

Working Capital: US $ 2.600.000

Production :

AN (33,5% N)	18.144 MTPY	
NPK	72.867 MTPY	
Total	91.011 MTPY	

Item	Charge	Cost/year US $	Cost/m.ton US $	Subtotal US $
Maintenance	2,5% on inv. 1	962.500	10,58	10,58
Capital costs				
Average int. on inv.	3,7% on inv. 4	1,525.000	16,76	
Depreciation on inv.	10% on inv. 4	4,121.500	45,29	
Interest on work. cap.	10% on W. cap.	271.500	2,98	65,03
Insurance Cost	0,95% on inv. 1	365.800	4,02	4,02
Fixed cost price, excluding cost of price escalation				79,63

Tabulation No 23

TOTAL COST PRICE CALCULATION
ALTERNATIVE A
(Excluding cost of price escalation)

	Cost per metric ton US $
Ammonia for sale	
Variable cost price	275,89
Fixed cost price	not allocated
Total	275,89
Ammonium Nitrate (33,5% N)	
Variable cost price	154,08
Fixed cost price	91,27
Total	245,35
NPK (17-17-17)	
Variable cost price	189,49
Fixed cost price	91,27
Total	280,76
NPK (16-8-24)	
Variable cost price	170,61
Fixed cost price	91,27
Total	261.88
NPK (23-11,5-11,5)	
Variable cost price	177,68
Fixed cost price	91,27
Total	268,95
NPK (18-9-18)	
Variable cost price	171,24
Fixed cost price	91,29
Total	262,51

Tabulation No. 24

TOTAL COST PRICE CALCULATION
ALTERNATIVE B
(Excluding cost of price escalation)

	Cost per ton US $
Ammonia for sale	
Import price	200.00
Variable costs of storage	not allocated
Fixed costs of storage	not allocated
Total	200.00
Ammonium Nitrate (33.5% N)	
Variable cost price	119.14
Fixed cost price	79.63
Total	198.77
NPK (17-17-17)	
Variable cost price	176.41
Fixed cost price	79.63
Total	256.04
NPK (16-8-24)	
Variable cost price	156.42
Fixed cost price	79.63
Total	236.05
NPK (23-11.5-11.5)	
Variable cost price	157.20
Fixed cost price	79.63
Total	236.83
NPK (18-9-18)	
Variable cost price	154.98
Fixed cost price	79.63
Total	234.61

Tabulation No. 25

ANNUAL PRODUCTION FIGURES
(80% stream factor)

Ammonia for sale

3.000 x 0,80 = 2.400 short tons — 2,177 metric tons

Ammonium Nitrate

25.000 x 0,80 = 20.000 short tons — 18,144 metric tons

NPK Compound Fertilizers:

Grade (17-17-17)

40.000 x 0,80 = 32.000 short tons — 29,030 metric tons

Grade (16-8-24)

30,000 x 0,80 = 24.000 short tons — 21,773 metric tons

Grade (23-11.5-11.5)

15.200 x 0,80 = 12.160 short tons — 11,032 metric tons

Grade (18-9-18)

15.200 x 0,80 = 12.160 short tons — 11,032 metric tons

Tabulation No. 26

ALTERNATIVE A
ANNUAL MANUFACTURING COSTS
(excluding cost of price escalation of delivery and construction of plant)
&
ANNUAL SALES REVENUES &
ANNUAL DEFICIT
(80% stream factor)

Annual Manufacturing Costs

			U.S. $
Ammonia:	2.177 metric tons	@ US $ 275,89	= 600.600*
AN (33,5% N)	18.144 metric tons	@ US $ 245,35	= 4.451.600
NPK (17-17-17)	29.030 metric tons	@ US $ 280,76	= 8.150.500
NPK (16-8-24)	21.773 metric tons	@ US $ 261,88	= 5.701.900
NPK (23-11,5-11,5)	11.032 metric tons	@ US $ 268,95	= 2.967.100
NPK (18-9-18)	11.032 metric tons	@ US $ 262,51	= 2.896.000
Total			= 24.767.700

Annual Sales Revenues

			U.S. $
Ammonia	2.177 metric tons	@ US $ 220,46	= 479.900
AN (33,5% N)	18.144 metric tons	@ US $ 209,44	= 3.800.100
NPK (17-17-17)	29.030 metric tons	@ US $ 202,79	= 5.887.000
NPK (16-8-24)	21.773 metric tons	@ US $ 190,70	= 4.152.100
NPK (23-11,5-11,5)	11.032 metric tons	@ US $ 181.40	= 2.001.200
NPK (18-9-18)	11.032 metric tons	@ US $ 197.21	= 2.175.600
Total			= 18.495.900

Annual Decifit = 6.271.800

* Cost of light naphtha as specified by N-Ren will increase cost of end-product.

Tabulation No. 27

ALTERNATIVE B
ANNUAL MANUFACTURING COSTS
(excluding cost of price escalation of delivery and construction of plant)

&

ANNUAL SALES REVENUES &
ANNUAL DECIFIT
(80% stream factor)

Annual Manufacturing Costs

			U.S. $
Ammonia	2.177 metric tons @ US $ 200,00	=	435.400
AN (33,5% N)	18.144 metric tons @ US $ 198,77	=	3,606.500
NPK (17-17-17)	29.030 metric tons @ US $ 256,04	=	7.432.800
NPK (16-8-24)	21.773 metric tons @ US $ 236,05	=	5,139.500
NPK (23-11,5-11,5)	11.032 metric tons @ US $ 236,83	=	2.612.700
NPK (18-9-18)	11.032 metric tons @ US $ 234,61	=	2.588.200
Total		=	21.815.100

Annual Sales Revenues

Ammonia	2.177 metric tons @ US $ 220,46	=	479.900
AN (33,5% N)	18.144 metric tons @ US $ 209,44	=	3.800.100
NPK (17-17-17)	29.030 Metric tons @ US $ 202,79	=	5.887.000
NPK (16-8-24)	21.773 metric tons @ US $ 190,70	=	4.152.100
NPK (23-11,5-11,5)	11,032 metric tons @ US $ 181,40	=	2,001.200
NPK (18-9-18)	11.032 metric tons @ US $ 197,21	=	2.175.600
Total			18.495.900

Annual Decifit = 3.319.200

4.12 Site of plant, off-sites, harbour facilities, and further obligations of Government of Liberia.

The proposals and quotations submitted by N-Ren Corporation comprise the packaged process units and facilities and certain construction elements for buildings within the battery limit of the plant site.

Further materials, services, construction works, etc. within battery limits and which are not the explicit responsibility of N-Ren Corporation according to their proposal will have to be provided and paid by the Government of Liberia. All tie-ins, facilities, materials, etc. as required outside the battery limit as necessitated in order to make the plant able and ready to operate must be provided and paid by the Government of Liberia.

All these extra materials, services, works, supplies, etc. will have to be paid in addition to the monetary obligation of the Government of Liberia under a possible contract with N-Ren Corporation. There is no doubt that all these extra charges will have to be paid cash by the Government of Liberia, and in view of the character and terms of a possible contract with N-Ren Corporation as suggested in their proposal these extra charges and commitments can hardly be financed by any banks or international funds.

A non-exclusive list of the extra tasks and commitments to be provided and paid by the Government of Liberia is given below:

- Procure all necessary priorities, allocations, and allotments for materials and operating equipment, and all licenses and permits, including building permits, required by Governmental or regulatory authorities in connection with the supply, erection and operation of the plant.

- Site area, which shall be clear and solid with a permissible bearing load of 3.000 lbs per sq.ft. Any piling shall be paid by Government of Liberia. Any obstructions to overground or underground pipes, cables, foundations, etc. such as rocks, etc. must be removed at Government's expense and responsibility.

- Site levelling (if necessary), topographical maps, soil examination, proper bench marks, elevations and lines for location of plant, and stake out and install monuments locating the battery limit lines.

- Flooding protection of site from rivers and neighbouring areas.

- Adequate, adjacent site of solid ground for unloading, moving and storage of materials and operating equipment and temporary buildings during construction perios.

- Railroad siding at grade of plant, within 100 yards of battery limit and from nearest ocean harbour and allow N-Ren to unload all materials and operating equipment therefrom.

- Parking area adjacent to battery limits for use of N-Ren subcontractors' employees during construction period.

- Furnish and maintain all times a clear, solid roadway or roadways connecting battery limits, storage area and parking area with a main public highway.

- Keep areas adjacent to battery limits and between buildings and construction site and between storage area and construction site clear so as not to hamper or delay N-Ren's work.

- Furnish a site for disposal of spoil within 0,5 miles from battery limits.

- Furnish at battery limits all necessary fill in excess of that excavated by N-Ren as requested by N-Ren.

- Supply drinking water at battery limits.

- Furnish for construction purposes water and electricity all in sufficient quantities and of proper character, at the battery limits.

- Furnish and install whatever permanent fire-fighting equipment Purchaser deems necessary for the plant.

- Furnish water in adequate quantity and under sufficient pressure for fire-fighting during construction, provide N-Ren with fire-fighting assistance within the construction area of plant, and provide watchmen if required by Purchaser.

- Furnish all materials and operating equipment and do all works outside the battery limits of plant and connect at battery limits all piping built by N-Ren. This shall include service lines for water, naphtha, steam, fuel oil, fuel gas, flaring, and sewers. Furnish and install all machinery devices and shut-off valves required or desired in such lines.

- Furnish all utilities in sufficient quantities and of proper character as and when required for the testing of operating equipment and for operation of plant.

- Supply and install raw water tank and softened water tank within battery limits.

- Supply and install raw water pumps and water line to battery limits of plant. It is estimated that to service the water utilities of plant approximately 700 US gallons of water per minute as make-up will be required. It is expected that Government safeguards to supply this water in a continuous and reliable manner, as the plant cannot be run without a safe water supply.

- Supply and install necessary sub-station, including breakers, starters, necessary transformers and necessary conduit lines outside battery limits.

- Supply to battery limit of plant all indigenous materials like cement, gravel, sheets, bricks, windows, doors, asphalt, wood, reinforcement iron (?), etc. for construction of foundations, buildings, etc. within battery limits of plant.

- Supply and pay the salaries and wages of all indigenous personnel and labour as required for construction of the battery limit plant, or to hire and pay local contractors to do such work.

- Furnish all necessary charging stock, catalysts, (including platinum), chemicals, lubricants and supplies required for the starting and operating of the plant in quantities and of the kind and quality necessary, and which do not contain impurities in such quantities as to interfere with the proper operation of the plant, and the equipment required to introduce such charging stock, catalysts, chemicals, lubricants, and supplies into the plant. According to the previous proposal, the initial catalysts and chemicals will be delivered by N-Ren. This is not reaffirmed in the revised proposal.

- Furnish all spare parts as recommended by N-Ren.
- Furnish furnitures and equipment of offices.
- Furnish all laboratory equipment as recommended by N-Ren.
- Furnish inert nitrogen system.
- Furnish all maintenance and safety equipment as recommended by N-Ren. All machinery, equipment, tools, etc. for mechanical, electrical, and instrument workshops will be at Government's expense.
- Tie-in all rainwater canals from battery limit of plant .
- Tie-in all liquid effluent sewers, including sanitary sewer at battery limit of plant.
- Furnish and install any sewage water treatment plant to handle the chemical and sanitary water effluents of plant, if required.
- Furnish and install any hot water installation as may be convenient in any buildings in addition to the administration building and the change house.
- Build housing, facilities, school, etc. for personnel and workers of plant.
- Employ and pay indigenous personnel and workers for operation, maintenance, etc. of plant prior to start-up.

- Training of personnel and workers.
- Employ and pay consultants and service staff to represent and handle Government's tasks and obligations during construction and initial operation period.
- Furnish external telephone and telex communications lines of plant.
- Furnish and install internal telephone system of plant.
- Furnish micro-wave communication system of plant.
- Furnish and install pipes and pumps or furnish vehicles for transportation of naphtha and fuel oils from Liberia Refinery Company to the plant.
- Furnish and install extra fractionating unit in Liberian Oil Refinery.
- Furnish or reserve ocean harbour and unloading and storing facilities and transportation vehicles for the import of the phosphatic and potassic raw materials through the harbour to the plant site.
- In case of Alternative B, provide or reserve a ocean harbour pier or quay for liquid ammonia tanker ship. The distance from the ship to the ammonia storage tank of the plant is envisaged by N-Ren to be 4.000 ft. in pipe length. If distance will be different, this will call for modification in the supplies of N-Ren on the ammonia terminal equipment.
- Furnish or reserve ocean harbour site, including stores and loading facilities and road transportation vehicles for the export of NPK compound fertilizer.
- Install a separate and new ocean harbour, including stores and loading facilities and transportation vehicles, all complying with the "US Coast Guard Regulations" for the export of ammonium nitrate (33,5% N) which is
- Furnish rolling stock of plant

- classified as an explosive and cannot be passed through a harbour serving other ships and commodities.
- Provide and build central and local stores, transportation vehicles and employ personnel and workers for marketing and distribution of the end-products in Liberia.
- Liberian farmers' credit schemes for purchase of fertilizers.

4.13 Export of ammonium nitrate and fertilizers from Liberia.

It is very important to know that the export sales of a fertilizer plant of Liberia is bound to take place at lower ex factory prices than can be obtained on the fertilizers sold to the domestic market.

In case that a duty-free import of fertilizers will be maintained in Liberia, the factory will have to compete on equal terms on the domestic market with the CIF Monrovia prices of the import agents of foreign fertilizer houses.

Likewise, a Liberian factory will have to sell on any export market at prices which are not higher than the prices of the competitors in the respective areas. As in Liberia, agents importing from the large foreign fertilizer suppliers will be active in these areas.

Most fertilizers on the export markets are sold through agents from European and U.S. companies, which beside fertilizers are manufacturing many other products for the agriculture, etc. Consequently, the import agents of said companies are not dependent only on the sales of fertilizers, but benefit as well as from the marketing of many other commodities. Usually, any such agent represents one or a few international companies and are not free to join business with other exporting companies, in particular not if they are competitors to the principals of the agents.

Consequently, a Liberian factory will have to establish its own sales channels on the export market and must be prepared to offer higher commission fees to the import agents than the international chemical houses, because a Liberian factory will merely be able to deliver ammonium nitrate and NPK compound fertilizers.

Besides, a Liberian factory may need to get disposed of the products all over the year, while the international dealers may have available large storages and be capable to withhold their products and ship at intervals as may be most suitable and economic to the export markets.

Because the fertilizer consumption of most African countries is modest, a Liberian fertilizer plant would need to export to many countries, and the freight costs will depend upon the distances from Liberia to the export markets.

It is noted that Exchem-West African Explosives and Chemicals Ltd. at Charlesville covers nearly all the market on explosives in the West African countries. This means that the export market on ammonium nitrate from Liberia must be found in more distantly placed countries in Africa, which will add to the freight and marketing costs and reduce the ex factory price correspondingly. Such export could only be made to countries which do dispose of their own explosive manufacturing, blending, and preparation facilities

At present Exchem, Charlesville is importing in the order of 12.000 metric tons of ammonium nitrate (33,5% N) per year and the domestic market on NPK compound fertilizers is less than 10.000 metric tons per year.

This means that at a stream factor of 80% a Liberian factory as proposed by N-ren Corporation would need to export in the order of 6.000 metric tons of ammonium nitrate (33,5% N) per year and in the order of 63.000 metric tons of NPK grades per year in addition to its sales to the domestic market at its present consumption.

In retrospect of the above, the ex factory prices for the export markets will need to cover allowances for harbour, loading, freight, insurance, and unloading costs and relatively largecommission fees to the import agents abroad.

These allowances may very well amount to say US $ 50-70 per metric ton or more at the actual conditions of the world market, meaning US $ 3,5-4,8 million per year or more at the annual export sales rate given above.

It is added that the export of most fertilizers nowadays from the industrial countries is ruled by the marketing and price conditions of a few marketing cartels, which counts nearly all the big fertilizer manufacturers of the countries such as USA, Western Europe, and Japan.

It goes without saying that a small Liberian fertilizer factory which again depends upon phosphatic and potassic raw materials possibly being controlled by these cartels might be exposed to a serious competition on the export markets from the cartels, in particular as their factories run at much lower manufacturing costs and have less marketing costs.

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DATE: 13th August 1976

TERMINAL REPORT
REPORT PART 5

ANNEX TO REPORT PARTS 1 AND 4

FEASIBILITY STUDY AND ASSESSMENT OF A CHEMICAL COMPLEX, CONSISTING OF AN AMMONIA PLANT, A NITRIC ACID AND AMMONIUM NITRATE PLANT, AND A NPK COMPOUND BLENDING AND GRANULATION PLANT AS PROPOSED BY N-REN CORPORATION, AND OUTLINE OF NORMAL PROCEDURES FOR TENDERING, DELIVERY, CONSTRUCTION, AND INITIAL OPERATION OF A FERTILIZER PLANT.

LIBERIA

(IS/LIR/74/012)

by

Karl Kjeldgaard,

expert of the United Nations Industrial Development Organization acting as Executing Agency for the United Nations Development Programme

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Attached:

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(Nos. of tabulations are a continuation of the series of nos. of the tabulations of Report Part 4).

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Cash flow and capital investment requirements by Government of Liberia 5.25

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Cash flow and capital investment requirements by Government of Liberia 5.27

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5.1 Summary, conclusion, and recommendations

5.1.1 Cash flow calculations have been made in the present report, which show that the Government of Liberia at realization of the fertilizer plant proposed by N-Ren Corporation would have to render and reimburse the capital investment requirements in the order of:

US $ 70 million in Alternative A,

and in the order of:

US $ 60 million in Alternative B,

during the two years of delivery and construction period and the subsequent seven years of operation.

These reimbursements would comprise the pay-up of the Government shares and the deficits of the plant during repayment of the suppliers' loan and accrued interest because of the insufficiency of the revenue at sale of the end-products at competitive prices as compared to the sum of variable operation costs (excl. fixed costs), maintenance cost and insurance cost.

Since the Government is conditioned to sign a surety guarantee on the financial portion of the price of a possible contract with N-Ren Corporation, the Government would not be able to release itself of the obligation of paying the deficits of the plant operation at any time for instance through declaring the fertilizer company bankrupt.

Only after the seven years of loan repayments the fertilizer plant would be able to operate at a profit, however all too small to regain the above payments by the Government before the obselescence and wear-out of the plant. Besides, the N-Ren Corporation would have a 30% right of such belated profits in view of 30% of the share capital being the possession of the N-Ren Corporation through their modest retainment of 8% from the contract price.

In simple words, this means that the Government would have to invest US $ 60 - 70 million in order to get a fertilizer plant to sell its products at competitive prices, as compared to the alternative of continuing to import the products at the same prices and invest nothing. This latter alternative must be regarded as the reasonable one to pursue.

Alternative A constitutes a fertilizer plant including an ammonia plant, while Alternative B has no ammonia plant, but imports ammonia from abroad.

The above deficits are based upon reduced prices on naphtha and Diesel gasoil from Liberia Refining Company as expected to be granted by the President's Price Commission to the fertilizer plant as a major consumer.

The above deficits have been based upon a stream factor of 35% during the first year, a stream factor of 70% during the second year, and a stream factor of 80% during the third and subsequent years of operation in accordance with the recommendations of UNIDO/FAO/IBRD (World Bank) for a fertilizer plant in a developing country.

The above deficits and obligatory payments by Government do not include site purchase and site preparation, off-sites, auxiliary deliveries, etc., selling, general and administrative expenses, waste of raw materials during operation upsets, any abnormal equipment replacements or repair costs, etc.

5.1.2 Due to the present small consumption of fertilizers and an expected slow growth during the next years in Liberia, most of the production would have to be exported to neighbouring countries at competitive prices. Even at such prices, it may be doubtful and difficult to find adequate market outlets in neighbouring countries. At any rate, such an export of the production would have to be studied, planned, and organized carefully and in details in advance.

5.1.3 It is normal practice of industry and highly recommended that the establishment and operation of a fertilizer plant is secured in advance by long term agreements on the supplies, specifications, prices, and shipment of all the raw materials and combustibles.

It is warned against relying upon short term or spot deliveries even if the prices may be low sometimes, but not necessarily always, since such deliveries may not constantly be available, and any failure in any of these deliveries will mean a complete stand-still of the fertilizer plant.

5.1.4 The total annual manufacturing cost and annual deficit calculations of Report Part 4 were based upon a stream factor of 80%, upon the higher prices on naphtha and Diesel gasoil originally quoted by Liberia Refining Company, and/ simultaneously, upon a too optimistic appraisal of the electricity cost. These calculations have been repeated on the same basis in the calculations of Case 1 of the present report.

In the calculations of Case 2 of the present report the total annual manufacturing cost and annual deficit for a stream factor of 80% have been found at the reduced prices of naphtha and Diesel gasoil from LRC expected to be granted by the President's Price Commission and at a correct entering of the electricity cost of the necessary electric power station of the plant.

In Case 2 and Case 1, but not in Report Part 4 an allowance of US $ 1,6 million have been deducted from the sales prices of present level of c.i.f., Monrovia to cover handling, freight, and insurance costs and import dealers' fees at the export of NPK fertilizers.

The annual deficits of Case 2 (80% stream factor) as corrected in the above manners are still very substantial.

The Cases 3,4, and 5 calculations of the present report are based upon the same assumptions as Case 2, except that the stream factor is varied at 70%, 35%, and 100%, respectively.

In all the Cases 1,2,3,4 and 5 the fixed and variable manufacturing costs have been included. Straight-line depreciation over 10 years, 3,7% p.a. average interest on investments, and 10% p.a. interest on working capital have been assumed. However, the fixed costs of site, off-sites, etc, selling costs, etc. as given under above item 5.1.1. are not included.

The calculated annual deficits are as follows:

Case	Stream factor	Annual deficit in million US $	
		Alternative A	Alternative B
4	35%	9,2	8,0
3	70%	7,7	6,6
2	80%	7,3	6,2
(1)	(80%)	(7,9)	(5,1)
5	100%	4,5	3,4

5.1.5 The total manufacturing costs, sales revenues, and annual deficit of Case 2 (80% stream factor) are detailed below:

Alternative A		Million US $
Fixed manufacturing costs.		
Depreciation and interest		7,54
Maintenance		1,23
Insurance		0,46
Subtotal		9,23
Variable manufacturing costs.		
Naphtha :		
14.373 metric tons at US$	165,00 =	2,37
Fuel oil No.2 (Diesel gasoil):		
20.139 metric tons at US$	135,00 =	2,72
Bunker C fuel oil:		
2.695 metric tons at US$	127,80 =	0,34
Mono-amm-phosphate:		
18.934 metric tons at US$	208,00 =	3,94
Muriate of potash:		
22.798 metric tons at US$	139,00 =	3,17
Labour and staff:		1,38
Other variable costs:		1,06
Subtotal		14,98
Total manufacturing costs		24,21
Sales revenues		
93.188 metric tons at US$ (average minus export allow. - price)	181,04 =	16,87
Annual deficit		7,34

Alternative B			Million US $
Fixed manufacturing costs.			
Depreciation and interest			6,66
Maintenance			1,09
Insurance			0,41
	Subtotal		8,16
Variable manufacturing costs.			
Ammonia :			
24.944 metric tons at US$		200,00 =	4,98
Naphtha :			
654 metric tons at US$		165,00 =	0,11
Diesel gasoil :			
1.329 metric tons at US$		135,00 =	0,18
Bunker C fuel oil :			
2.695 metric tons at US$		127,80 =	0,34
Mono-amm-phosphate:			
18.934 metric tons at US$		208,00 =	3,94
Muriate of potash:			
22.798 metric tons at US$		139,00 =	3,17
Labour and staff:			1,22
Other variable costs:			0,99
	Subtotal		14,93
Total manufacturing costs			23,09
Sales revenues			
93.188 metric tons at US$		181,04 =	16,87
Average minus export allow. -price			
Annual deficit			6,22

As apparent from the above figures, the fertilizer project of either Alternative A or Alternative B could only be feasible, if a combination of adequate savings in fixed costs and the raw materials costs on naphtha, Diesel gasoil, Bunker C fuel oil, mono-ammonium-phosphate, and muriate of potash and higher end-product sales prices could be achieved Lower prices, even much lower prices of two or three of the raw materials would not by far be enough.

5.1.6 It is recommended and it is normal practice of the industry to establish fertilizer plants on careful planning and competitive bidding.

In the chapters 5.4, 5.5 and 5.6 the normal actions for the establishment of a fertilizer plant, the tender papers for the bidding, and the names of some possible suppliers of small fertilizer plants are stated.

It is pointed out that competitive bidding may not be obtained on small fertilizer plants nowadays, unless it is verified in advance that the project concerned will be feasible and realized.

5.1.7 Minutes of the last meetings on 12th and 14th July 1976 in the Ministry of Agriculture with representatives of N-Ren Corporation are given in chapter 5.2

5.2 Meetings on 12th and 14th July 1976 in the Ministry of Agriculture with N-Ren Corporation and N-Ren letter of 13th July 1976.

Participants in meeting on 12th July 1976:

From Ministry of Agriculture:

Hon. Louis A. Russ, Minister of Agriculture.

Dr. Patrick Bropleh, Deputy Minister of Agriculture.

Mr. Joshua Cooper, Director, Planning Division.

From N-Ren Corporation:

Mr. Martin A. Train, Executive Vice President.

Mr. Jean Lariviere, Process Coordinator.

Mr. Sheikh Almoody, Advisor.

From The Liberian Development Corporation:

Mr. Hilary B. Wilson, Sr., General Manager.

Mr. William T. Diggs, Sr., Manager of Project Research and Evaluation Division.

Mr. Karl Kjeldgaard, UNIDO Expert.

From A.B. Tolbert Law Firm:

Mr. A.B. Tolbert, Lawyer and Agent of N-Ren Corporation.

Mr. Jusu Wood, Lawyer.

Participants in meeting on 14th July 1976:

Same persons as above, except that Hon. Louis A. Russ, Minister of Agriculture had been prevented from coming, and Mr. A.B. Tolbert was not present, but replaced by Mr. Abraham L. James, Lawyer.

Minister Russ declared at the start of the meeting on 12th July 1976 as follows:

- That the Government of Liberia was concerned that the domestic market would not become big enough during the next many years to consume the production of the proposed fertilizer plant, so that a substantial portion of the production would have to be exported
- That the Government of Liberia was concerned that the proposed plant would not be competitive and able to operate at manufacturing costs below the competitive market prices on the products.

Mr. Train answered that the fertilizer prices on the world market went up and down. The prices had been very high 1 - 2 years ago and were at present relatively low. Mr. Train stated that N-Ren Corporation would be prepared to establish and finance at a certain interest charge an equalizing fund for the valleys and tops of the market prices. The fund would reimburse the production losses of the proposed fertilizer plant during valleys of the market and would be repaid by the plant during tops of the market.

Minister Russ said that the operation and conditions of such a fund would have to be studied in all its implications and details, and he asked Mr. Train that N-Ren Corporation should present its offer and conditions on the equalizing fund in writing to the Ministry of Agriculture.

Regarding the manufacturing costs, Mr. Train suggested that the Liberia Refining Company might produce naphtha in excess of the domestic market on gasoline, thus implying that LRC might be prepared to sell naphtha at a low price to the proposed fertilizer plant both for process feedstock and fuel, rather then have to export the excess naphtha at high shipment costs and consequently low ex-refinery price to clients abroad. In fact, if the fertilizer plant could be supplied with cheap naphtha, the manufacturing costs would decrease appreciably for Alternative A.

Minister Russ handed over a copy of the Report Part 4 worked out by Mr. Karl Kjeldgaard to Mr. Train of N-Ren Corporation and asked him to submit the written, objective comments of N-Ren Corporatinn without any subjective remarks for a next meeting in the Ministry of Agriculture within the next couple of days.

For the next meeting on 14th July 1976 N-Ren Corporation had prepared their letter of 13th July 1976 addressed to Hon. Louis N. Russ M. Russ, Minister of Agriculture, Minister of Agriculture, where N-Ren Corporation are stating their comments on the Report Part 4 by Mr. Karl Kjeldgaard.

This letter contains the following two clarifications on the extent of the revised N-Ren quotation and proposal:

- The price quoted includes all work within the battery limits, such as indigeneous building materials, civil engineering works and salaries of local personnel, but is exclusive of site preparation.

- The price quoted is fixed.

  Mr. Train supplemented during the meeting, that this meant that the price would be fixed during the whole delivery and construction period. No price escalation would be demanded by N-Ren Corporation during the two years of delivery and construction period.

Mr. Train stated that N-Ren Corporation would airmail at the latest 23rd July 1976 from Bruxelles their additional comments on the Report Part 4 and on the project as a whole, to the Ministry of Agriculture.

Mr. Wilson reminded and asked Mr. Train that this forthcoming letter ought to include, as follows:

- Terms and interest on equalizing fund for valleys and tops of market.
- Guarantee on export marketing through an offer in writing.

Besides, Mr. Kjeldgaard asked Mr. Train that N-Ren Corporation would submit to the Ministry of Agriculture, as follows:

- Synopsis of contract terms as suggested by N-Ren Corporation.
- Consumption of Diesel gasoil of the Diesel motors driving the electric generators, which are included in the N-Ren proposal and must be regarded as a necessary and integrated utility unit of a fertilizer plant in a developing country.
- Statements and specifications of primary reformer, naphtha reforming process and instrumentation, naphtha reforming catalyst, design naphtha (design naphtha specification must correspond exactly to the specification of the naphtha to be supplied by LRC or alternative source), and patent impingement clause on the naphtha reforming process.

Definitely, the previous Girdler reformer design with two rows only of wall burners, as indicated on the process flow diagram no. S-3 in the revised N-Ren proposal book of February 1976 and the N-Ren article "Realizing the potential of the small ammonia plant" in Nitrogen, March/April 1976, which was distributed to the meeting participants on 12th July 1976 by Mr. Martin A. Train, is unsatisfactory and should not be accepted for naphtha reforming.

- Possibly, quote an alternative ammonia plant, based on 30 - 35 Kg/cm^{2}g. reforming pressure, no injection of quench water to gas preparation train, and a hot pot wash instead of a Girbotol - MEA wash for CO_2 removal, involving a 20-30% decrease in consumption of naphtha plus fuel oil no. 2 to the primary reformer

- Possibly, replace the Girdler ammonia synthesis converter internals and pancake electric start-up heater with Topsoe-TVA ammonia synthesis converter internals and built-in electric start-up heater.

- Specifications and limits on all gaseous, aqueous, and dust effluents of plant and specification of pollution abatement in nitric acid plant, and complex plant.

- Besides, Mr. Train was invited to provide, following his allegations as brought forward during the meetings and in the N-Ren letter of 13th July 1976, any written quotations from suppliers on long term deliveries of naphtha, Diesel gasoil, MAP, and muriate of potash at substantially lower prices than presently available to LDC and used as basis in the Report Part 4 and the present report.

5.3 Revaluation of Revised N-Ren proposal of February 1976.

5.3.1 Cash flow and capital investment requirements by Government of Liberia.

A revaluation of the revised N-Ren proposal of February 1976 has been carried out in order to establish the cash flow and capital investment requirements by the Government of Liberia, if the proposed fertilizer plant would be built.

The capital investment requirements by the Government will comprise the pay-up of the Government shares and the cost of site, site preparation, off-sites, auxiliary deliveries, etc. during the pre-operation period and the reimbursements of the deficits of the plant during the first seven years of operation, when the suppliers' loan shall be repaid.

It is recalled that the Government of Liberia is conditioned to sign a surety guarantee on the financial portion of the price of a possible contract with N-Ren Corporatoon according to the N-Ren letter of 12th March 1976 to President William R. Tolbert, and therefore the Government would have to reimburse any outstanding and due payments.

These deficits have been calculated as the fifference between the sum of the loan repayment and accrued interest, variable operation costs (excl. fixed costs), maintenance cost, and insurance cost and the sum of the revenues or prices from the sales of products.

The cash flow and capital investment requirements by the Government are shown in the enclosed tabulations nos. 28 and 29 for Alternative A and Alternative B, respectively of the revised N-Ren proposal.

According to these tabulations the Government would have to pay in total in the order of:

US $ 70 million in Alternative A,

and in the order of:

US $ 60 million in Alternative B,

during the two years of delivery and construction period and the subsequent first seven years of operation.

Only after the full repayment of the suppliers' loan, the plant will be able to operate at a profit, however all too little to recover the above payments before the plant will get obsolete or worn out.

The repayment and interest schedule of the tabulations nos. 28 and 29 have been copied from the N-Rum proposal book, while the figures on variable costs, maintenance costs, insurance costs and sales revenues have been taken from and are calculated in the enclosed tabulations nos. 35-42 for Alternative A and tabulations nos. 48-55 for Alternative B.

5.1.2 Stream factors

In compliance with the recommendations by UNIDO/FAO/IBRD for developing countries, the cash flow calculations have been based upon the following stream factors:

	Percentage production of daily design capacity through 340 days a year.
1st. year	35%
2nd. year	70%
3rd. and subsequent 4 years	80%

5.3.3 Recalculation of manufacturing cost factors from specific values into annual amounts.

In the enclosed tabulations nos. 30-34 for Alternative A and tabulations nos. 43-47 for Alternative B the total annual manufacturing costs and the annual deficits have been calculated for Case 1 on basis of the same raw material prices, fertilizer sales prices, and other assumptions as in Report Part 4, chapter 4.11 regarding Economic evaluation of the revised N-Ren proposal of February 1976.

In Report Part 4 the specific manufacturing costs of the products are given in US $ per metric ton, and the various variable cost factors such as raw materials, utilities, and labour and staff are entered on a unit cost basis in the calculations. Thus, the annual amounts of the various variable cost factors are not apparent from Report Part 4.

On the contrary, the purpose of the new calculations in tabulations nos. 30-34 and 43-47 has been to calculate the annual amounts of both the fixed costs and the variable costs in order to see the proportion in which each cost factor enters in annual amount in the total annual manufacturing cost.

Logically, the annual manufacturing costs as found in the latter calculations of Case 1 as apparent from tabulation no. 33 for Alternative A and tabulation no. 46 for Alternative B are equal to the figures of tabulation no. 26 and tabulation no. 27, respectively of Report Part 4.

In the sales revenues of Case 1 an allowance of US $ 25 per metric ton for harbour, loading, freight, insurance, and unloading costs and fees to import agents on an estimated quantity of 65.000 metric tons of end-products for export, corresponding to US $ 1,6 million is foreseen, and therefore, the annual deficits of Case 1 as apparent from the enclosed tabulations nos. 34 and 47 are US$ 1,6 million higher than in the tabulations nos. 26 and 27 of Report Part 4.

5.3.4 Prices on naphtha, Diesel gasoil, and Bunker C fuel oil.

It is recalled that the manufacturing cost estimates of the revised N-Ren proposal are based upon unrealistically low prices on combustibles, at least as compared to the ex-refinery prices of Liberia Refining Company (LRC). The N-Ren prices are, as follows:

- Naphtha : US$ 100,00/short ton,
  equal to US$ 110,23/metric ton.
- Fuel oil No.2 (Diesel gasoil) : US$ 80,00/short ton,
  equal to US$ 88,18/metric ton.
- Bunker C fuel oil : US$ 80,00/short ton,
  equal to US$ 88,18/metric ton.

However, in the enclosed tabulations nos. 30-34 and 43-47 mentioned above, like in Report Part 4, the following prices on the combustibles have been applied:

- Naphtha (predesulphurized) : US$ 227,40/metric ton
- Fuel oil No.2 (Diesel gas oil): US$ 183,30/metric ton
- Bunker C fuel oil : US$ 127,80/metric ton

These prices (excl. duty) were quoted by Liberia Refining Company in January 1976 during visits and discussions at the refinery. By LDC letter of 23rd February 1976 LRC was asked to reconfirm these prices at earliest convenience. First by letter of 16th April 1976 LRC wrote to LDC that the proposed fertilizer company might be allowed reduced price from the refinery depending upon negotiations with the President's Pricing Commission.

At the time of receipt of the latter letter it was conceived that the anticipated reduction of the prices on naphtha and Diesel gasoil from LRC, although appreciable in annual amount, would still be all too small to turn the fertilizer project into a viable and feasible plant.

Meanwhile, in order to check upon the possible saving in the cost of naphtha, Diesel gasoil and Bunker C fuel oil from LRC the writer had a meeting on 15th July 1976 with Mr. Gerald Padmore, Deputy Minister of Finance and, upon Mr. Padmore's suggestion, subsequent meetings on 15th, 16th, and 28th July 1976 with Mr. James E. Hay, Resident Manager, Whinney Murray & Co. Monrovia, who is in charge, on behalf of the Ministry of Finance, of the development of prices of the direct supplies from LRC to the enterprises classified as major consumers, taking into consideration the volumes, the market prices and the contribution made to the economy by such major consumers.

Mr. Hay has developed the following prices on the above assumptions:

- Naphtha : US$ 165/metric ton
- Fuel oil No.2 (Diesel gasoil) US$ 135/metric ton
- Bunker C fuel oil : US$ 127/metric ton

These prices have been confirmed to LRC by the Ministry of Finance by a letter of August 2, 1976.

As apparent, the Bunker C fuel oil price has not been decreased, as the volume to be consumed by the fertilizer plant will be too small to permit a price benefit.

During the meeting on July 12, 1976 in the Ministry of Agriculture Mr. Martin A. Train anticipated that Liberia Refining Company might produce naphtha in excess of the needs of the domestic market and, thus had to export the surplus naphtha at low prices to distant clients abroad. This question has been checked on 13th July 1976 with LRC. At present LRC does not produce or have to produce a surplus of naphtha. Reference is made to a memorandum of 14th July 1976, which the writer of the present report has submitted to Mr. Hilary B. Wilson, Sr., General Manager of LDC on this matter.

With respect to the suggestion by N-Ren Corporation to consider whether cheap naphtha may be available through import from abroad, it is warned against basing the fertilizer project on short term deliveries at low spot prices from the world market. Only supplies based on long term contracts ought to be considered.

Besides, it is emphasized that the naphtha quality is restricted to be "straight-run" for the fertilizer project and must be approved in advance by the supplier of the naphtha reforming catalyst of the plant, because any other naphtha qualities as cracked naphtha, etc. are not suitable to the naphtha reforming process and might lead to serious operating troubles.

5.3.5 Prices on imported mono-ammonium-phosphate, muriate of phosphate, and ammonia and on finished products.

The manufacturing cost estimates as given in the revised N-Ren proposal are based upon low raw material fertilizer prices, as follows:

- Mono-amm-phosphate : US$ 133,00/short ton,
- equal to : US$ 146,60/metric ton.
- Muriate of potash : US$ 86,00/short ton,
  equal to : US$ 94,80/metric ton.

The prices on all materials as applied in the manufacturing cost calculations of Report Part 4 and the present report are defined and listed in chapters 4.7.10 and 4.11.2 and tabulations Nos. 11 and 12 of Report Part 4.

As described, the prices on imported mono-ammonium-phosphate and muriate of potash and the prorated sales prices on NPK fertilizers as applied in Report Part 4 have been based upon a Quotation of 7th April 1976 received by LDC from ULRC., Monrovia on supplies at c.i.f. Monrovia prices from BASF, West Germany. For the calculations, the MAP and KCl prices are reduced by 10% in order to consider shipment in larger lots than the lots of 50 - 100 metric tons as envisaged in the ULRC/BASF quotation. No such reduction has been applied for the NPK fertilizers.

The MAP and KCl raw material prices used in Report Part 4 are repeatedly used in the manufacturing cost calculations of the present report, as follows:

- Mono-amm.-phosphate: US$ 208,00/metric ton
- Muriate of potash : US$ 139,00/metric ton

Referring to Report Part 3, alternative sources for MAP and KCl to BASF may be considered and examined, but in view of the Europe Fertilizer Cartel it may be doubtful that substantially lower prices can be obtained on these raw materials from other sources in West Europe than BASF at present.

The price of US$ 200/metric ton on imported raw material ammonia for Alternative B as applied in Report Part 4 and the present report is 10% lower than the price of US$ 200/short ton = US$ 220,46/metric ton as applied in the N-Ren proposal.

In Report Part 4 and the present report the sales prices on ammonia for the rubber plantations and on ammonium nitrate for the explosives industry have been assumed the same as in the N-Ren proposal, namely US$ 220,46/metric ton and US$ 209,44/metric ton, respectively.

The prorated sales prices c.i.f., Monrovia on NPK fertilizers based on the ULRC/BASF quotation as entered in the sales revenues calculations of Report Part 4 and the present report are in average US$ 198,48/metric tons and are 10% lower than the average sales price on NPK fertilizers of US$ 200/short ton = US$ 220,46/metric ton as supposed in the revised N-Ren proposal of February 1976.

It is true that the fertilizer prices were much higher (around US$ 350/metric ton) on the world market during 1973 - 1975 as compared to the present level of about US$ 180 - 200/metric ton, c.i.f., Monrovia. Undoubtedly, the drastic price peak during 1973 - 1975 was caused by enormous purchases of fertilizers on the world market by USSR and China. In the meantime, the construction has been completed and the operation started of around 25 - 30 large fertilizer plants, each with a yearly capacity in the order of 400.000 - 1.000.000 metric ton in USSR, China, and elsewhere, or in the order of 150-250 times the capacity of the present N-Ren project.

Therefore, the fertilizer prices on the world market may show stability during the forthcoming years or a slow escalation in possible reflection of any increases in the raw material prices on crude oil, rock phosphate, muriate of potash, etc.

5.3.6 Total annual manufacturing costs and annual deficits.

In the enclosed annual manufacturing cost and annual deficit calculations Nos. 35 - 36 and Nos. 48 - 49 for Alternative A and Alternative B, respectively on Case 2 the reduced prices on combustibles from LRC (see above chapter 5.3.4) have been entered in replacement of the original LRC prices of Case 1 and Report Part 4. The stream factors is 80% in Case 2 as in Case 1 and Report Part 4.

At the same time, the Case 2 calculations have been based upon the full investment prices of the N-Ren proposal and corresponding higher fixed manufacturing costs, and the Diesel gasoil consumption of the Diesel motor driven electric generators have been estimated at 0,32 metric ton/1.000 KWH consumed corresponding to a Diesel gasoil cost of US$ 0,043 per KWH consumed at a Diesel gasoil price of US$ 135,00/metric ton, rather than subtracting an estimated investment cost of US$ 5,5 million, lower the fixed manufacturing costs accordingly, and enter the total electricity cost at the price of US$ 0,055/KWH of Liberia Electricity Corporation to industrial consumers as done in Case 1 and Report Part 4.

Although this was specifically requested during the meeting on July 14, 1976 in the Ministry of Agriculture, N-Ren Corporation have not so far advised the Diesel gasoil consumption of the electric power station, which is included in the in the N-Ren proposal, and which must be an integrated unit of a fertilizer plant in a developing country in order to avoid frequent shut-downs due to power failures. The above Diesel gasoil consumption figure of 0,32 metric ton/1.000 KWH has kindly been estimated by the technical management of the electric generating station of Liberia Electricity Corporation in Monrovia.

In spite of the reduced prices of combustibles the annual deficits of Case 2 in Alternative A have been decreased by merely US$ 0,6 million and have even been increased by US$ 1,0 million in Alternative B as compared to Case 1 and Report Part 4 because the correct adjustment on manufacturing cost of the electric power station adds to the total manufacturing cost. It is noted that the electric power station of Alternative B as proposed by M-Ren Corporation is too big, corresponding to an estimated excess of US$ 0,6 million in fixed manufacturing costs.

The annual sales revenues of Case 2 are identical to Case 1 (see above chapter 5.3.3).

In the enclosed calculations Nos. 37 - 42 for Alternative A and nos. 50 - 55 for Alternative B the total annual manufacturing costs, annual sales revenues, and annual deficits have been recalculated by prorating the figures of Case 2 (80% stream factor) for the stream factors 70%, 35%, and 100% for Cases 3,4 and 5, respectively.

A summary of the annual deficits as calculated in dependence of the stream factor is given below:

Case	Stream factor	Annual deficit, in million US$	
		Alternative A	Alternative B
4	35%	9,2	8,0
3	70%	7,7	6,6
2	80%	7,3	6,2
(1)	(80%)	(7,9)	(5,1)
5	100%	4,5	3,4

Except for the differences explained above, the fixed manufacturing cost calculations of Case 1 and Report Part 4, Case 2, Case 3, Case 4, and Case 5 have been made on the same basic conditions, as follows:

- Maintenance:

  2,5% p.a. on investments.
  This rate is modest and is likely to be bigger, in particular during the first years of operation and in a developing country.

- Average interest:

  3,7% p.a. on investment, corresponding to the interest charge on the suppliers' loan of the N-Ren proposal, prorated over 10 years.

- Depreciation:

  10% p.a. on investments.
  This rate ought to be fixed from the point of view of business risk, rather than expected equipment life or taxation rules.

- Interest on working capital:

  10% p.a.

- Insurance of plant:

  0,99% p.a. on investment as in the N-Ren proposal.
  A higher premium of say 2% p.a. or more might be more in line with the reality depending upon the insurance coverage wanted and the higher risk of shut-downs and repairs in a developing country.

It is noted that the annual deficits of neither Report Part 4 nor the present report take into account the selling, general and administrative expenses of US$ 1,1 million per year as assumed in the revised N-Ren proposal.

Moreover, in order to avoid to have to build a special harbour for export of AN (33,5% N) a smaller quantity will have to be produced of this product in accordance with the consumption of the Liberian explosives factory, and correspondingly more NPK fertilizers will have to be produced and exported at the stream factors of 70% - 100%. As the production and sale of NPK fertilizers is resulting in an even higher loss than AN (33,5% N), this will mean somewhat higher annual deficits than given above.

In addition, the above annual deficits as calculated do not include the substantial capital cost of site purchase, site preparation, off-sites, auxiliary deliveries, etc.

Besides, the above annual deficits do not take into account any wastes of raw materials and utilities during operation upsets and shut-downs, which may occur frequently during the first years of operation in a developing country.

ALTERNATIVE A

CASH FLOW AND CAPITAL INVESTMENT REQUIREMENTS BY GOVERNMENT OF LIBERIA

Figures are given in million US $

Investments and financing (see Report Part 4, Tabulation no. 15)

Battery limit plant	49,100
Pre-operating interest	3,520
Working capital	3,260
Total	55,880
Share capital	14,280
Suppliers' loan	41,600
Site, off-sites, etc.	not evaluated

Cash flow and payments by Government of Liberia.

2 years' period of delivery and construction of plant.

	Payments Government - Returns
Government shares (70 % of share capital)	9,996
Site, off-sites, etc.	Returns

Operation period.

Suppliers' loan			Manufacturing costs				Total revenues	Payments Government - Returns
Instalment	Interest	Total	Variable costs	Maintenance	Insurance	Total		
1st year	(35 % stream factor - Case 4)							
5,944	3,984	9,928	7,329	1,228	0,467	9,024	7,318	11,571
2nd year	(70% stream factor - Case 3)							
5,944	3,075	9,019	13,278	1,288	0,467	14,973	14,762	9,230

- Continued

Tabulation no. 28, continued.

Suppliers' loan			Manufacturing Costs				Sales revenues	Payments by Government - Deficits
Instalment	Interest	Total	Variable costs	Mainte-nance	Insurance	Total		
3rd year	(80% stream factor - Case 2)							
5,944	2,540	8,484	14,977	1,228	0,467	16,672	16,871	8,285
4th year	(80% stream factor - Case 2)							
5,944	2,005	7,949	14,977	1,228	0,467	16,672	16,871	7,750
5th year	(80% stream factor - Case 2)							
5,944	1,470	7,414	14,977	1,228	0,467	16,672	16,871	7,215
6th year	(80% stream factor - Case 2)							
5,944	0,935	6,879	14,977	1,228	0,467	16,672	16,871	6,680
7th year	(80% stream factor - Case 2)							
5,944	0,400	6,344	14,977	1,228	0,467	16,672	16,871	6,145
(41,608)	(14,409)	(56,017)						Profits
8th year	(100% stream factor* - Case 5)							
-	-	-	18,376	1,228	0,467	20,071	23,120	3,049

* 100% stream factor is given in order to illustrate the modest profit at end of loan repayment period, even if full capacity during the calendar year would be achieved. However, a stream factor beyond 80% even after 5-10 years of operation may not be attainable in a developing country.

Tabulation no. 22

ALTERNATIVE B

CASH FLOW AND CAPITAL INVESTMENT REQUIREMENTS BY GOVERNMENT OF LIBERIA

Figures are given in Million US $

Investments and financing. (see Report Part 4, Tabulation no. 15)

Battery limit plant	43,500
Pre-operating interest	3,115
Working capital	2,700
Total	49,315
Share capital	12,600
Suppliers' loan	36,715
Site, off-sites, etc.	Not evaluated

Cash flow and payments by Government of Liberia.

2 years' period of delivery and construction of plant.

	Payments to Government
Government shares (70% of share capital)	8,820
Site, off-site, etc.	accrual

Operation period.

Suppliers' loan			Manufacturing Costs				Sales revenue	Payments to Government
Instalment	Interest	Total	Variable costs	Maintenance	Insurance	Total		
1st year	(35% stream factor - Case 4)							
5,245	3,186	8,431	7,219	1,088	0,413	8,720	7,381	9,770
2nd year	(70% stream factor - Case 5)							
5,245	2,714	7,959	13,219	1,088	0,413	14,720	14,762	7,917

- Continued

Suppliers' loan			Manufacturing Costs				Sales revenues	Payments by Government - Deficits
Instalments	Interest	Total	Variable	Mainte-nance	Insurance	Total		
3rd year	(80% stream factor - Case 2)							
5,245	2,242	7,487	14,933	1,000	0,413	16,434	16,871	7,050
4th year	(80% stream factor - Case 2)							
5,245	1,770	7,015	14,933	1,000	0,413	16,434	16,871	6,578
5th year	(80% stream factor - Case 2)							
5,245	1,298	6,543	14,933	1,000	0,413	16,434	16,871	6,106
6th year	(80% stream factor - Case 2)							
5,245	0,826	6,071	14,933	1,000	0,413	16,434	16,871	5,634
7th year	(80% stream factor - Case 2)							
5,245	0,354	5,599	14,933	1,000	0,413	16,434	16,871	5,162
(36,715)	(12,390)	(49,105)						
8th year	(100% stream factor* - Case B)							Profits
-	-	-	18,362	1,000	0,413	19,863	23,120	3,257

* 100% stream factor is given in order to illustrate the modest profit at end of loan repayment period, even if full capacity during the calendar year would be achieved. However, a stream factor beyond 80% even after 5 - 10 years of operation may not be attainable in a developing country.

Tabulation no. 30

ALTERNATIVE A
BREAK-DOWN OF TOTAL ANNUAL PRODUCTION
(80% Stream Factor)

			Metric tons
Ammonia			
For sale			2.177
For nitric acid	:	0,292 x 40.925 =	11.950
For AN (33,5% N)	:	0,223 x 18.144 =	4.046
For NPK (17-17-17)	:	0,081 x 29.030 =	2.351
Pro NPK (16-8-24)	:	0,088 x 21.773 =	1.916
For NPK (23-11,5-11,5)	:	0,127 x 11.032 =	1.401
For NPK (18-9-18)	:	0,100 x 11.032 =	1.103
		Total	24.944
Nitric acid			
For AN (33,5% N)	:	0,813 x 18.144 =	14.751
For NPK (17-17-17)	:	0,313 x 29.030 =	9.086
For NPK (16-8-24)	:	0,339 x 21.733 =	7.381
For NPK (23-11,5-11,5)	:	0,489 x 11.032 =	5.396
For NPK (18-9-18)	:	0,391 x 11,032 =	4.313
		Total	40.925
AN (33,5% N)			18.144
NPK (17-17-17)			29.030
NPK (16-8-24)			21.773
NPK (23-11,5-11,5)			11.032
NPK (18-9-18)			11.032

ALTERNATIVE A

ANNUAL RAW MATERIAL AND UTILITY CONSUMPTION

(80% Stream Factor)

		Metric tons
Naphtha		
For ammonia	: 0,55 x 24.944 =	13.719
For nitric acid	: 0,[illegible]16 x 40.925 =	654
	Total	14.373
Fuel oil No. 2 (= Diesel gasoil)		
For ammonia	: 0,50 x 24.944 =	12.472
For Diesel motors of electric generators	: corresponding to electricity consumption	
Bunker C fuel oil		
For NPK (17-17-17)	: 0,037 x 29.030 =	1.074
For NPK (16-8-24)	: 0,037 x 21.773 =	805
For NPK (23-11,5-11,5)	: 0,037 x 11.032 =	408
For NPK (18-9-18)	: 0,037 x 11.032 =	408
		2.695
Mono-amm. - phosphate (11-48-0)		
For NPK (17-17-17)	: 0,361 x 29.030 =	10.479
For NPK (16-8-24)	: 0,170 x 21.773 =	3.701
For NPK (23-11,5-11,5)	: 0,234 x 11.032 =	2.581
For NPK (18-9-18)	: 0,179 x 11.032 =	2.173
		18.934
Muriate of potash (60% K_2O)		
For NPK (17-17-17)	: 0,289 x 29.030 =	8.389
For NPK (16-8-24)	: 0,408 x 21.773 =	8.883
For NPK (23-11,5-11,5)	: 0,187 x 11.032 =	2.062
For NPK (18-9-18)	: 0,314 x 11.032 =	3.464
	Total	22.798

5.31
Tabulation no. 31 continued.

			Metric tons
Coating agent			
For AN (33,5% N)	:	0,010 x 18.144 =	182
For NPK (17-17-17)	:	0,010 x 29.030 =	290
For NPK (16-8-24-)	:	0,010 x 21.773 =	218
For NPK (23-11,5-11,5)	:	0,010 x 11.032 =	110
For NPK (18-9-18)	:	0,010 x 11.032 =	110
		Total	910
Bagging materials			US $
For AN (33,5% N)	:	7,72 x 18.144 =	140.100
For NPK (17-17-17)	:	7,72 x 29.030 =	224.100
For NPK (16-8-24)	:	7,72 x 21.773 =	168.100
For NPK (23-11,5-11,5)	:	7,72 x 11.032 =	85.200
For NPK (18-9-18)	:	7,72 x 11.032 =	85.200
		Total	702.700
Catalysts			
For ammonia	:	0,70 x 24.944 =	17.500
For nitric acid	:	1,68 x 40.925 =	68.800
		Total	86.300
Lube oil, chemicals			
For ammonia	:	0,60 x 24.944 =	15.000
For AN (33,5% N)	:	0,11 x 18.144 =	2.000
For NPK (17-17-17)	:	0,11 x 29.030 =	3.200
For NPK (16-8-24)	:	0,11 x 21.773 =	2.400
For NPK (23-11,5-11,5)	:	0,11 x 11.032 =	1.200
For NPK (18-9-18)	:	0,11 x 11.032 =	1.200
		Total	25.000

- continued

Tabulation no. 31, continued.

Electricity				KWh
For Ammonia	:	794 x 24.944	=	19.806.000
For nitric acid	:	5 x 40.925	=	205.000
For AN (33,5% N)	:	41 x 18.144	=	744.000
For NPK (17-17-17)	:	44 x 29.030	=	1.277.000
For NPK (16-8-24)	:	44 x 21.773	=	958.000
For NPK (23-11,5-11,5)	:	44 x 11.032	=	485.000
For NPK (18-9-18)	:	44 x 11.032	=	485.000
			Total	23.960.000
External steam				US $
For AN (33,5% N)	:	0,86 x 18.144	=	15.600
For NPK (17-17-17)	:	1,58 x 29.030	=	45.900
For NPK (16-8-24)	:	1,58 x 21.773	=	34.400
For NPK (23-11,5-11,5)	:	1,58 x 11.032	=	17.400
For NPK (18-9-18)	:	1,58 x 11.032	=	17.400
			Total	130.700
Cooling water				
For ammonia	:	1,20 x 24.944	=	30.000
For nitric acid	:	0,44 x 40.925	=	18.000
			Total	48.000
Boiler feed water				
For ammonia	:	0,49 x 24.944	=	12.200
For nitric acid	:	0,23 x 40.925	=	9.400
			Total	21.600

ALTERNATIVE A
ANNUAL LABOUR AND STAFF COST

			US $
Ammonia plant	12,51 x 24.944	=	312.000
Nitric acid plant	4,62 x 40.925	=	189.100
Complex plant:			
AN operation	6,82 x 18.144	=	123.800
NPK operation	6,26 x 72.867	=	456.100
		Subtotal	1.081.000
Electric power station, BFW unit,			
CW towers, etc.	estimated		300.000
	Total		1.381.000

ALTERNATIVE A

ANNUAL MANUFACTURING COSTS

Case I: (as in Report Part 4, chapter 4.11)

- -80% stream factor
- -Naphtha price: US $ 227,40/metric ton
- -Fuel oil no. 2 price: US $ 183,30/metric ton
  Diesel gasoil for Diesel-electric generators not allocated (see below).
- -Depreciation and interest on estimated US $ 5.500.000 for electric power station excluded, while electricity priced at US $ 0,055/KWH.

			US $
Fixed costs (see Report Part 4, tabulations nos. 15,16 and 21)			
Maintenance	:	2,5% on US $ 44.100.000 =	1.102.500
Average interest	:	3,7% on US $ 47.220.000 =	1.747.500
Depreciation	:	10% on US $ 47.220.000 =	4.722.000
Interest on work cap.	:	10% on US $ 3.160.000 =	316.000
Insurance cost	:	0,95% on US $ 44.100.000 =	419.000
		Total	8.307.000

- Continued

3.55
<u>Tabulation no. 11, continued.</u>

		US $
Variable costs.		
Naphtha	: 14.373 metric tons at US$ 227,40 =	3.268.400
Fuel oil no. 2	: 12.472 metric tons at US$ 183,30 =	2.286.100
Bunker C fuel oil	: 2.695 metric tons at US$ 127,80 =	344.400
Mono-amm.-phosphate	: 18.934 metric tons at US$ 208,00 =	3.938.300
Muriate of potash	: 22.798 metric tons at US$ 139,00 =	3.169.000
Coating agent	: 910 metric tons at US$ 44,00 =	40.000
Electricity	: 23,96 million KWH at US$ 0,055 =	1.317.000
Bagging materials	:	708.700
Catalysts	:	86.300
Lube oil, chemicals	:	25.000
External steam	:	130.700
Cooling water	:	48.000
Boiler feed water	:	21.600
Labour and staff	:	1.081.000
	Total	16.458.300

Total manufacturing costs	24.766.300

ALTERNATIVE A
ANNUAL DEFICIT

Case I: See tabulation no. 33

		US $
Annual Manufacturing costs		24.766.300
Annual Sales Revenues		
Ammonia	: 2.177 metric tons @ US $ 220,46 =	479.900
AN (33,5% N)	: 18.144 metric tons @ US $ 209,44 =	3.800.100
NPK (17-17-17)	: 29.030 metric tons @ US $ 202,79 =	5.887.000
NPK (16-8-24)	: 21.773 metric tons @ US $ 190,70 =	4.152.100
NPK (23-11,5-11,5)	: 11.032 metric tons @ US $ 181,40 =	2.001.800
NPK (18-9-18)	: 11.032 metric tons @ US $ 197,21 =	2.175.600
	93.188 metric tons Subtotal	18.495.900

Less allowance for harbour, loading, freight, insurance, and unloading costs and fees to import agents on export of estimated 65.000 metric tons at US $ 25,00 = 1.625.000

Total 16.870.900

Annual Deficit 7.895.400

ALTERNATIVE A
ANNUAL MANUFACTURING COSTS

Case 2:

- 80% stream factor.
- Naphtha price: US $ 165,00/metric ton.
- Fuel oil no. 2: US $ 135,00/metric ton.
- Depreciation and interest on US $ 5.500.000 (otherwise subtracted in Case I) included for electric power station, and electricity calculated at price of Diesel gasoil at [illegible]imated consumption of 0,32 metric ton/1.000 KWh consumed (corresponding to US $ 0,32 x 135 x 0,001 = 0,043 per KWh).

Fixed costs: (See Report Part 4, tabulations nos. 15 and 16).

		US $
Maintenance	: 2,5% on US $ 49.100.000 =	1.227.500
Average interest	: 3,7% on US $ 52.620.000 =	1.947.200
Depreciation	: 10% on US $ 52.620.000 =	5.262.000
Interest on work cap.	: 10% on US $ 3.260.000 =	326.000
Insurance cost	: 0,95% on US $ 49.100.000 =	466.500
	Total	9.230.000

Variable costs

Naphtha	: 14.373 met[illegible] ton at US$ 165,00 =	2.371.600
Fuel oil no. 2	: 12.472 metric ton at US$ 135,00 =	1.683.700
Diesel gasoil for electric generators:		
	7.667 metric tons at US$135,00 =	1.035.000
Labour and staff :		1.[illegible]1.000
Other variable costs (as in Case I)		[illegible]06.000
	Total	14.977.300

Total manufacturing costs 24.207.300

ALTERNATIVE A
ANNUAL DEFICIT

Case 2: See tabulation no. 35.

	DM 1
Annual Manufacturing Costs.	44,207,300
Annual Sales Revenues (as in Case I)	36,870,900
Annual Deficit	7,336,400

ALTERNATIVE A
ANNUAL MANUFACTURING COSTS

Case 3:

- 70% stream factor
- Other conditions as Case 2

	US $
Fixed costs (as in Case 2)	9.230.000
Variable costs	
Labour and Staff (as in Case 2)	1.381.000
Other variable costs:	
Case 2 x 0,70 : 0,80 =	
US $ 13.596.300 x 0,8750 =	11.896.000
Total	13.277.000
Total manufacturing costs	22.507.000

5.40
Tabulation no. [illegible]

ALTERNATIVE A
ANNUAL DEFICIT

Case 3: See tabulation no. 37.

	US $
Annual Manufacturing Costs	22.507.000
Annual Sales Revenues:	
Case 2 x 0,70 : 0,80 =	
US $ 16.870.900 x 0,8750 =	14.762.000
Annual Deficit	7.745.000

9.41
Tabulation no. [illegible]

APPENDIX A
ANNUAL MANUFACTURING COSTS

Case A:

- 95% stream factor
- Other conditions as Case 2.

	US $
Fixed costs (as in Case 2)	[illegible]
Variable costs	
Labour and Staff (as in Case 2):	1.3[illegible].000
Other variable costs:	
Case 2 x 0,35 : 0,80 =	
US $ 13.596.300 x 0,4375 =	5.9[illegible]
Total	7.3[illegible]
Total manufacturing costs	16.5[illegible]

ALTERNATIVE A
ANNUAL DEFICIT

Case A: See tabulation no. 39.

	US $
Annual Manufacturing Costs	16.550.400
Annual Sales Revenues. Case 2 x 0,35÷0,80 = US $ 16.870.900 x 0,4375 =	7.381.000
Annual Deficit	9.170.400

ALTERNATIVE A
ANNUAL MANUFACTURING COSTS

Case 5:

- 100% stream factor
- All production sold on domestic market.
- Other conditions as Case 2.

	US $
Fixed costs (as in Case 2)	9.230.000
Variable costs:	
Labour and Staff (as in Case 2)	1.381.000
Other variable costs:	
Case 2 x 1,00 : 0,80 =	
US $ 13.596.300 x 1,25 =	16.995.400
Total	18.376.400
Total manufacturing costs	27.606.400

Tabulation no. 42

ALTERNATIVE A

ANNUAL DEFICIT

Case 5: See tabulation no. 41.

	US $
Annual Manufacturing Costs	27.606.400
Annual Sales Revenues	
Case I (brutto)x1,00 : 0,80 =	
US $ 18,495.900 x 1,25 =	23.119.900
Annual Deficit	4.486.500

5.45

Tabulation no. 43

ALTERNATIVE B
BREAK-DOWN OF TOTAL ANNUAL PRODUCTION
(80% Stream Factor)

	Metric tons
Ammonia	Imported
Nitric acid (as Alt. A)	40,925
AN (33.5% N) (as Alt. A)	18,144
NPK (17-17-17) (as Alt. A)	29,030
NPK (16-8-24) (as Alt. A)	21,723
NPK (23-11.5-11.5) (as Alt. A)	11,032
NPK (18-9-18) (as Alt. A)	11,032

Tabulation no. 44

ALTERNATIVE I

ANNUAL RAW MATERIAL AND UTILITY CONSUMPTION

(80% Stream Factor)

	Metric tons
Ammonia	24,944
Naphtha	
For nitric acid	654
Fuel oil no. 2 (=Diesel gasoil)	
For Diesel motors of electric generators:	corresponding to electricity consumption.
Bunker C fuel oil	2,695
Mono-amm.-phosphate (11 48-0)	18,934
Muriate of potash (60% K_2O)	22,798
Coating agent	910
	US $
Bagging materials	292,700
Catalysts	60,800
Lube oil, chemicals	20,000
	KWH
Electricity (electricity for ammonia terminal and storage not included)	5,154,000
	US $
External steam	130,700
Cooling water	25,000
Boiler feed water	9,400

3.47
Tabulation no. 41

ALTERNATIVE I
ANNUAL LABOUR AND STAFF COST

		US $
Ammonia storage and terminal	estimated	150.000
Nitric acid plant		189.100
Complex plant:		
AN operation		123.800
NPK operation		456.100
	Subtotal	919.000
Electric power station, [illegible] unit, CW towers, etc. estimated		300.000
	Total	1.219.000

ALTERNATIVE B
ANNUAL MANUFACTURING COSTS

Case I: (As in Report Part 4, chapter 4.11)

-80% stream factor.

-Naphtha price : US $ 227,40/metric ton

-Fuel oil no. price: Diesel gasoil for Diesel electric generators not allocated (see below).

-Depreciation and interest on estimated US$ 5.500.000 for electric power station excluded, while electricity priced at US $ 0,055/KWH.

Fixed costs: (See Report Part 4, tabulation nos. 15,16 and 22)

			US $
Maintenance	: 2,5% on US $ 38.500.000	=	962.500
Average interest	: 3,7% on US $ 41.215.000	=	1.525.000
Depreciation	: 10% on US $ 41.215.000	=	4.121.500
Interest on work cap.	: 10% on US $ 2.600.000	=	260.000
Insurance cost	: 0,95% on US $ 38.500.000	=	365.000
		Total	7.234.000

- continued

Tabulation no. 46 continued.

Variable costs

			US $
Ammonia	:	24.944 metric tons @ US$ 200,00 =	4.988.800
Naphtha	:	654 metric tons @ US$ 227,60 =	148.700
Fuel oil no. 2	:		---
Bunker C fuel oil	:	(as Alt. A)	344.400
Mono-amm.-phosphate	:	(as Alt. A)	3.938.300
Muriate of potash	:	(as Alt. A)	3.169.000
Coating agent	:	(as Alt. A)	40.000
Electricity	:	4,154 million KWH @ US$ 0,055 =	228.500
Bagging materials	:	(as Alt. A)	702.700
Catalysts	:		68.800
Lube oil, chemicals	:		20.000
External steam	:	(as Alt. A)	130.700
Cooling water	:		25.000
Boiler feed water	:		9.400
Labour and staff	:		919.000
		Total	14.733.300

Total manufacturing costs 21.960.100

ALTERNATIVE B
ANNUAL DEFICIT

Case I: See tabulation no. 46.

US $

Annual Manufacturing Costs 21.968.100

Annual Sales Revenues

Ammonia	: 2.177 metric tons @ US$ 220,46 =	479.900
AN (33,5% N)	: 18.144 metric tons @ US$ 209,44 =	3.800.100
NPK (17-17-17)	: 29.030 metric tons @ US$ 202,79 =	5.887.000
NPK (16-8-24)	: 21.773 metric tons @ US$ 190,70 =	4.152.100
NPK (23-11,5-11,5)	: 11.032 metric tons @ US$ 181,40 =	2.001.200
NPK (18-9-18)	: 11.032 metric tons @ US$ 197,21 =	2.175.600
	93.188 metric tons Subtotal	18.495.900

Less allowance for harbour, loading, freight, insurance, and unloading costs and fees to import agents on export of estimated 65.000 metric tons @ US$ 25,00 = 1.625.000

Total 16.870.900

Annual Deficit 5.097.200

ALTERNATIVE [illegible]

ANNUAL MANUFACTURING COSTS

Case 2:

- 80% stream factor
- Naphtha price:
- Fuel oil No. 2 price: US $ 165,00/metric ton.
- Depreciation and interest on US $ 5.500.00 (otherwise subtracted in Case I) included for electric power station, and electricity calculated at price of Diesel gasoil at estimated consumption of 0,32 metric ton/1.000 KWh consumed (corresponding to US $ 0,32 x 135 x 0,001 = 0,043 per KWH).

		US $
Fixed costs (See Report Part 4, tabulations nos. 15 and 16).		
Maintenance	: 2,5% on US $ 43.500.000 =	1.087.500
Average interest	: 3,7% on US $ 46.615.000 =	1.724.800
Depreciation	: 10% on US $ 46.615.000 =	4.661.500
Interest on work cap.	: 10% on US $ 2.700.000 =	270.000
Insurance costs	: 0,95% on US $ 43,500.000 =	413.300
	Total	8.157.100
Variable costs		
Naphtha	: 654 metric tons@US$ 165,00=	108.000
Diesel gas oil for electric generators:		
	1.329 metric tons @ US$ 135,00=	179.400
Labour and staff:	:	1.219.000
Other variable costs	: (as in Case I)	13.477.100
	Total	14.983.500
Total manufacturing costs		[illegible].600

5.32

Tabulation no. [illegible]

ALTERNATIVE B
ANNUAL DEFICIT

Case 2: See tabulation no. 40.

	[illegible]
Annual Manufacturing Costs	[illegible]
Annual Sales Revenues (as in Case I)	[illegible]
Annual Deficit	[illegible]

ALTERNATIVE [illegible]
ANNUAL MANUFACTURING COSTS

Case 3:
- 70% stream factor
- Other conditions as Case 2.

	US $
Fixed costs (as in Case 2)	[illegible]
Variable costs	
Labour and staff: (as in Case 2)	1.819.000
Other variable costs:	
Case 2 x 0,70 : 0,80 =	
US $ 13.714.930 x 0,8750 =	12.000.[illegible]
Total	[illegible]
Total manufacturing costs	[illegible]

Tabulation no. [illegible]

ALTERNATIVE B
ANNUAL DEFICIT

Case 1: See tabulation no. 50.

	US $
Annual Manufacturing Costs	[illegible]
Annual Sales Revenue	
Case 2 x 0,70 x 0,80 =	
US $ 16.870.900 x 0,875 =	[illegible]
Annual Deficit	[illegible]

ALTERNATIVE 3
ANNUAL MANUFACTURING COSTS

Case 4:
- 35% stream factor
- Other conditions as Case 2.

	US $
Fixed costs (as in Case 2)	8.157.100
Variable costs	
Labour and staff: (as in Case 2)	1.219.000
Other variable costs:	
Case 2 x 0,35 : 0,80 =	
US $ 13.714.500 x 0,4375 =	6.000.100
Total	7.219.100
Total manufacturing costs	15.376.200

ALTERNATIVE B
ANNUAL DEFICIT

Case 4: See tabulation no. 52.

	US $
Annual Manufacturing Costs	15.376.200
Annual Sales Revenues	
Case 2 x 0,35: 0,80 =	
US $ 16.870.900 x 0,4375 =	7.381.000
Annual Deficit	7.995.200

5.57
<u>Tabulation no. 34</u>

ALTERNATIVE B
ANNUAL MANUFACTURING COSTS

<u>Case 3:</u>

-100% stream factor.

-All production sold on domestic market.

-Other conditions as Case 2.

	US $
<u>Fixed costs</u> (as in Case 2)	<u>8.157.100</u>
<u>Variable costs:</u>	
Labour and staff: (as in Case 2)	1.219.000
Other variable costs:	
Case 2 x 1,00 : 0,80 =	
US $ 13.714.500 x 1,25 =	<u>17.143.100</u>
Total	<u>18.362.100</u>
<u>Total manufacturing costs</u>	<u>26.519.200</u>

Tabulation no. 55

ALTERNATIVE B
ANNUAL DEFICIT

Case I: See tabulation no. 54.

	US $
Annual Manufacturing Costs	26.519.200
Annual Sales Revenues Case I (brutto) x 1,00 : 0,80 = US $ 18,495.900 x 1,25 =	23.119.900
Annual Deficit	3.399.300

5.4 Normal actions for the establishment of a fertilizer plant.

A non-comprehensive list on normal and necessary actions for the establishment of a fertilizer plant is given below. More actions may be needed and the order of actions may be changed according to circumstances.

- Pre-feasibility study.
- Quotations from alternative suppliers of raw materials for both ex factory, mine or terminal delivery and c.i.f. delivery.
- Quotations on shipment of raw materials.
- Quotations on utilities.
- Study of market outlets and market prices in all market areas (domestic and export markets) concerned of the finished products and shipment methods.
- Quotations on shipment of finished products.
- Appointment of experts and consulting engineers, if own experienced and highly qualified staff is not at hand.
- Study of shipment, harbour and unloading facilities and storage of raw materials
- Study of storage, harbour and loading facilities, and distribution of finished products.
- Study of alternative plant sites and selection, site survey and soil investigation of final site.
- Study of road, railway (if any), necessary off-sites, supply of electricity, supply and data of water for process and cooling purposes, etc.
- Study of climatic conditions. Meteorological data over more years ought to be available.
- Study of regulations, codes and standards, etc. of authorities for construction and operation of plant, environmental protection standards, health standards, safety standards, equipment inspection regulations, etc.

- Study of availability of staff and labour for construction, operation, and maintenance of plant, of labour laws, etc.

- Study of availability of housing for expatriates and p riates during construction and operation of plant.

- Study of availability of detailed engineering firms, civil engineering and erection subcontractors, etc.

- Study of availability of domestic workshops, etc, for maintenance and repairs of plant.

- Elaboration of tender papers for engineering, delivery, construction, and initial operation of plant.

- Study of alternative ways for financing of plant.

- Study and selection of possible bidders.

- Tendering on the engineering, delivery, construction, and initial operation of the plant.

- Evaluation of bids.

- Final feasibility and assessment study.

- Quotations on financing.

- Signing of letters of intent for raw materials supplies and shipment on long term basis.

- Signing of letters of intent for marketing and shipment of finished products to major clients and dealers on long term basis.

- Signing of letters of intent for utility supplies on long term basis.

- Purchase of plant site.

- Selection of successful bidder and final contract negotiations.

- Signing of contract with successful bidder and contractor for the engineering, delivery, construction, and initial operation of plant.

- Signing of contract on financing.

- Signing of contract with an inspection agency for inspection and approval of equipment in Contractor's and manufacturers' workshops in advance of shipment.

- Establishment and employment of Purchaser's staff for survey, control, and auditing of contracts and works and for fulfillment of all Purchaser's obligations, etc.

- Bidding and signing of contracts with:

  - Forwarding agents.
  - Detailed engineering design firms.
  - Civil engineering subcontractors.
  - Erection subcontractors.
  - Erection material and utility supply companies.
  - Security and guard companies.
  - Erection insurance and personnel damage and sickness insurance company etc.
  - Etc.
  - Engineering, bidding, and signing of contracts on harbour facilities, roads, railway (if any), utility supplies, site preparation, sewers, housing, etc.

- Employment and training of local staff and labour for construction and erection of plant.

- Employment and training of staff and labour for management, operation, and maintenance of plant. Possibly, signing of contract on general management, operation and maintenance of plant.

- Employment and training of marketing and sales staff, purchasing and storekeeping staff, bookkeeping, auditing, financial, cashier and statistic staff, personnel employment staff, secretaries, other administrative personnel, personnel safety staff, first-aid clinic and infirmary staff, social benefits staff, gate, guard and security people, etc.

- Signing of contract with plant insurance company.

- Signing of contracts for raw materials supplies and shipment on long term basis.

- Signing of contract for marketing and shipment of finished products to major clients and dealers on long term basis.

- Signing of contracts for utility supplies on long term basis.

- Signing of contracts with possible local workshops and contractors for maintenance of plant during overhauls, etc.

5.5 Tender Papers for engineering, delivery, construction, and initial operation of a fertilizer plant.

A non-exclusive summary list of the items of contents of a typical set of comprehensive tender papers for the engineering, construction, and initial operation of a fertilizer plant is given below. Such tender papers will have to be worked out by experts and consulting engineers.

List of contents of tender papers

- Plant capacities and end-product specifications.
- Background of project.
- Process units, utility units, and off-sites.
- Basic design data:
  - Raw material specification.
  - Utility specifications.
  - Climatic conditions.
  - Climatic design basis.
- Process design, design principles, regulations and codes and standards for equipment, buildings, installations, construction, etc.
- Unit costs of raw materials, utilities, and labour, and design and calculating basis for evaluation, balancing, and determination of optimal design and minimum of the sum of variable costs and fixed costs
- Plant site, location, map and dimensions, elevations, soil investigation data, ground water levels, anti-flooding measures, road connections, etc.
- Engineering package, definition, details, requirements, etc.

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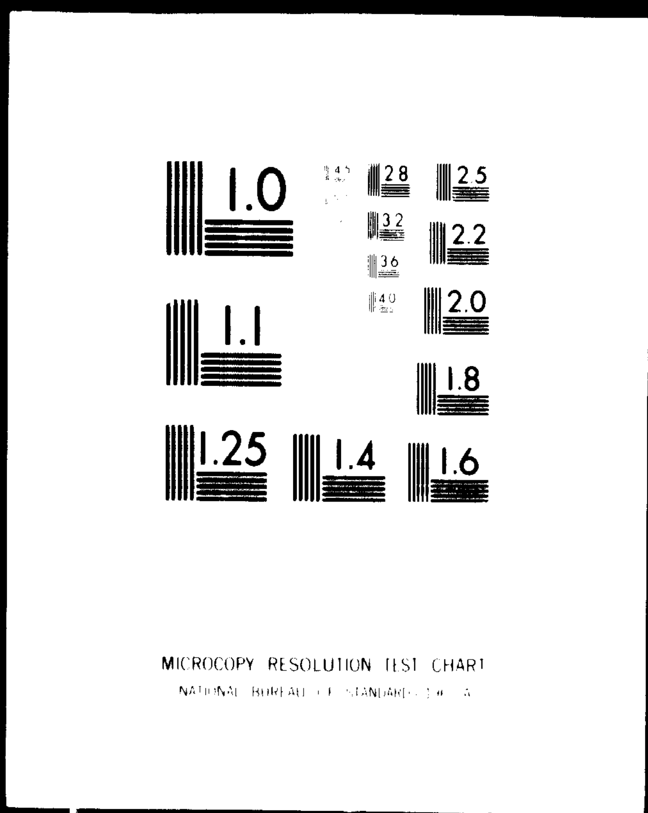

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- Presentation and approval procedures of process design drawings, engineering and utility diagrams, instrumentation design and specifications, equipment drawings and specifications, basic civil engineering design and specifications, etc..

- Detailed list, grouping, data, etc. of all equipment and materials, and of excluded equipment and materials to be clearly stated by bidders.

- Detailed list, grouping, data, etc. on catalysts, packings, chemicals, lubricating oil and grease, etc.

- Detailed list, grouping, data, etc. on emergency replacement and first year's normal replace ment of spare parts.

- Inspection rules and procedures of equipment and materials in manufacturers' workshops in advance of shipment.

- Quoted prices on equipment and materials, catalysts and similar materials, and spare parts:

  - Delivery terms, ex works, f.o.r., f.o.b., or c.i.f.,

  - Price basis on cash payment terms.

  - Currencies.

  - Break-down, grouping, details, currencies, etc. of quoted prices.

- Quoted lump sum remunerations and travelling expenses, or daily remunerations and expected man-days and number of men of each category and cost of airtickets of Contractor's foreign personnel for supervision of detailed civil engineering design, civil engineering design, civil engineering works, and erection works.

- Quoted lump sum living allowances, or daily living allowances and expected man-days and number of men of each category of Contractor's foreign personnel for supervision of detailed/civil engineering design, civil engineering works, and erection works.

- Quoted lump sum remunerations and travelling expenses, or daily remunerations and expected man-days and number of men of each category and cost of airticket of Contractor's foreign personnel for operation and maintenance of plant during first year's operation.

- Quoted lump sum living allowances, or daily living allowances and expected man-days and number of men of each category of Contractor's foreign personnel for operation and maintenance of plant during first year's operation.

- Payment terms, financing terms, interest charges and credit insurance costs on payment of quoted prices, renumerations, etc.

- Financing available to Purchaser by Purchaser's own sources.

- Purchaser's approval in advance and right of rejection of contractor's foreign personnel.

- Rules for payment and approval of living allowances to Contractor's foreign personnel.

- Contractor's requirements or estimated needs of each category of local staff and personnel for construction and erection works of plant.

- Contractor's requirements or estimated needs of each category of local staff and labour for operation and and maintenance of plant.

- Employment rules and approval and salary payment of local staff and labour.
- Role of selected consulting engineers and approval procedures by financing parties of Purchaser.
- Forwarding, transportation, insurance, and ownership transfer of equipment and materials.
- Basic civil engineering design.
- Detailed civil engineering design.
- Civil engineering works.
- Erection works.
- Training of staff and labour for erection.
- Training of staff and labour for operation and maintenance of plant.
- Commissioning, start-up, and first year's initial operation.
- Purchaser's obligations, like site preparation and protection, off-sites, roads, utility supplies for construction and erection, employment of staff and labour for construction, erection, operation, and maintenance, housing, applications to authorities and approvals, auxiliary equipment procurement, raw material and utility supplies for commissioning start-up and operation, etc.
- Guarantees by contractor:
  - Reliability of equipment and operation during first year's operation.
  - Performance guarantees.
  - Guaranteed consumption figures.
  - Guaranteed end-product specifications.
  - Guaranteed limits of effluents for environmental protection.
  - Test-run procedures.

- Replacement of unsatisfactory equipment and materials and correcting measures and procedures at non-fulfillment of Contractor's guarantees and repeated test-runs.

- Time schedules and guaranteed limits.

- Penalties at non-filfillment of guaranteed time limits.

- Financial securities:
  - Letters of credit or bonds by Purchaser.
  - Letters of advance payment guarantee by Contractor and certified by reputated banks. Contractor ought to render such letters of advance payment guarantee on all advance payments made by Purchaser which are liberated eventually as equipment and materials are approved, shipped, and taken over by Purchaser.
  - Letters of performance guarantee by Contractor and certified by reputated banks.

- Liability of Contractor.

- Royalty and patent clauses, patent impingement.

- Language of contract.

- Arbitration rules.

- Laws.

- Secracy.

- Adjudication rules.

- Submittance of bids, opening of bids, dates and address of Purchaser.

- Bid security.

- Evaluation of bids, forfeit of bids, selection of successful bidder, invitation to contract negotiations, etc.

- Negotiations and signing of contract.

5.6 Suppliers of small fertilizer plants.

Below is given a non-exclusive list of engineering and contracting firms which may be interested in bidding on small fertilizer plants.

- Chiyoda Chemical Engineering and Construction Company, Japan
- Chemico, U.S.A.
- Coppee-Rust, Belgium.
- Davy - Powergas, England.
- N-Ren Corporation, U.S.A. and Belgium.
- Simon - Carves Ltd., England.
- SNAM Progetti, Italy.
- Friedrich Uhde G.m. b.H., West Germany.
- Voest - Alpine, Austria.

Before tenders should be called for, it ought to be ascertained that the project will be realistic and be feasible. No reputated engineering and contracting firm is willing to bid on unfeasible projects noting that it costs at least in the order of US $ 50.000 - 100.000 to prepare a complete bid, which will stand any chance under competitive bidding conditions.

Besides, before tendering is arranged, the bidders contemplated by Government ought to be contacted and information be given on the project in advance in order to convince the bidders that the project may be realized. It is noted that small fertilizer plants are not considered feasible in general in the industry nowadays.

Possibly, the bidders and the number of bidders will have to be limited to certain companies and a certain number.

Possibly, Government will have to offer certain bidding rewards to the best bidder, the second best bidder and maybe, the third best bidder as found in accordance with stipulated adjudication and evaluation rules by a neutral committee in order to encourage reputated companies to participate in the bidding.

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