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THE FERTILIZER INDUSTRY OF IRAN[1/]

by

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Iran

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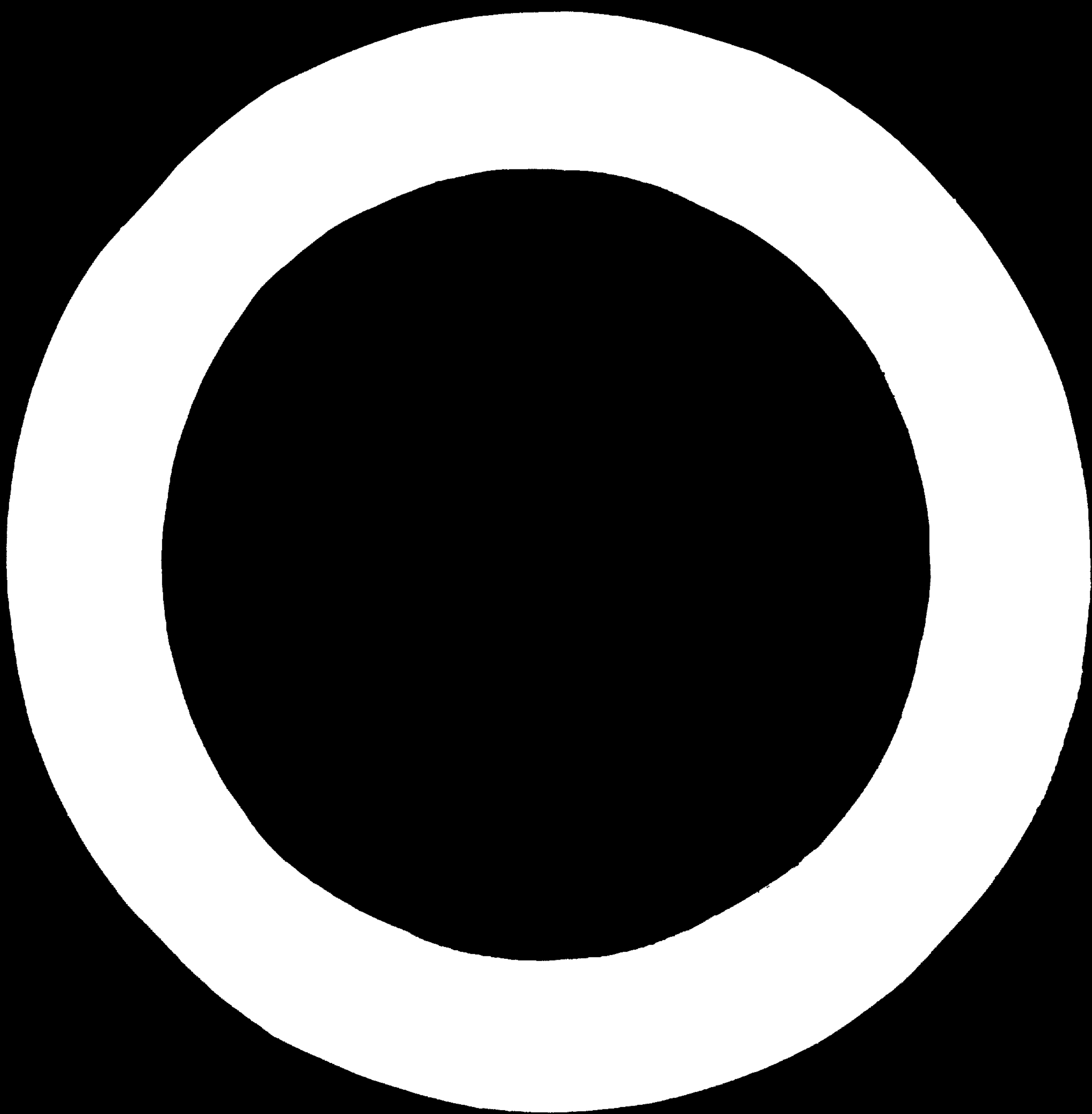


Introduction

Soil. Climate and Agriculture in Iran

Iran is essentially an agricultural country with a population of about 28 million on a land area of around 165 million hectares, of which only 7.65 million hectares (4.6 per cent) is farmed. see Table 1.

Climatically, the country is divided into three distinct regions by two massive ranges of mountains starting from the north west and extending one along the north to the east and the other along the west to the central south east. Thus, along the Caspian coast in the north the climate is temperate with a fairly high humidity and rainfall (100-200 cm. annually). In the central plateau with its cold winters and fairly hot summers the snow and rainfall is restricted mainly to winter and early spring. The southern and eastern central area of the country is generally arid desert with little rain.

The average annual precipitation of the country is about 24 cm. which is about 3½ times less than the average for the whole world. Only 9 per cent of the land has a sufficient precipitation necessary for agriculture (over 50 cm.). On a further 17 per cent of the land surface, where the annual precipitation is between 25-30 cm. dry farming is feasible, while on the remaining 74 per cent even dry farming is not feasible because of the poor rainfall ------ see, Table 2.

The shortage of water is one of the most critical and pressing factors limiting the expansion of agriculture in Iran. The total amount of water received annually by the country (by means of precipitation and rivers) is estimated at about 400 billion cubic metres, of which only about 78 billion cubic metres (19 per cent) is utilised. Owing to insufficient rainfall, farming depends on irrigation in many parts of the country. In the history of Iranian agriculture, "ghanats" (underground water channels) have been the most important means of exploiting underground water resources for agriculture. At present, the amount of water obtained by "ghanats" is believed to be about 6 billion cubic metres a year.

Agriculture constitutes about 30 per cent of Iran's Gross National Product and it is the country's second largest foreign currency earner, representing about 70 per cent of its exports other than oil.

The amount of agricultural products grown in 1966 was about 11.5 million tonnes, of which about 5.5 million tonnes (48%) was grains, 2.3 million tonnes (20%) industrial crops. 1.3 million tonnes (11%) vegetables and 1.06 million tonnes (9%) fruit. It is intended to increase the amount of agricultural products to about 19 million tonnes by the end of the Fourth Five Years Plan (March 1972). This increase is to be achieved not so much by increasing the area under cultivation but more important by increasing the average yield per hectare by the use of fertilisers.

The country's long term objective (by about 1980) is of course to attain optimum crop yields from the cultivated area. In achieving this beside having to increase the use of fertilisers on a much larger scale than practiced at present, many other complex technical and non-technical problems have to be overcome.

Additional dams for irrigation should be built; the present roads and communication networks must be greatly improved; a more effective programme to educate farmers on the use of fertilisers is needed; more distribution centres and warehouses for fertilisers should be built; additional agricultural equipments (tractors and harvesting machines, in particular) and improved seeds and plants should be provided to the farmers.

Furthermore, more experts and specialists are needed to advise on soil testing, selecting the best crop for a particular environment, the use of best fertilisers for a particular soil and crop, the best method of application of fertilisers, application of herbicides and pesticides, control of plant diseases, and a host of other agricultural problems.

Fertiliser Demand in Iran

Of the primary nutrients only nitrogen can be supplied to the soil naturally.

The amount of nitrogen supplied by the atmosphere, through lightning, to the soil is believed to be less than 10 kilogrammes per hectare which is far too inadequate for agriculture. In Iran as in other developing countries, the land has been ploughed for years without the replacement of the soil nutrients, other than by natural means. The soil was ploughed on alternate years, so that it would gain some of its lost nitrogen nutrient.

The Iranian soil is relatively poor in phosphate content. Most of the naturally occurring phosphate in its agricultural soils has long been removed by plants and now, like nitrogen, phosphate fertilisers must be supplied to the soil. On the other hand most of the Iranian agriculture land is relatively rich in the other primary nutrient potassium, which of course, is essential for a lasting increase in yield and protection of plant against diseases.

The use of synthetic fertiliser in Iranian agricultural history is relatively new. In 1957 the total consumption of all synthetic fertiliser was only about 400 tonnes for the whole country. But as a result of an intensive programme on farmers' education and field demonstrations on the use of fertilisers, the consumption of fertiliser has increased quite appreciably. Tables 3 and 4 show the consumption of fertilisers over the past decade 1961-1970 and its projected consumption over the next few years. In 1970, over 233,000 tonnes of synthetic fertilisers, corresponding to about 111,000 tonnes of nutrients (N, P_2O_5 and K_2O) were used throughout the country. This represents an increase of over six folds over the last 10 years. During the current year about 275,000 tonnes of synthetic fertilisers, equivalent to about 126,000 tonnes of nutrients N, P_2O_5 and K_2O, will be used and it is anticipated that the consumption will have an annual growth rate of over 15 percent over the next 5 years.

Despite the fairly large tonnage of fertilisers used, the Iranian consumption is still very low. Every hectare of the area under cultivation (about 7.6 million hectare) last year received on the average about 14.2 kilogrammes of the nutrients N, P_2O_5 and K_2O. This is only a tenth of the consumption rate of Europe and about 1.5 folds below the reported consumption rate of Asia ----- see, Table 5 . During the year 1971-72 about 16.8 kilogrammes of the primary nutrient per hectare of land is to be used, an increase of about 18.6 per cent over the previous year.

On per capita basis, last year about 4.0 kilogrammes of the primary nutrient per capita was used. This compares with the World's consumption of about 18 kilogrammes of primary nutrients per capita last year. During the current year, the Iranian consumption should increase to about 4.6 kilogramme of primary nutrients per capita, a modest increment of about 15 per cent over the previous year.

Generally the pattern of fertiliser consumption in Iran has been influenced by what has been produced within the country. At present urea is the most popular and widely used fertiliser both in terms of nitrogen fertiliser and total (N, P_2O_5, and K_2O) fertiliser. Since 1968, it has accounted for over 40 per cent of the total synthetic fertilisers used. Its annual consumption growth over the past decade has varied from as low as 9 per cent (1964 to 1965) to as high as 90 per cent (1965 to 1966). Its consumption last year stood at about 108,000 tonnes (50,000 tonnes N) an increase of about 30 per cent over the previous year, and during the current year this consumption should increase to about 138,000 tonnes (64,000 tonnes N), which will be about 50 per cent of the total synthetic fertilisers consumed. The marked growth in the consumption of urea may be attributed to its high nitrogen content and the rapid resutls obtained by the farmer from its application.

After urea, diammonium hydrogen phosphate is the next widely used fertiliser. It accounts for about 23 per cent of the total fertilisers consumed. Last year about 54,000 tonnes were consumed, an increase of about 23 per cent over the previous year, and during the current year its consumption should increase by about 25 per cent to about 67500 tonnes.

Mixed NPK fertilisers, notably 20-20-0 and 15-15-10 compound formulated, are very popular among the Iranian farmers. Since these types of fertilisers are not manufactured in Iran, and with the comparatively high cost of imported material the consumption of these fertilisers will be limited and well below the demand in the next few years. Farmers will be encouraged to use alternate locally produced fertilisers, such as urea and ammonium phosphate, until the present mixed NPK compound fertiliser project is implemented.

The potential demand for fertiliser in Iran is higher than the consumption figures show in Table 3 . In a developing country such as Iran, numerous factors hinder the true and real consumption growth of fertiliser. Despite the fact that fertilisers are delivered at low prices ex-factory, the distribution costs over thinly spread farming area around the country are relatively high and a good number of farmers are reluctant to pay for fertilisers. A system of deferred payment, whereby farmers receive long term credit from Agricultural Banks, has helped to ease the financial burden involved.

Moreover, due to inadequate communication and the long distances between warehouses and the consuming areas (farms) the prompt and timely delivery of fertilisers has proved quite difficult.

Although an intensive campaign on the use of fertilisers has been in progress for sometimes, the limited number of qualified agricultural advisers to assist in farmer education programme has hindred the expected rise in the consumption of fertilisers.

Generally there is a noticeable shortage of experts in most areas of agricultural industry. Perhaps, the most serious shortage is in the fields of soil testing, and on the use of right fertilisers for a particular soil and crop. It is in these areas, as indeed in a number of others that the good offices of United Nations are most welcome.

On the basis that about 50 kilogrammes of mixed fertiliser (N, P_2O_5, K_2O) per capita per year is required to produce sufficient food per capita per year (about 2,500 calories per capita per day), Iran's consumption of these macro-nutrients should be about 1.4 million tonnes per year or about 182 kilogrammes of plant nutrients per hectare of the presently farmed land. However, since the Iranian soils are adequately rich in potassium, this latter figure drops to about 121 kg./hectare. This is about seven times more than the present (1971-72) consumptions. With the difficulties outlined earlier it will take some time before Iran can achieve this optimum fertiliser application.

Fertiliser Production in Iran.

At present fertilisers and sulphur are produced in 3 complexes namely Shiraz Fertiliser Factory, Shahpur Chemical Company and Kharg Chemical Company.

Shiraz Fertiliser Factory.

In 1961, Shiraz Fertiliser Factory, situated not far from Persepolis, commenced production of urea and calcium ammonium nitrate. Being the first of its kind in both Iran and the Persian Gulf, Shiraz Fertiliser Factory was built to satisfy the local fertiliser requirement, which have long since outgrown its production capacity. It was built on the eve of a technical revolution in fertiliser plant design, and so it was obsolete almost from the very start of operation. Ininital technical problems resulted in a poor start during which much product was lost. However, this plant provided a good ground for training personnel and gaining experience in this field. The factory was initially commisioned to manufacture daily about 110 tonnes of urea and 120 tonnes of calcium ammonium nitrate. However, following the optimisation and modification carried out by the engineers in charge of the plant, the urea production was increased to about 175 tonnes per day, in 1964-65, with an insignificant additional investment.

Some 90 million cubic metres per year of natural gas associated with the crude petroleum production in Gach Saran, South Iran, is used as feedstock for this plant after the removal of sulfur by amine treatment at an installation near the oil fields.

Shiraz Fertiliser Factory comprises synthesis gas, ammonia, urea, nitric acid and ammonium nitrate units as well as all other utility and ancilliary plants.

Synthesis Gas Unit - Sulphur Removal and Gas Reforming Unit.

The organic sulphur compounds, such as, mercaptans and thioethers, in the gas are catalytically reduced over a cobalt-molybdinum based catalyst to hydrogen sulphide, which is then removed by a base.

The sweet gas, which contains over 85 per cent methane, is steam reformed over nickel oxide based catalyst to a mixture essentially consisting of hydrogen, carbon mono- and dioxides and unreformed methane.

The reformed gas is then oxidised with sufficient air to provide the necessary nitrogen for ammonia synthesis and to supply the necessary heat to reform the remaining hydrocarbons. The carbon monoxide is steam reformed to carbon dioxide which is then removed by a monoethanolamine wash.

Ammonia synthesis Unit

Afther the removal of traces of carbon monoxide by washing with an aqueous solution of cupro-acetic acid-ammonia complex, the synthesis gas is passed over an iron-based catalyst in beded in a reactor, where ammonia is synthesised at the rate of about 135 tonnes per day.

Urea Unit.

The unit is a total carbamaterecycle of Montecatini design. Liquid ammonia and gaseous carbon dioxide are reacted at about 180-190°C and under a pressure of about 190 atmospheres. From the resulting carbamate; on dehydration, a urea solution is obtained, which on concentration and prilling forms pure prilled urea (99 per cent). As mentioned earlier, the unit was originally designed to manufacture 110 tonnes per day which has since been optimised to about 175 tonnes per day.

Nitric Acid Unit

Gaseous ammonia is combusted with a limited air to nitric oxide which in turn is oxidised with excess air to nitrogen dioxide. On dissolving in water, nitrogen dioxide gives an acidic solution, containing a mixture of nitrous and nitric acids, which on air oxidation forms nitric acid.

Ammonium Nitrate Unit.

An aqueous ammonium nitrate solution is prepared by neutralising nitric acid solution with aqueous ammonium hydroxide. On concentration and dilution with lime, a paste of calcium ammonium nitrate (N-26 per cent) is obtained, which is then granulated and treated with a coating to reduce the caking properties of the product. A maximum of 120 tonnes of the nitrate (N 26%) can be manufactured per day.

Shahpur Chemical Company

At a cost of over $ 230 million, Shahpur Chemical Company, the biggest complex of its kind in Asia, went on stream during October 1970. The complex, situated near Bandar Shahpur on the Persian Gulf, utilises Jurasic sour natural gas from Asmari Zone in Masjid-i-Suleiman area, and imported phosphate rock to manufacture a number of fertilisers.

Wet sour gas, at a rate of 170 million standard cubic feet per day, from five gas wells passes through separators and after being dehydrated by molecular sieves it is sent through a 170 kilometer long, 20 inch seamless, pipeline to Shahpur Complex.

The Complex site, as shown in figure 1 , is situated on the shore of Khor Moosa, in between Mahshahr and Bandar Shahpur. It is a complete "grass roots" project which encompassed the preparation of the site on marshy land, the driving of piles on a large scale to support the weight of the heavy installations, along with a power generation unit, distribution facilities, a marine terminal, a rail road spur, water supplies, workshops, laboratories, administration buildings, etc.

A simplified block diagramme of the units of Shahpur Chemical Complex is shown in figure 2, and the output of Shahpur is given in Table 6.

The Shahpur industrial complex contains seven units, brief details of which is given below:-

Sulphur Unit:

The unit consists of two identical trains of diethabolamine (DEA). hydrogen sulphide removal unit and a modified Claus sulphur unit, each with a capacity of 750 tonnes per day of sulphur. It is the sixth largest sulphur recovery unit in the world.

Of the 495,000 tpa capactiy, about 150,000 tpa is used captively on site as raw material for sulphuric acid unit.

Ammonia Unit.

About 42 MMSCF/D of sweet gas is used in the unit as fuel and process feed gas, and of the remaining 67 MMSCF/D about 15 MMSCF/D is used in the utilities and the rest (52 MMSCF/D) is flared. The ammonia unit is a single train 1000 tonnes per day capacity of M.W.Kellog design. The unit consists of a hydro-desulphurisation section, primary and secondary reformers, high and low temperature shift convertors, a carbon dioxide removal section, a methanation section and a synthesis loop.

Urea Unit.

The 500 tonnes per day capacity urea unit is an Allied/C.P.I. design in which anhydrous ammonia instead of the corrosive aqueous carbamate solution is recycled to the reactor. The reactor operates at the high pressure of about 6000 psig and because of the absence of water in the feed to the reactor, about 70 per cent conversion, based on carbon dioxide, per pass is obtained. Pure prilled urea of lowbiuret content is obtained from the urea solution from the reactor.

Sulphuric Acid Unit.

Liquid sulphur is burnt in dry atmospheric oxygen to sulphur dioxide which in turn is oxidised to sulphur trioxide in a convertor with four beds of the catalyst, vanadium pentoxide (as potassium vanadate). The trioxide, after cooling, is dissolved in 98 per cent sulphuric acid, which is then diluted to about 93 per cent and exported to phosphoric acid unit. The capacity of the unit is 1320 tonnes per day (as 100 per cent H_2SO_4 sulphuric acid)

Phosphoric Acid Unit.

Pulverised phosphate rock is digested in 60 per cent sulphuric acid, and the resulting week phosphoric acid is separated from the gypsum slurry and concentrated to about 74.5 per cent phosphoric acid (ca. 54 per cent P_2O_5).

The production rate is about 450 tonnes per day as P_2O_5, of which 150 tonnes is used in the diammonium hydrogen phosphate and triple-superphosphate unit and the remaining 300 tonnes is exported as 54 per cent P_2O_5 acid.

Diammonimum Hydrogen Phosphate and Triple - Super Phosphate Unit.

This dual purpose unit can produce either 300 tonnes per day of diammonium hydrogen phosphate (DAP) or 450 tonnes per day of triple-super phosphate.

Other Facilities

Utilising natural gas, the complex can produce 37000 KVA of electricity. The nine million cubic metes per year of clarified water required for operating the plant is obtained by means of a 96 kilometres, 40 inch diameter, water pipeline that connects the Karun River to the plant site.

The complex marine terminal has three berths: One for liquid loading, another for bagged products and general cargo and the thid for loading and unloading of bulk materials. The terminals can handle up to 50,000 tons ships or ships with a draft of up to 40 feet.

Kharg Chemical Company

Khemco, as the company is also referred to, processes sour gases from crude production facilities at the Darius Field on Kharg Island in the Persian Gulf. Incoming gases, at a rate of about 145 MMSCF/D, are first compressed and then amine sweetened to remove the hydrogen sulphide from the hydrocarboh gases. On regeneration, the hydrogen sulphide is partially oxidised and catalytically converted to sulphur (600 tonnes per day). Incidentially from the sweeten hydrocarbon gases, propane and butane are isolated and exported. It is intended to manufacture : methanol or ammonia in the near future from the residue gas, predominantly, methane.

Future of Fertiliser Industry - Fertiliser Projects Under Study

With the projected increase in the internal consumption of fertilisers and with an abundance of natrual gas associated with the crude petroleum production, National Petrochemical Company is actively pursuing a number of projects to utilise and process these gases to produce petrochemicals such as olefins, methanol, ammonia, etc.

With the internal consumption growth of fertilisers at its present rate the existing production capacity will not be sufficient for the country's needs in the near future and therefore more fertiliser plants are to be built during the Fifth Five Year Plan(1972-1977) to satisfy the growing domestic requirement. Future expansion in production are planned as described below:-

1. Expansion of Shahpur Complex.

When installed, adequate provision in terms of pipeline capacity and plant area were made for an ultimate doubling of the output of Shahpur Complex. Under the present plans, the urea production is to be increased by about 132,000 tonnes per year, while the production of sulphuric and phosphoric acids and diammonium phosphate and triple-super phosphate are all to double the present ultimate capacity.

2. Ammonia Project

If the present negotiations with a foreign consuming country are fruitful, then an ammonia plant will be built, independent of Shahpur industrial complex, at Bandar Shahpur on 50-50 joint venture basis. The plant will have a 1000 tonnes per day capacity and will be predominantly export oriented. As an alternative to this, Shahpur's planned expansion will also contain doubling its ammonia production (to 2, 000 tonnes per day).

3. Mixed NPK Fertiliser Project.

Due to internal demand, a mixed NPK fertiliser plant is to be built in Shiraz. The plant will annually manufacture 30, 000 tonnes of 20-20-0 and 20, 000 tonnes of 15-15-10 formulated compound (N, P_2O_5, K_2O) fertilizer. The plant will utilise the residual phosphoric acid from the phosphoric acid purification unit of a sodium tripolyphosphate plant as its raw material, together with urea or ammonium nitrate and imported potassium sulphate.

It is expected that when introduced in the market (in 1975), the consumption of this fertiliser will rapidly increase.

4. Compost Fertilisers.

Plans are in progress to install a compost plant in Tehran to utilise and process the town's carbagge to fertilisers. The output of this plant is expected to be between 300 to 350 tonnes per day. NPK fertiliser will be blended with this to make it more concentrated. Similar smaller units are considered for other cities.

5. Other Future Projects for Local Demand

The present fertiliser consumption in any single agricultural area is not high enough to justify establishment of regional plants. However, the potential future demand in some agricultural areas is expected to justify building of fertiliser units near these consuming areas.

The provinces of Khorrasan (in the north east) and Kermanshahan (in the west) are such areas, and, fortunately both of these provinces are very rich in natural gas found at Sarakhs and Tang-e-Bijar, respectively. It is expected that by about 1980, fertiliser plants will be installed in these provinces.

6. Future Projects in Partnership with Consuming Countries.

The natural gas produced in association with crude oil production in Iran last year was about 1.1×10^{12}SCF. This is sufficient for the manufacture of roughly two-thirds of the world present nitrogen fertiliser consumption (31.6 million tonnes.)

Although some outlets are developed for utilisation of this valuable resource by exporting through pipelines or as LNG, and also its application as an energy source or petrochemical feedstock nevertheless it appears that for many years to come a substantial quantity of this natural gas has to be wastefully flared.

It is in this context that Iran is continuously searching for useful outlets for its natural gases. As far as nitrogen fertiliser is concerned, the aim is to manufacture with the participation of other concuming countries, bulk intermediates such as ammonia, which will provide low cost raw materials for further processing into finished products within and outside Iran. This is perhaps the most effective way of supplementing and accelerating development schedules of the nations east of Suez and of closing the regional gap between the abundant natural resources and rapidly increasing demand for consumer products.

Ammonia Production Cost.

The nitrogen fertiliser industry is based almost entirely on synthetic ammonia, the exception being calcium cyanamide and natrurally occuring inorganic nitrates. Therefore ammonia production cost is of paramount importance to the fertiliser industry.

Fixation of nitrogen as ammonia is a high pressure process, requiring appreciable capital investment. Ammonia is prepared by the reaction between nitrogen and hydrogen basically using the famous Haber-Basch process. The hydrogen, in turn, is prepared from either steam reforming or partial oxidation of hydrocarbons.

Prior to World War II, about 90 per cent of world ammonia production was based on coal as the source of hydrogen, but in recent years the raw material, coal, has been replaced by natural gas or naphtha because of lower production cost. Today, perhaps less than 20 per cent of the total world ammonia production is based on coal sources and it is anticipated that within the next four years this figure will decline to less than 10 per cent. It may. therefore be said that natural gas and petroleum fractions (naphtha, fuel oil, etc.) are paramount in the manufacture of nitrogenous fertilisers.

Without a doubt, the capital cost required for ammonia plants based on natural gas is lower than those based on naphtha, fuel oil, coke oven gas or coal. The use of natural gas instead of naphtha, for example, will affect the investment by 10 to 15 per cent. If the raw material cost differential between natural gas and the other feed stocks, was put aside, the ammonia production cost based on natural gas would be 5 to 8 per cent lower than from a plant based on naphtha feed. With addition of the raw material cost portion, this difference becomes quite marked. Thus, as an example, for a 1000 tonnes per day ammonia unit, the production cost per tonne of ammonia by the steam reforming of natural gas and naphtha are approximately as follows:-

	From Natural gas	From Naphtha
Production cost excluding raw material ($/MT)	17.0	18.2
Raw material	7.2 (a)	17.5 (b)
Total ($/MT)	24.2	35.7

(a) @ 20¢/10^6 Btu (b) @ $20/MT

It can clearly be seen that the cost of raw material has a profound effect on the production cost of ammonia. Furthermore, with natural gas at 20¢ per million Btu, ammonia can be produced at only 64 per cent of the cost as compared to naphtha ------ i.e., the production cost ratio of ammonia from natural gas to naphtha is approximately 1:1.55. With natural gas at 50¢ per million Btu, the production cost of ammonia ($35.2/MT) is still lower than that from naphtha.

Considering the very low price of natural gas in Iran at only about 5 ¢ per million Btu., the cost advantage of producing ammonia in such a location becomes apparent.

Financing of Fertiliser Projects

Generally speaking there are five ways of financing projects of this nature:-

(1) Cash. This is uncommon. Indeed bearing in mind various loan and credit terms possible it will not be a dynamic and progressive company which will finance its projects by cash.

(2) Government to Government loans. This sort of loan which usually has the best conditions and terms prevailing is normally advanced by developed countries for basic industries in developing countries.

(3) Untied loans. This sort of loan, normally advanced by World Bank or from Governmental sources has many advantages in giving the freedom of international shopping for best prices, provided, of course, that its terms and conditions are competitive.

(4) Buyers Credit. This type of credit is usually arranged through Government agencies in the donor country. It does not tie the borrower to any particular supplier but usually most of the money has to be spent in the donor country.

(5) Suppliers Credit. This is arranged by suppliers of equipment or the contractor selected to execute the project. The money is normally borrowed from financing institutions with a repayment guarantee cover by Governmental agencies.

It is also possible to employ a combination of some of the 5 methods outlined above. The general policy with any organisation is to use its cash resources to maximum advantage. In Iran with a great number of highly viable and attractive projects possible this rule is fully observed, bearing in mind, of course, maintenance of a healthy balance of payment for the country.

In financing of fertiliser projects in Iran normally an equity/loan ratio of 1 to 2 is aimed for. Because of the comparatively high plant costs and desirability for access to best international financing sources, The Plan Organisation of Iran, which is an agency of the Imperial Iranian Government assists the National Petrochemical Company in providing or obtaining the necessary credit financing for fertiliser and other petrochemical projects. This has enabled financing of projects at very favourable terms and conditions through access to various credit sources.

The credit arrangements for financing of the existing fertiliser projects have been of the suppliers' credit and buyer's credit referred to above.

The suppliers credit type of financing is, of course, traditional in many countries. Iran used this form of financing to a limited extent in the Shahpur project, and as the sole credit financing arrangement for Kharg Chemical Company. The supplier of the goods, the prime contractor for the project, arranged the financing from its own banking sources and National Petrochemical Company was in no way involved with the lending banks.

In the case of Kharg Chemical Company, a 33 million dollar credit arrangement was signed with the prime contractor for the project. The financing features of the agreement included:-

(a) Interest at 5 3/4 percent on financing for the off site work-or work performed on the contract outside Iran, including equipment shipped from abroad-and with 12 years to repay;

(b) Interest at 6 per cent for on site work in Iran with 7 years repayment term;

(c) Substantial grace periods after start up before the first installment of both principal and interest is due, and

(d) Minimum down payments of 5 per cent of the total contract value upon signing the contract and 5 per cent after completion of construction - both these amounts were paid from the equity.

The buyer's credit type of financing was used primarily for the financing of the Shahpur Complex. It involved entering a host of credit financing arrangements with the financing instutions in the U.S.A., France, U.K., Italy, and Central Bank of Iran. The supplier or the contractor was not involved in any way in this type of financing. By direct negotiations with the banks, favourable terms and conditions for buyer's credit were obtained. The interest rate on the foreign credits were between 5 3/4 to $6\frac{1}{4}$ percent; the terms of repayment approximately ten years after start up and, in most cases, with significant grace period before the first installment of principal became due and payable.

Incidientally, this type of financing was also employed for the procurement and installation of Abadan Petrochemical Complex.

As a general guide our experience shows that of the two types of credit arrangements, the suppliers credit with competitive bidding made on a lump sum or guaranteed maximum basis is preferred for the projects.

Conclusion

The fertiliser industry in Iran has had a good start and as a consequence, Iran is no longer an importer of plant macronutrients. Fertiliser demand, while still modest, is growing rapidly. It is increasing at the rate of over 15 per cent per annum and it is expected to surpass half a million tonnes per year within the next four or five years.

A number of projects to utilise gaseous hydrocarbons, associated with the production of crude petroleum, to manufacture fertilisers (and other petrochemicals) is in advance stage of techno-economic evaluation. However, some of these gases will have to be wastefully flared if alternative sources to utilise them are not found.

With the very low price of natural gas together with a host of other advantages, the cost advantages of producing ammonia in Iran is too apparent.

Considering the great need for fertiliser consumption to increase much needed agricultural products in the region, cooperation to process these gases to manufacture nitrogen fertilisers, and indeed other petrochemicals, to the mutual advantage of the participating countries deserved very serious considera-tion. Furthermore, in a world where over half the population is underfed utilising the resources of the earth to feed its inhabitant merits serious attention.

United Nations. Organisation is in a good position to initiate this sort of cooperation.

TABLE 1

LAND UTILIZATION (THOUSANDS OF HECTARES)

Type of Land Utilisation	Area	Percentage of total land area of country
1. Land under cultivation		
a) Area under annual and permanent cultivation	7,650	4.6
Area under irrigated cultivation	(3,450)	(2.1)
Area prepared for cultivation beneath dams	(100)	(0.6)
Area under dry farming	(4,100)	(2.5)
b) Area temporarily fallow	11,350	6.9
Total	19,000	11.5
2. Permanent pastures and meadows (1)	10,000	6.1
3. Forest and coppices (2)	19,000	11.5
4. Uncultivated land capable of reclamation and development (3)	31,000	18.8
5. Uncultivatable lands, (mountains, deserts, lakes, swamps, cities, roads, etc.)	86,000	52.1
TOTAL	165,000	100.0

(1) Only includes relatively good pasture land.

(2) Part of these forests and coppices is also permanent pastures

(3) Part of these areas is presently in use as second and third class pastures.

TABLE 2

DISTRIBUTION OF RAINFALL IN IRAN

Annual Rainfall (millimetres)	Recipient area (Million of hectares)	Ratio of recipient area to total area of the country (%)
Less than 100	22	[illegible]
100 to 250	100.5	61
250 to 500	28	17
500 to 1000	13	[illegible]
over 1000	1.5	1
TOTAL	165.0	100

TABLE 3

FERTILISER CONSUMPTION IN IRAN (1961 - 1970).

Type of Fertiliser	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Urea	6915	6320	13972	19454	21152	40245	62788	74000	83000	108000
Ammonium Nitrate	1883	842	3628	4207	5627	11415	12717	17700	18000	25000
Ammonium Sulphate	5613	4084	3080	3500	6600	6493	14297	11400	6500	15600
Diammonium Hydrogen Phosphate	1600	3957	8515	11043	12843	21889	33310	30000	44000	54000
Triple-Super Phosphate	5262*	12512*	4950*	12648	11060*	28800*	30843*	23466*	26700	26000
Potassium Sulphate	2090	1950	2475	-	100	1600	2200	1200	400	900
N.P.K.	13223	13550	17183	19253	28069	13464	21807	26600	1600	2600
Calcium Ammonium Nitrate	-	500	2752	-	-	-	1810	-	-	-
Others	110	79	250	-	-	464	343	30	80	510
TOTAL	36696	43794	58805	70105	85459	124370	180047	181930	180280	232610

* **Includes normal super phosphate.**

TABLE 4

PROJECTED CONSUMPTION OF FERTILISERS IN IRAN IN (1971 - 1975)

Type of Fertilisers	1971	1972	1973	1974	1975
Urea	138000	177000	221000	276000	331000
Ammonium Nitrate	27000	27000	27000	27000	27000
Ammonium Sulphate	1000	10500	11000	11500	12000
Diammonium Hydrogen Phosphate	67500	84000	101000	121000	139000
Triple-Super Phosphate	27300	28700	30100	31600	33200
Potassium Sulphate	990	1100	1200	1300	1300
N.P.K.	2900	3200	3500	3900	4300
Others	540	570	600	630	660
TOTAL	274230	332070	395400	472930	548460

TABLE 5

FERTILISER APPLICATION PER HECTARE OF ARABLE LAND AND LAND UNDER PERMANENT CORPS (1969/70) *

Continent	Amount
Europe	158 kg. of all fertiliser nutrients per hectare of arable land and land under permanent corps
North and Central America	66 " " "
USSR	35 " " "
Oceania	33 " " "
Mainland China	30 " " "
Asia	22 " " "
(Iran) +	(14)
S. America	14 " " "
Africa	7 " " "

* **Source: "F.A.O. Statistics", Feb. 1971.**

\+ **Author's Estimate**

TABLE 6

SHAHPUR CHEMICAL COMPANY PRODUCT OUTPUT

Product	Output			
	Present		After Expansion	
Sulphur	1500 MTD		1500 *	MTD
Ammonia	1000		1000**	
Sulphuric Acid	1300		2600	
Urea	500		900	
Phosphoric Acid (as P_2O_5)	450	(P_2O_5)	900	(P_2O_5)
Diammonium Phosphate	300		600	
or				
Triple Superphosphate	430		860	

* Will be increased to 3000 tonnes per day, depending on world market situation

** Will be double if other ammonia projects do not materialise

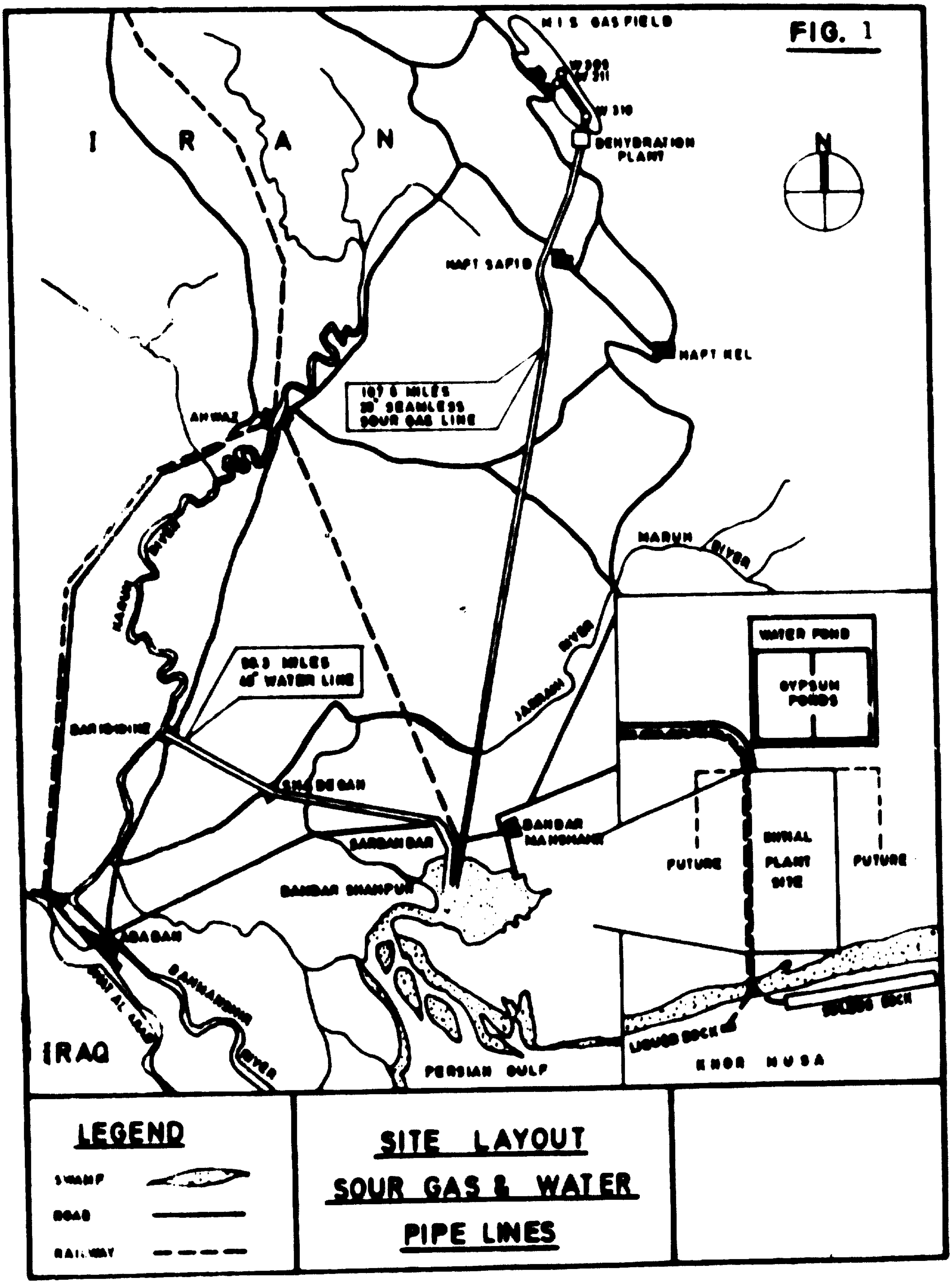
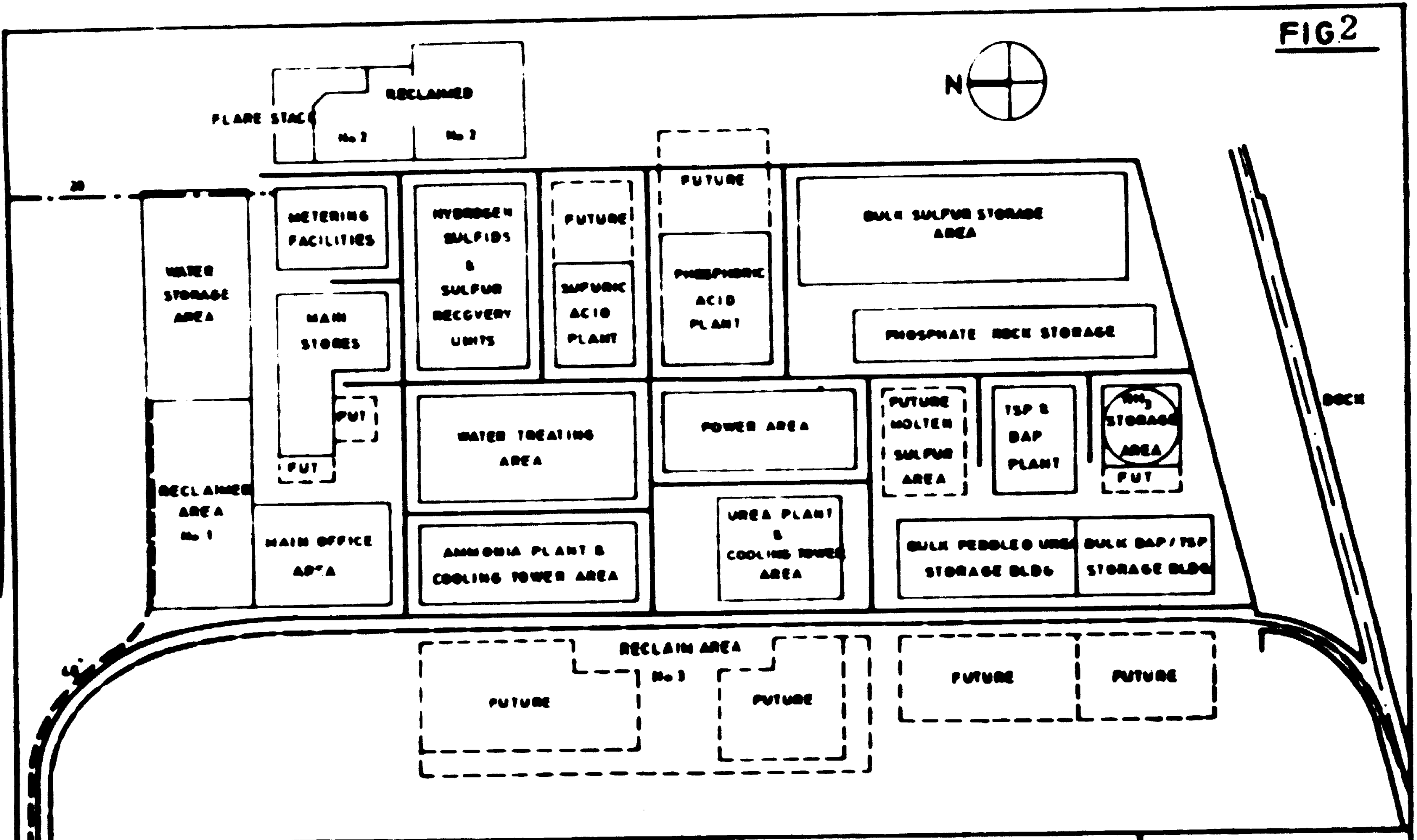


FIG. 1
IRAN
MIS GASFIELD
DEHYDRATION PLANT
NAFT SAFID
NAFT KEL
AHWAZ
107.5 MILES 20" SEAMLESS SOUR GAS LINE
MARUN RIVER
JARRAHI RIVER
WATER POND
GYPSUM PONDS
63.3 MILES 48" WATER LINE
SHADEGAN
BANDAR MAHSHAHR
FUTURE
INITIAL PLANT SITE
FUTURE
BANDAR SHAHPUR
ABADAN
IRAQ
PERSIAN GULF
KHOR MUSA
LEGEND
SWAMP
ROAD
RAILWAY
SITE LAYOUT
SOUR GAS & WATER
PIPE LINES

FIG 2



LEGEND

ROAD
RAILWAY
WATER LINE
GAS LINE

SITE GENERAL ARRANGEMENT

74. 10. 14