CHAPTER I

INTRODUCTION

หอสมุดกลาง สถาบันวิทยบริการ จุฬาลงกรณ์มหาวิทยาลัย

1.1 The Role of Fertilizer in Agriculture

Fertilizers, the nutrients of plants, can be classified broadly into 3 kinds, primary nutrient, secondary nutrient and micronutrient. Primary nutrient, the greatest amount needed by plants, constitutes commercial fertilizer industry and trade. It consists of 3 elements: nitrogen, phosphorus and potassium. The other classified fertilizers, secondary nutrients and micronutrients consist of calcium, magnesium, sulfur, copper, zinc, iron, etc. In fertilizer trade, these are rather insignificant and mostly are traded in complex-form fertilizer for special uses.

Of the three main elements required by plants, nitrogen is required by all kinds and nearly in every stage of growth of plants; seeding, stalk growth, flowering and fruit bearing, as this element is required by cells in all types of growth. It is found plentiful in legumes, waste meat, manure, guano, animal waste, etc., which, in the past, were used as sources of nutrient fertilizer to plants.

Potassium is also required by fruit-bearing plants. It is also required by plants in growth. Applied together with nitrogen, it will increase the rate of growth and resistance to diseases.

Phosphorus, the last macronutrient of the three, was required by plants bearing seeds. They can be found plentiful in plant seeds while its natural source is phosphate rock, treated or untreated.

By combining the three main elements in a proper proportion required by plants, plant growth and fruit bearing will reach or approach the maximum. However, each type of plants requires different composition.

The other elements are also needed by plants, but, to a certian extent and in a small quantity as they are generally available in soils. These are calcium, magnesium, sodium, chlorine, sulfur, etc. Shortage of any of these elements will endanger plants in various ways: stagnation of growth, less resistance to diseases, no fruit-bearing, infertility or, ultimately, death. Deficiency of iron and/or magnesium will result in the lack of chlorophyll, an important factor used by plants to synthesize starch from water and carbon dioxide. Deficiency of calcium, copper, zinc, boron, etc. will cause less resistance to diseases, stagnation of growth with evidence visible or invisible, or infertility up to death.

1.2 The Role of Fertilizer in Thailand

Synthetic fertilizer was introduced to Thailand after the second World War. From that time on, its demand has been increasing steadily. At present, there is only one semi-government enterprise producing fertilizer, namely; the Bangkok Fertilizer Factory. All others are privately owned.

The Bangkok Fertilizer Factory produces organic fertilizers which are mixed with chemical fertilizers in order to increase the nutrient content. Its production increased from 3,496 tons in 1961 to 9,497 in 1973. Table I-1 shows the production figures of this plant.

Table I-1

Organic Fertilizer Nutrient and Production

Bangkok Fertilizer Factory, 1961-1974

(ton)

Year	Quantity	N	P_2O_5	K_2O
1961	3,496	55	83	30
1962	9,108	77	88	66
1963	9,663	143	141	143
1964	12,863	190	181	192
1965	11,119	167	173	160
1966	16,018	274	382	176
1967	2,792	78	56	39
1968	2,064	60	49	31
1969	4,337	120	59	98
1970	6,553	137	131	86
1971	3,463	57	62	47
1972	10,459	184	169	149
1973	9,497	195	205	158
1974	9,497	195	205	158

Source: Impact of Fertilizer Shortage: Focus on Asia

Asian Productivity Organization, 1975

A synthetic fertilizer plant was built and started up in 1966, producing ammonium sulphate and urea from domestic lignite coal. Its production is summarised in Table I-2. This plant, the Mae Moh Fertilizer Factory which had a lot of problems, including management, production and raw material, was closed down by the Government in 1979.

Table I-2

Fertilizer Production Mae-Moh Fertilizer Factory

(ton)

Year	Ammonium Sulphate	Urea	Total	Nutrient
1966	4,325	-	4,325	887
1967	27,459	6,885	34,344	8,727
1968	19,838	7,045	26,883	7,237
1969	12,012	5,028	17,040	4,725
1970	27,034	12,629	39,663	11,245
1971	27,756	10,219	37,975	10,288
1972	25,651	5,500	31,151	7,723
1973	19,226	3,965	23,191	5,726
1974	7,503	2,309	9,812	6,722
1975				6,298

Note: 1) The figures are estimated by Division of Agricultural Economics, Office of the Under-Secretary of State, Ministry of Agriculture and Co-operatives.

2) The capacity of the plant is 27,000 tons/year (in the form of nitrogen nutrient only).

Source: Impact of Fertilizer Shortage: Focus on Asia Asian Productivity Organisation, 1975

However, the production of fertilizers in Thailand cannot meet the fast-growing demand. The main supply of fertilizers is through importation. Table I-3 shows the figures of imported fertilizers.

Other than the above-mentioned fertilizer plants, there are also private fertilizer plants producing fertilizers according to formulas appropriate for each kind of plants. These plants are blending plants using ingredients imported from abroad. They are:

Thai Central Chemical Company Limited

This is a blending plant which imports primary fertilizer in various forms and blends the fertilizer according to formulas for specific use by each kind of crop. The amount of fertilizer imported is 70,000 - 80,000 tons per year. There are many blends of fertilizers produced, e.g. for cane-sugar 21-10-18, 12-12-17, for rice 20-20-0, 26-20-0, for cassava 13-13-13, for garlic 15-15-15, etc.

Other Small Plants

There are also some 20 other small blending plants, with total capacity of 150,000 tons per year.

1.3 Application of Fertilizer in Thailand

In the past, fertilizers was available in natural forms, i.e. dungs, waste, legumes, etc. Farmers began to use concentrated (synthetic) fertilizers after the second World War but to a limited extent. The role

Table I-3

Importation of Fertilizer into Thailand

Year	Nitrogen	Phosphorus	Potassium	Total
1960				
1961				
1962	15,119	8,605	3,460	27,184
1963				
1964				
1965	17,917	8,693	3,726	30,246
1966	33,887	24,255	7,902	66,044
1967	43,286	35,667	12,689	91,642
1968	36,776	38,100	10,800	85,676
1969	41,000	45,300	10,800	97,100
1970	36,000	23,544	15,000	74,544
1971	27,000	43,339	22,800	93,139
1972	55,000	55,900	42,000	152,900
1973	52,854	51,384	40,064	144,302
1974	73,123	70,407	38,378	181,908
1975	74,554	62,223	39,074	175,851
1976	129,700	80,300	20,500	230,500

Notes: The weights are calculated according to the weight of the nutrients only, that is, nitrogen (N), Phosphorus pentoxide (P_2O_5), and Potassium oxide (K_2O)

Source: FAO Fertilizer Yearbook, 1967-1978

of fertilizer in Thailand became significant only during the past few decades. This can be seen from Table I-4. The demand of fertilizers doubled itself from 1971 to 1976 while the first doubling was from mid 1965 to 1971. It can be deduced that the demand will tend to increase in that way.

Application of fertilizer in kg/ha in Thailand, compared with other countries is also listed in Table I-5, Table I-6 shows the production of cereals in kg/ha.

The soil of Thailand has been used for agricultural purpose for centuries. The nutrients, contained in the soil are mostly used up. The application of fertilizer and the productivity of the land are compared in Table I-7 between Thailand and other Asian countries.

The hectareage productivity of the other countries relative to Thailand's are, 2.86 for Japan, 2.44 for Rep. of Korea, 1.67 for Malaysia, 1.13 for China, etc. The relatively higher productivities are partly due to the application of fertilizer (as this can be seen from Table I-7). This productivity can also be attributed to the application of more fertilizer together with other techniques, such as irrigation, etc. The potential of fertilizer application in Thailand is rather high, and, according to the projection of past record should double itself in the next 5-6 years. A preparation for this demand is needed now.

Table I-4

Fertilizer Demand of Thailand

Year	Production	Importation	Total
1960			
1961			
1962		27,184	27,184
1963			
1964			
1965		30,246	30,246
1966	887	66,044	66,931
1967	8,727	91,642	100,369
1968	7,237	84,906	92,143
1969	4,725	97,100	101,825
1970	11,245	74,544	85,789
1971	10,288	93,139	103,427
1972	7,723	152,900	160,623
1973	5,726	144,302	150,028
1974	6,722	181,908	188,630
1975	6,298	175,851	180,149
1976	6,852	230,500	236,852
1977	8,900	313,600	322,500

Notes: Weights of fertilizers are in nutrients (ton): Nitrogen, P_2O_5 and K_2O, excluding nutrients from the production of Bangkok Fertilizer Plant as the latter is insignificant in trade

Source: FAO Fertilizer Yearbook, 1967-1978.

Table I-5

The Fertilizer Application in Some Asian Countries

.1 kg/ha

		1961-65	1966	1971	1976
Thailand	N	12	26	44	76
	P_2O_5	7	18	30	45
	K_2O	3	6	16	11
	Total	21	51	90	132
Japan	N	1,223	1,422	1,177	1,329
	P_2O_5	822	1,023	1,152	1,334
	K_2O	943	1,032	1,006	1,248
	Total	2,989	2,477	3,336	3,911
Korea, Rep. of	N	926	1,037	1,517	1,622
	P_2O_5	496	540	691	629
	K_2O	142	254	405	620
	Total	1,565	1,832	2,613	2,851
North Korea	N	533	605	1,031	1,216
	P_2O_5	230	300	467	572
	K_2O	-	25	112	170
	Total	763	930	1,610	1,958
Israel	N	189	200	266	299
	P_2O_5	100	86	129	149
	K_2O	25	37	99	147
	Total	314	323	494	595

Table I-5 (Continued)

.1 kg/ha

		1961-65	1966	1971	1976
Burma	N	5	6	29	41
	P_2O_5	1	3	14	7
	K_2O	1	3	1	1
	Total	7	11	41	49
China	N	31	61	93	131
	P_2O_5	10	17	27	41
	K_2O	4	8	10	12
	Total	45	85	131	184
Malaysia (Pen.)	N	116	167	212	282
	P_2O_5	23	23	27	95
	K_2O	52	109	183	438
	Total	191	299	422	815
Indonesia	N	31	39	70	120
	P_2O_5	10	10	8	36
	K_2O	1	1	2	10
	Total	43	50	80	167
The Philippines	N	65	85	153	206
	P_2O_5	29	36	63	46
	K_2O	25	16	46	59
	Total	119	130	262	310

Source: FAO Fertilizer Yearbook, 1967-1978.

Table I-6

Productivity of Cereals in kg/ha in Some Asian Countries

	1969-71	1975	1976	1977
Thailand	2,011	1,894	1,851	1,759
Japan	5,046	5,932	5,292	5,914
Korea, Rep. of	3,496	4,086	4,519	4,992
D.P. of	2,707	1,105	3,303	3,519
Israel	1,445	2,075	1,734	1,999
Burma	1,610	1,700	1,686	1,708
Malaysia	2,777	2,958	3,081	3,078
China	1,875	2,074	2,091	2,061
Indonesia	2,010	2,306	2,455	2,397
The Philippines	1,298	1,321	1,355	1,436

Source: FAO Fertilizer Yearbook, 1967-1978.

Table I-7

Relative Application of Fertilizer and Productivity of Land in 1976

	Relative application	Relative productivity
Thailand	1	1
Japan	29.6	2.86
Korea, Rep. of	21.6	2.44
D.P. of	14.6	1.78
Israel	4.5	0.94
Burma	0.4	0.91
China	1.4	1.13
Malaysia (Pen)	6.2	1.67
Indonesia	1.3	1.33
The Philippines	2.3	0.73

1.4 Demand of NH_3 (Ammonia) in Thailand

During the past 14 years from 1962 to 1976, the demand of nitrogen fertilizer has four-folded itself, the first doubling of which occured in the first 5 years (approximately) and the second doubling took place in the last 10 years. However, the hectareage consumption is still low compared with the figures from other Asian countries. Japan, the leading country in using fertilizer, applies 29.6 times that of Thailand, while Korea (North) 14.8, Malaysia 6.2, the Philippines 2.3, etc. The hectareage productivity of cereals of these countries are found to be much higher than that of Thailand (see Table I-7).

Thailand has potential of higher productivity and in this, fertilizer will surely play an important role. Most of the commercial nitrogen fertilizer has ammonia as its basic material, whatever its source of raw material. The production of nitrogen fertilizer in Thailand from 1966-1976 had by far lagged behind the demand in the market and actual production never reached fifty percent of its plant full capacity (27,000 nutrient tons/year). This is due to obsolete production process, low-quality raw materials, and bad marketing policy. Table I-8 shows the percentage of production of nitrogen fertilizer compared to domestic requirements and actual production compared to the capacity of the plant (27,000 tons/year).

The importation of nitrogen fertilizer is shown in Table I-4. It is estimated by the author that the nitrogen fertilizer demand will reach 241,448 tons in 1985, 294,639 tons in 1990 and 347,826 tons in 1995.

Table I-8

Percentage of Production of Nitrogen Fertilizer Compared to Domestic Requirements and Actual Production Compared to Capacity

Year	Production/demand %	Production/capacity %
1966	2.40	8.78
1967	8.70	32.32
1968	7.84	26.80
1969	4.64	41.60
1970	13.10	38.10
1971	9.95	28.60
1972	4.80	21.20
1973	3.81	23.35
1974	3.56	15.92
1975	2.40	
1976		

There is a need for a new fertilizer production plant to meet this rapidly-increasing requirement of fertilizer. In the case of nitrogen-nutrient, this means that a new ammonia plant should be constructed.

One of the ASEAN projects, the soda ash project, utilizing rock salt discovered in the north-east region of Thailand will require ammonia as a path or raw material of its manufacture. However, this will depend on the process adopted to run the plant. The A-C process will ideally require ammonia 0.91 tons for every ton of soda ash produced. The Solvay process will require ammonia to operate. The Japanese N-A

(New Asahi) process will produce ammonium chloride as by-products and ammonia requirements for each ton of soda ash produced in this process will depend on the ammonium chloride demand in the market since the amount of ammonium chloride from the process is adjustable. As this project will start to produce 9,000 tons of soda ash in 1986 and 500,000 tons in 1997, a preparation for this project should be made beforehand and the process adopted be studied.

The project of production of explosives requires nitric acid which, in turn, is manufactured from ammonia. The production of explosives can be done by reacting raw materials with nitric acid to produce trinitroglycerine, trinitrotoluene, etc. and there is still no nitric acid plant in Thailand, as there is no ammonia plant to supply raw material. This also stresses that an ammonia plant be set up, as this is a part of a complete fertilizer complex.

All demands of these industries leads to one same point, a steady and secure supply of ammonia. A supply from abroad will not be so steady due to price changes, political situations and impacts of the world especially in the case of ammunition industry. A domestic supply is absolutely necessary and urgent. Raw materials usable to manufacture ammonia include:

1. Natural gas
2. Coal
3. Naphtha
4. Oil
5. By-product of spongy iron project

6. Coal gasification

7. Oil refinery light hydrocarbons

005303

Options 3 to 7 are dim, as 3, 4 and 7 are based on imported oil, the supply of which varies greatly during the recent years due to world political situations, 6 is due to the fact that Thailand has not developed a coal gasification plant to produce coke and other products of its own, while 5 is available only from a gigantic iron foundry industry. Only 1 and 2 has high potential. Ammonia from coal is a possible solution as oil price is going up rapidly. Coal in Thailand is mainly lignite, with high content of calcium which will create operating problems. The choice of natural gas to produce ammonia is justifiable as natural gas has been discovered in great amount in the Gulf of Thailand and the cost of production of ammonia from natural gas is presently the cheapest in the world. In short, a plant based on naphtha will cost 10% more, and one based on coal 100% more (Lowenhein, 1975).

1.5 Natural Gas in the Gulf of Thailand

Thailand started her exploration for oil and natural gas projects in the Gulf of Thailand in June 1971 and up to March 1979, the results of exploration and drilling tests discover, from 47 wells drilled, 3 crude oil wells in the plot 6, 12, 15 and 18 wells of natural gas from plot 10, 12, 13, 15, 16 (NGOT, 1979). The major product discovered is natural gas being in 2 big wells. That is:

Well A, owned by Union Oil Co., has a natural gas reserve of 1-2.2 trillion cubic feet which is available for supply at the rate of

150-250 million cubic feet a day for 20 years. It is situated from Nakorn Srithammarat for 160 km. and from Sattahip for 425 km.

Well B, owned by Texas Pacific Co., has an estimated reserve of natural gas for 1-4.4 trillion cubic feet. Being available at the rate of 250-600 million cubic feet per day, it can supply up to 20 years. It is situated from Songkla for 210 km. and from Sattahip for 605 km. (NGOT, 1979).

Other than that, there are 15 more wells which also contain natural gas but no declaration of the gas quantity has been made on these. The natural gas price agreed and signed by the Union Oil Co., and the Petroleum Authority of Thailand is US$ 1.046 for 1 million BTU or 1,000 cubic feet of natural gas with escalation factor.

The projected consumption of natural gas beginning 1981 are as follows:

1. Power station consumption 350 million ft^3/day.
2. Large scale industry
   - 2.1 Spongy Iron. The consumption of which is 9 million ft^3/day in 1983 to 49.3 million ft^3/day in 1991.
   - 2.2 Ammonia and Soda Ash Industry. Natural gas consumption is 20.3 million ft^3/day in 1982 to 39.6 million ft^3/day in 1991.
3. Medium and small scale industries requirement is approximately 29 million ft^3/day. The natural gas will be supplied to the areas reached by gas lines only.
4. Household consumption in the modern area is estimated at 1.5 million ft^3/day (for 15,000 units of lodgings at Bangplee).

1.6 The Purpose of This Study

Fertilizer demand, ammunition industry, soda ash project and other industries indicate a big demand for ammonia. Fertilizer demand is of prime importance to be considered as the biggest demand is from this sector. The ammonia used in the soda ash project will turn out as ammonium compound by-products and, at the end, used in agricultural application. The nitrogen nutrient used in agriculture can be seen from Table I-3 and it is projected by linear regression analysis that the nitrogen nutrient demand in Thailand will be 160,965 tons in 1985, 196,426 tons in 1990 and 231,884 tons in 1995. According to a study by Groll (1971) fertilizer application of Thailand in the past was less than the minimum fertilizer required by plants. Also as of Tables I-5, I-7, Thailand fertilizer application in 1976 was less than that of other Asian Countries except Burma. It is estimated that Thailand nitrogen fertilizer application in the future will be 1.5 times that of the figures projected from the linear regression analysis; that are, 241,448 tons in 1985, 294,639 tons in 1990 and 347,826 tons in 1995.

This study will serve to see the prefeasibility of a 1,200 tons/day ammonia plant using natural gas from the Gulf of Thailand, as 1,200 tons/day ammonia is to be supplied to the fertilizer complex, soda ash plant, transforming to nitric acid for ammunition factory and industrial uses in 1995. It will contain process study ammonia synthesis, preliminary design of equipment, costing of equipment and investment analysis.