China

Yunnan Fertilizer Plant Construction Project (1)(2)(3)

Report Date：October 2002
Field Survey：July 2001

1. Project Profile and Japan's ODA Loan

Site Map：Anning, Kunming, Yunnan Province

Site Photo: Yellow Phosphorus Plant of Yunnan Fertilizer Plant

1.1 Background

Annual food production of China in 1980s was in the range from 320 million tons to 410 million tons. For the year of 2000, Chinese government set its food production target at 500 million tons based on the population of 1,250 million and per capita food requirement of 400 kg per annum. The Government has realized that it is essential to increase the input of fertilizer to increase the volume of food production, which significantly contributes to the improvement in the productivity of food production. On the other hand, there is a considerable gap in the supply and demand of fertilizer in China and the nation is importing fertilizer in great volume every year. Volume of fertilizer imported in 1989[1] was 13.93 million tons (in weight[2]) and the amount of foreign currency paid for such import was as much as $2,360 million. Because of the situation, there is an urgent need of domestic fertilizer production for stable fertilizer supply and to save foreign currency. Gap between supply and demand of phosphorus fertilizer in 1985 was 580,000 tons and 25% of the consumption was covered by the import. Ratio of nitrogenous fertilizer and phosphorus fertilizer in the total chemical fertilizer in 1987 was as low as 1:0.22, while the demand of agricultural department was 1:0.5. Since this situation was calling serious limitation on the agricultural production, it was an urgent task to construct phosphorus fertilizer plant to improve this ratio. To solve this supply and demand gap in fertilizer, Chinese government has prepared a plan to construct 10 fertilizer plants in the whole nation with a total production capacity of 2.43 million tons (in net volume[3]) in its 8th Five-Year Plan (1991～1995).

Since Yunnan Province, which is an objective site of this project, is rich with resources of phosphate rocks and inexpensive power supply by hydroelectric power generation, it was decided to construct a triple superphosphate[4] (TSP) via phosphate by an electric furnace method in Anning, Kunming, Yunnan Province (47km west from the center of Kunming).

1.2 Objectives

Objectives of this project are to cope with the demand of fertilizer and to improve the productivity in

[1] Chinese fiscal year is from January to December.
[2] Total of actual weight of all fertilizer types such as nitrogen, phosphate, potassium and complex type
[3] Total weight of active ingredients (nitrogen, phosphate and potassium) contained in the above fertilizers
[4] Phosphate fertilizer produced from phosphoric acid and phosphate rock contains 40 to 50% of water-soluble phosphoric acid portion.

the food production for entire China through the construction of triple super phosphate (TSP) fertilizer plant with annual production capacity of 400,000 tons (or 191,000 tons in net volume).

1.3 Project Scope

Subject of the loan is the total amount of foreign currency portion of the project cost required to construct plants for yellow phosphorus[5], phosphorus, and TSP to produce triple superphosphate (TSP) fertilizer in the volume of 400,000 tons per annum.

1.4 Borrower/Executing Agency

External Trade Department, The People's Republic of China[6]/Chemical Industry Department, The People's Republic of China

1.5 Outline of Loan Agreement

	First	Second	Third	Total
Loan Amount Loan Disbursed Amount	2,633 Million Yen 2,633 Million Yen	5,690 Million Yen 5,690 Million Yen	5,745 Million Yen 5,745 Million Yen	14,068 Million Yen 14,068 Million Yen
Date of Exchange of Notes Date of Loan Agreement	November 1990 November 1990	September 1991 October 1991	August 1993 August 1993	- -
Terms and Conditions Interest rate: Repayment period: (Grace period)	 2.5% 30 years (10 years) General untied	 2.6% 30 years (10) General untied	 2.6% 30 years (10) General untied	- - - -
Final Disbursement Date	December 1995	November 1996	October 2000	-

2. Results and Evaluation

2.1 Relevance

This project has a high priority, as it is in line with the basic policy of planned economy of China in its 8th Five-Year Plan to solve supply-demand gap in fertilizer and to save foreign currency that will be spent for the import of fertilizer. And also, the plan is relevant from a viewpoint of food production increase and foreign currency saving, as it aims to increase domestic fertilizer production. Furthermore, stable food production is a continuously important political issue for China, though a drastic change has occurred in the economic climate in the course of project implementation to introduce market economy system. Even today, relevance of this project does not change at all in view of the production and sales of fertilizer, which contributes to the improved productivity in food production.

Originally, it was planned to produce triple super phosphate (TSP) in this project by employing electric furnace method (dry process)[7] and taking an advantage of inexpensive power supplied from MANWAN hydraulic power plant of Yunnan Province. However, this project became unprofitable because of increased power cost and sluggish market price of TSP product. Under such circumstances, project operator (Yunnan Phosphorus Fertilizer Industry Co. Ltd.) has given up the production

[5] Yellow phosphorus is produced in electric furnace after phosphate rock is mixed with silica sand and coke.

[6] Present External Trade Economic Collaboration Department. Also, after 1999, borrower of the Japanese Loan to China was changed to the government (Finance Department) of the People's Republic of China.

[7] As a process to manufacture phosphoric acid required for TSP production from phosphate rock, dry process and wet process are available. Dry process is a technology to manufacture phosphoric acid through the yellow phosphorus manufacturing process with electric furnace that can be applied to phosphate rock with relatively poor quality, but it requires inexpensive supply of electricity. Wet process is a method to decompose phosphate rock with sulfuric acid or nitric acid. Generally speaking, however, sulfuric acid is used for the decomposition.

method to use electric furnace but has been trying to change the production system to wet process with which production is possible without electricity to produce TSP via phosphorus production. Bases that the dry process was adopted in the planning stage were; (1) difficulty to obtain sulfuric acid required in the wet process, (2) limited supply of phosphate rock that fits to use in the wet process in Yunnan Province, (3) availability of inexpensive electricity with suitable condition for the production in dry process, and so forth. However, in the project under price controlled economy like this project, it was highly possible to have serious influence on the sustainability of the project due to the change in the macroeconomic policy such as the shift into market economy or in the movement of the international product market. As such, it could be said that the detailed study was necessary on these factors in the stage of project appraisal.

2.2 Efficiency

1) Project Cost

As a result of considerable increase in the project cost in Chinese currency portion to 2,005 Million RMB from planned 1,020 Million RMB, total cost in Japanese currency overran as much as 19%. Project operator explained that the increase in Chinese currency portion was due to underestimate of civil engineering and construction costs at the time of planning and to cost increase in the construction materials such as steel or cement owing to the shift into market economy system.

Though there was not a problem in the loan disbursement, very tight financing in Chinese currency was one of the causes that delayed construction period.

2) Implementation Schedule This project was started with the bidding for the plant in January 1991. Trial run delayed 8 months from original schedule and commercial operation started in June 1997. The causes of such 8 months delay were delayed completion of yellow phosphorus plant due to the reasons at contractor's side, delayed input of the fund in Chinese currency, and delayed delivery of domestically procured equipment due to the confusion caused by the reform in the economical structure and transition from the planned economy.

2.3 Effectiveness

1) TSP Production Volume

Annual TSP production volumes during its operating period of this project were as shown in Table 1. Percentage points of actual annual production against production capacity of 400,000 tons/year resulted in very low levels of 5.5% in 1997, 6.5% in 1998, 6.0% in 1999, and 13.2% in 2000. Operation factor of the plant in terms of operation days resulted in as low as 23% in 1997, 11% in 1998, 8% in 1999, and 21% in 2000.

Table 1：TSP Production in Electric Furnace Method and Number of Days in Operation

	1997 (Completed)	1998 (2nd year)	1999 (3rd year)	2000 (4th year)
Actual Production (Ton/year) (*)	21,812	25,975	23,908	52,797
Annual number of days in operation (days)	69.7	33.4	25.8	64.2

Source: Data of Implemented Organization

(*) In weight

Project operator reported that the reasons of low production volume and low number of days in operation were decreased profitability of TSP production with electric furnace process resulted from

the steep electricity cost increase[8] and low operating factor of yellow phosphorus plant and phosphoric acid plant due to the trouble of equipment.

This project operator had stopped TSP production with electric furnace process at the end of 2000 and since early 2001, it had been carrying out TSP production using phosphoric acid purchased from outside source. Also, project operator decided to switch phosphoric acid production process from electric furnace process to wet process, as a result of consultation with National Planning Committee and Yunnan Province Government, and was constructing a wet process phosphoric acid plant with its own fund. This plant had completed in July 2001 and it was in the stage of trial run at the time of this evaluation.

2) Supply and demand gap on phosphorus fertilizer in China

Annual TSP production volumes at project plant are very small as shown in Table 1 and, therefore, this project has hardly contributed to satisfywith the demand for phosphorus fertilizer or domestic fertilizer in general. Table 2 shows supply and demand balance of phosphorus fertilizer in China. It shows that the supply and demand gap for phosphorus fertilizer is expanding and a large portion of the demand is still filled by imported phosphorus fertilizer.

Table 2 Production/Consumption Balance in Phosphorus Fertilizer (Unit: 10,000 tons/year net)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Production (*1)	412	416	455	417	497	619	575	560	663	636
Consumption (*2) (Note 1)	619	687	729	818	877	941	996	1,056	1,061	1,103
Assumed Import (*3) (Note 2)	207	271	274	401	380	322	421	496	398	467
Assumed Import Ratio (*4) (Note 3)	33%	39%	38%	49%	43%	34%	42%	47%	38%	42%

Source: China Almanac and Chemical Industry Almanac

Note 1: Compensated by assuming components of composite fertilizer as 18% nitrogen portion and 46% phosphorus portion.

Note 2: Since actual import data was not available, import was calculated by deducting production from consumption.

Note 3: Import ratio was calculated by dividing import volume by consumption.

3) Consumption of phosphate rock

In China, Yunnan Province and Kueichou Province have a large reserve of phosphate rock. In particular, the reserve near SHINIKE, Anning, Yunnan Province is the largest in China and this was one of the reasons that it was selected as a project site. SEKAGEYAMA phosphate mine we visited at the time of evaluation is located at 32 km distance from the project site. We were told that it is possible to mine and transport phosphate rock up to 2.4 million tons per annum. Initially, if the total planned volume of TSP was produced in the project plant, estimated requirement for raw phosphate rock was around 800,000 tons per annum. However, since the production has not been made as scheduled at the project plant, consumption of phosphate rock is not as scheduled.

4) Consumption of electricity

Expecting inexpensive power supply from MANWAN power plant in Yunnan Province, TSP production system through the production of yellow phosphorus in electric furnace method was adopted for this project. Power generating capacity of MANWAN power plant is 1.25 million kW

[8] Cost of electricity at the time of evaluation was 0.2144 RMB/kWh, which is approximately 10 times of presumed unit electricity purchase cost of 0.0205 RMB/kWh at the time of appraisal (1990). Selling price of TSP in 2000 was 1,000 RMB/ton while presumed selling price was 696 RMB/ton at the time of appraisal (1990).

(250,000 kW x 5 units) and regular power generating capacity is 785,000 kW. It was a precondition of this project to have a supply of necessary power of 10,800 million kW per annum from this plant. However, since economic competitiveness of TSP production in electric furnace process has been lost due to very steep rise in the cost of electricity occurred as a result of the shift into market economy, planned electricity from MANWAN power plant has not been consumed by this project.

5) Recalculation of Internal Rate of Return (IRR)
At the time of appraisal, it was assumed that the financial internal rate of return (FIRR) will be 9.0% and economical internal rate of return (EIRR) will be 9.5%. However, since effectiveness of TSP production of this project in electric furnace process is limitted, internal rate of return resulted in negative figure.

2.4 Impact

1) Ratio between nitrogenous fertilizer and phosphorus fertilizer in China
Ratio between nitrogenous fertilizer and phosphorus fertilizer was 1:0.38 in 1990 and this ratio had gradually risen to 1:0.47 in 1999 as shown in Table 3, which was close to the requirement of agricultural department. However, this rise in the ratio is not only caused by the increase in the production volume in China but also largely caused by the import of phosphorus fertilizer by spending foreign currency. Also, since production volume of this project is very limited, it seems that this project has not made any significant contribution to the increase of this ratio.

Table 3 Ratio between Nitrogenous Fertilizer and Phosphorus Fertilizer

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Nitrogenous fertilizer (10,000 tons/year net)	1,700	1,799	1,839	1,930	1,990	2,143	2,277	2,316	2,381	2,339
Phosphorus fertilizer (10,000 tons/year net)	617	689	729	818	877	941	996	1,056	1,061	1,103
Ratio between nitrogenous fertilizer and phosphorus fertilizer	1:0.36	1:0.38	1:0.40	1:0.42	1:0.44	1:0.44	1:0.44	1:0.46	1:0.45	1:0.47

Source: China Almanac

Note: Compensated by assuming components of composite fertilizer as 18% nitrogen portion and 46% phosphorus portion.

2) Improved Food Production and Productivity in China
A policy target, “to increase food production to 500 million tons in 2000 based on the population of 1.25 billion and per capita food requirement of 400 kg per annum,” which was established under 8th Five-Year Plan, overall goal of this project, was materialized as shown in the data of Table 4. However, since production volume of the project plant was very limited, it is hardly said that the project has contributed to the materialization of the above overall goal.

Table 4: Improved Food Production and Productivity in China

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Food Production (10,000 tons/year)	44,624	43,529	44,266	45,649	44,510	46,662	50,454	49,417	51,230	50,839
Population (x10,000)	114,333	115,823	117,171	118,517	119,850	121,121	122,389	123,626	124,810	125,909
Per Capita Food Production (kg)	390	376	378	385	371	385	412	400	410	404
Fertilizer applied acreage = Planted acreage (x 1,000 ha)	113,466	112,314	110,560	110,509	108,544	110,060	112,548	112,912	113,787	113,161
Unit applied fertilizer (kg/ha) Net	228	250	265	285	306	326	340	353	359	364
Unit food production (kg/ha)	3,983	3,876	4,004	4,131	4,102	4,240	4,483	4,377	4,502	4,493

Source: China Almanac

3) Regional development and generation of employment opportunity in Yunnan Province
Since the project plant and related facilities were constructed, a plot of ground in the size of approximately 1,152 hectares was developed for the plant and peripheral site in the suburbs of Kunming city of Yunnan Province, which was originally an agricultural region, and a private railroad line in 12.9 km length and 10 km road were constructed.
Also, according to the Yunnan Phosphorus Fertilizer Industry Co., Ltd., a business operator of this project, the project directly created 2,517 employments (including 1,023 female employees), and residents increased in the surrounding area of this project approximately by 8,000. As such, it can be said that this project has contributed to the regional development and employment opportunity.

4) Impact on Natural Environment
Project operator has reported that air and water pollution monitoring is periodically conducted measuring fluoride, dust and sulfur dioxide in the air and phosphorus element, phosphate and fluoride in the wastewater, and that every item is within the acceptable range fixed by the relevant regulation. Business operator has also reported that they have not received any instruction or recommendation from the Environment Protection Bureau of Kunming City, which is a controlling government agency for environmental protection, relative to the environmental protection of this project.

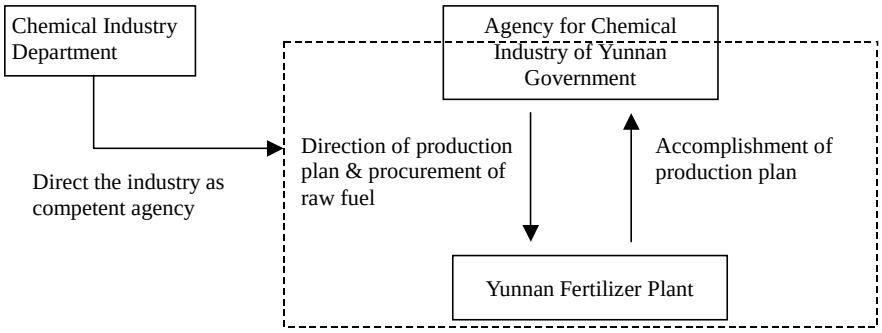
5) Impact on Social Environment
The business operator explained that no negative social impact including the relocation of residents has been reported on the construction of this project.

2.5 Sustainability

1) Operation and Maintenance System
At the time of appraisal, it was agreed that the Chemical Industry Department of the Central Government directs the industry as a competent authority under the planned economy system as shown in Fig. 1 and Yunnan Fertilizer Plant carries out actual operation and maintenance based on

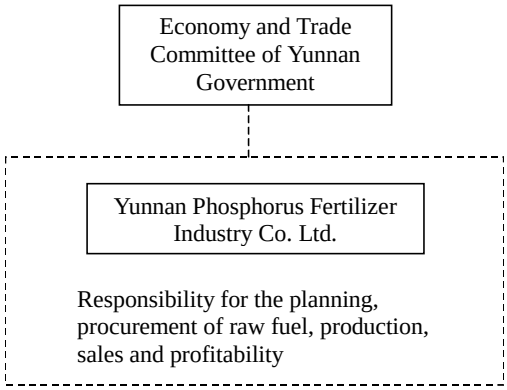
the production plan prepared by the Agency for Chemical Industry of Yunnan Government who is also responsible for the procurement of raw fuel. However, in the course of the project implementation, China has made a fundamental change in its economical principle and introduced socialism market economy and fertilizer field has also shifted into market economy around 1996 in the midst of such trend, and the transission is still continuing. Along withthe shift in the economic system, higher functions of central and provincial governments were abolished. And business operator itself started to carry out all necessary works such as planning, procurement of raw fuel, production, and marketing and assumed responsibility for the profitability of the project. Operation and maintenance system at the time of evaluation was changed as shown in Fig. 2.

Fig. 1: Control and Operation System at the time of Appraisal



Source: JBIC Data

Fig. 2: Control and Operation System at the time of Evaluation



Source: Data of Implemented Organization

Yunnan Phosphorus Fertilizer Industry Co. Ltd. (hereafter referred to as Yunnan Phosphorus Fertilizer Plant), which was organized under Economy and Trade Committee of Yunnan Government in April 1997, is responsible for the management and maintenance of this project. Total number of employee of Yunnan Phosphorus Fertilizer Plant at the time of appraisal was 2,517, which consisted from 1,638 in production department, 772 in production control and sales department and 107 in the party committee department.

2) Situation of Operation and Maintenance

Originally, it was planned to produce 400,000 tons of TSP per year by purchasing inexpensive electricity of hydraulic power and using dry phosphoric acid manufactured via yellow phosphorus by electric furnace process. However, as the cost of electricity has sharply increased according to the shift of economical system into market economy, and manufacturing cost of TSP has increased considerably, profitable operation could not be expected in the production and marketing of TSP. Under such circumstances, production and marketing of TSP via dry phosphoric acid had been interrupted since early 2001 until today.

On the other hand, Yunnan Phosphorus Fertilizer Plant had discussed reconstruction of this project with National Planning Committee and Yunnan Government in August 1999. As a result of this discussion, following decisions were made. (1) Reduce cost of electricity from 0.26 RMB/kWh to 0.2144 RMB/kWh for three-year period starting from January 2000. (2) Reduce burden of interest payment by converting borrowed money of 1.36 billion RMB into stocks. (3) Modify the plant to

produce TSP by newly installed wet process in lieu of electric furnace process. (4) Study to produce not only TSP but also DAP or NPK in the future. According to this decision, construction of phosphoric acid production plant in wet process, which is equivalent to 200,000 tons/year of TSP, was completed in July 2001 using its own fund (though the production had not been started at the time of field survey.) Yunnan Phosphorus Fertilizer Plant will not operate dry-process phosphoric acid production plant constructed by Japanese loan in the future, instead, it will be producing TSP using phosphoric acid produced by newly installed wet-process phosphoric acid production plant and asking National Commercial Bank for necessary liquidity finance.

3) Financial Situation

Though commercial operation of this project started in June 1997, production volumes of TSP from 1997 up to the time of evaluation were only around 9% of the plant capacity as shown in Table 1. As such, profitability of the project seemed extremely poor, however, we were unable to obtain the data that shows financial situation of the project.

Under such circumstances, Yunnan Phosphorus Fertilizer Plant, project operator of this project, is trying to establish TSP production system with wet process phosphoric acid through the construction of wet type phosphoric acid plant, as both sustainability and self-reliance could not be accomplished with dry type phosphoric acid. However, in view of the fact that the market for TSP to be produced in the future seems not yet established and the TSP market is very sluggish at the moment, it would be very difficult to maintain profitability even if they could sell 200,000 tons of TSP they could produce in a year. It is feared for them to keep sustainability and autonomous development. Therefore, we must carefully watch the managing situation of Yunnan Phosphorus Fertilizer Plant in the future.

3. Lessons Learned

It is extremely difficult to forecast the risk of market fluctuation under the price-controlled-economy like in the case of this project. In particular, when relevancy of supply and demand analysis is reviewed in the manufacturing project, thorough study must be made in the planning and appraisal stages of the project on the direction of macro-economic policy, which may give grave impact on the feasibility or sustainability of the project or international market condition of the product. As the case may be, study of concrete measure to alleviate the risk of market fluctuation would be necessary.

Comparison of Original Plan and Actual Scope

Item	Plan	Actual
① Project Scope		
Yellow phosphorus plant	60,000 tons/year	60,000 tons/year
Phosphoric acid plant	140,000 tons/year (in P_2O_5)	140,000 tons/year (in P_2O_5)
TSP plant	400,000 tons/year (actual)	400,000 tons/year (actual)
② Construction Period		
Yellow phosphorus plant	Mar 1993－Oct 1996	Mar 1993－Jun 1997
Phosphoric acid plant	Jun 1993－Jul 1995	Jun 1993－Jun 1996
TSP plant	Mar 1992－Sep 1995	Mar 1992－Aug 1996
Completion of total run	Oct 1996	Jun 1997
Start of commercial run	Oct 1996	Jun 1997
③ Project Cost		
Foreign Currency	14,068 Million Yen	21,357 Million Yen
Local Currency	21,318 Million Yen	18,662 Million Yen
	(1,020 Million RMB)	(2,005 Million RMB)
Total	35,386 Million Yen	42,138 Million Yen
ODA loan portion included	14,068 Million Yen	14,068 Million Yen
Exchange Rate	1 RMB = 20.9 Yen	1 RMB = 14.0 Yen (Note)

Source: JBIC Data and Data of Implemented Organization

Note: Actual exchange rate is a weighted average value.