Report No. 1247-KO

Korea
Yong San Gang Irrigation Project Stage II
Appraisal Report

January 3, 1977

Irrigation and Area Development
East Asia & Pacific Project Department

FOR OFFICIAL USE ONLY

Document of the World Bank

CURRENCY EQUIVALENTS

US$1	=	Won 485
Won 1,000	=	US$2.06
US$1 million	=	Won 0.485 billion
Won 1 million	=	US$2,062

WEIGHTS AND MEASURES

1 meter (m)	=	3.28 feet (ft)
1 kilometer (km)	=	0.62 miles
1 hectare (ha)	=	2.47 acres
1 million cubic meters (million cu m)	=	810 acre-feet
1 cubic meter per second (cu m/sec)	=	35.3 cu ft/sec
1 ton	=	2,205 pounds
1 kilogram (kg)	=	2.2 pounds

ABBREVIATIONS

ADC	-	Agricultural Development Corporation
FLIA	-	Farm Land Improvement Association
kVA	-	Kilovolt Amperes
MAF	-	Ministry of Agriculture and Fisheries
NACF	-	National Agricultural Cooperative Federation
ORD	-	Office of Rural Development
OSROK	-	Office of Supply of the Republic of Korea

GOVERNMENT OF KOREA FISCAL YEAR

January 1 - December 31

APPRAISAL OF THE YONG SAN GANG IRRIGATION PROJECT: STAGE II

TABLE OF CONTENTS

ANNEXES

CHARTS

MAPS

KOREA

APPRAISAL OF THE

YONG SAN GANG IRRIGATION PROJECT: STAGE II

SUMMARY AND CONCLUSIONS

1. The Government of the Republic of Korea has requested Bank assistance in financing the second stage of the Yong San Gang Irrigation Project. The project would provide irrigation and land development for some 20,700 ha and would directly benefit about 29,000 farm families or approximately 174,000 people. An estuary dam, constructed near the mouth of the Yong San Gang river, would create a reservoir from which water would be pumped to irrigate the surrounding lands. In addition to pumping stations and canal systems, the project would include the reclamation of about 5,500 ha of uncultivated tidal flats. Land development on the remaining 15,200 ha would include conversion of 3,250 ha of uplands to paddy; land consolidation on 3,200 ha of paddy; and upland irrigation on 1,050 ha. The project also includes construction of buildings, access roads and temporary piers, and engagement of consulting firms to assist in project implementation and a feasibility study for future development stages of the Yong San Gang Basin.

2. Major Government objectives in the agricultural sector are to achieve and maintain self-sufficiency in rice and barley production, and to raise incomes and living standards of the farming population. The proposed project would help the Government achieve these goals through increased productivity of existing lands and development of presently uncultivated lands. Other Bank Group investments in irrigation and land development include the Pyongtaek-Kumgang Irrigation Project (Loan 600-KO) and Yong San Gang Irrigation Project: Stage I (Loan 795/Credit 283-KO) covering 30,000 ha and 33,000 ha respectively; the minor irrigation (13,500 ha) and upland reclamation (4,500 ha) components of the Rural Infrastructure Project (Loan 1216-KO/1218T-KO), and the Miho Watershed Area Development Project (Loan 1319-KO), which would benefit some 12,700 ha.

3. Total cost of the project is estimated at US$167 million (Won 81 billion), including provision for price increases of US$55.2 million, or 33% of total project costs. The proposed Bank loan of US$95 million would finance the foreign exchange component of US$87 million, or 52% of the project cost and interest and other charges on the Bank loan of US$8 million. Contracts for construction of civil works (US$74.0 million, excluding expected price increases) and supply of sluice gates, pumping equipment, and construction materials (US$19.5 million) would be awarded on the basis of international competitive bidding in accordance with Bank guidelines for procurement. Contracts for the construction of the access road together with the left embankment of the estuary dam (US$2.5 million) and for buildings and other site facilities (US$0.8 million) would be awarded after local competitive bidding.

4. The Agricultural Development Corporation (ADC), a semi-autonomous agency operating under the Ministry of Agriculture and Fisheries (MAF), would be responsible for project implementation. Within ADC, responsibility for execution of the project would rest with the Yong San Gang Project Office, which is presently engaged in implementation of the first-stage project and was primarily responsible for the Stage II feasibility study.

5. The project would increase rice production by nearly 56,000 tons, and barley by nearly 30,000 tons. Farm income on an existing rainfed 0.3 ha farm benefitting from the project would increase from US$610 to US$850 at full development in 1989. For 1.0 ha and 2.0 ha farms, the respective increases in incomes would be from US$1,560 to US$2,350 and from US$2,960 to US$4,300. About one-third of the farmers in the project area own 0.5 ha or less; one-third between 0.5 ha and 1.0 ha; and about one-third between 1.0 ha and 3.0 ha. Some 3,800 new farms would be established on the reclaimed tidal land. The project's economic rate of return is estimated at 13%. The rate of return is only moderately sensitive to increases in costs and delays in benefits.

6. The proposed project is suitable for a Bank loan of US$95.0 million for a period of 17 years, including a three and one-half year grace period to the Agricultural Development Corporation, with the guarantee of the Republic of Korea.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

1. INTRODUCTION

1.01 The Government of the Republic of Korea has requested Bank assistance in financing construction of Stage II of the Yong San Gang Irrigation Project in the south-western part of Korea. The project would irrigate 20,700 ha from a reservoir created in the lower reach of the Yong San Gang river by construction of an estuary dam. The project was prepared by the Agricultural Development Corporation assisted by Sanyu Consultants International of Japan whose services were financed through the Yong San Gang Irrigation Project: Stage I (Loan 795/Credit 283-KO).

1.02 This report is based on the findings of a Bank mission which visited Korea in December 1975, comprising Messrs. W.T. Smith, R. Baskett, C. Goldfinger (Bank), J.C. Douglass and R.A. Pearse (Consultants). Mr. M. Saddington assisted in preparation of the report.

2. BACKGROUND

The Agricultural Sector

2.01 The Republic of Korea covers some 98,000 sq km, with about one-fourth its area in farms and two-thirds in forests. The 1975 population is estimated at 34.0 million, with a recent annual growth rate of 1.7%. Agriculture provides 25% of the GNP and 50% of the total employment. The rural population, consisting of almost 2.4 million households, accounts for 40% of the total population.

2.02 About 23%, or 2.3 million ha, of Korea's total land area is cultivated. Lowlands used primarily for rice production occupy just over 1.3 million ha and cultivated uplands account for nearly 1.0 million ha. Annual rice production in years of favorable rainfall is on the order of 4.2 million tons. Production of winter cereals, chiefly barley, generally approaches 2.0 million tons annually on a cropped area of some 1.0 million ha; about 45% of the winter cereals is grown on the lowlands after the rice harvest and the remainder as a winter crop on the uplands. Soybeans occupy the largest area of the summer crops grown on the uplands; annual production is about 300,000 tons on about 30% of the uplands. Other important upland crops are fruits, vegetables, tobacco and ginseng.

2.03 Annual food grain production has grown little over the past decade. A steady rise in rice production has been offset by declines in barley and wheat production due to conversion of uplands to paddy. Population growth coupled with rising per capita consumption has caused annual grain imports to grow from 700,000 tons in the early 1960s to an average of 3 million tons in the period 1971-75. In 1975, food grain imports cost US$724 million. Wheat and corn account for nearly two-thirds of the tonnage of imported food grains.

2.04 The Government places high priority on expanding food grain production to achieve self-sufficiency to the extent possible. While it is realized that overall self-sufficiency will not be possible, efforts are being made to expand production of rice, barley and soybeans to meet domestic requirements. This will have to be achieved mainly through higher yields on presently cultivated land since future expansion is limited to about 300,000 ha of uncultivated upland and tidal flats. Rice yields are already high (3-4 ton/ha of polished rice)/1 but are still below yields achieved in a similar environment in Japan. Yield increases are therefore possible through irrigation coupled with wider use of high yielding varieties. Areas devoted to winter cereals on the ricelands can also be increased where the construction of improved irrigation and drainage works allows more timely planting and harvesting of the rice crop. On the uplands, some increase in barley production should be possible through wider use of high yielding and early maturing varieties. Some increase in wheat production in the uplands is possible, but it would be insignificant in relation to domestic requirements. Yields of other upland crops could also be increased through use of new varieties and by lime application, which would increase the response to fertilizer.

2.05 Investment in agriculture during the Third Five-Year Plan (1972-76) was close to Won 800 billion compared with Won 260 billion in the Second Plan and Won 130 billion in the First Plan. Emphasis was being placed on increasing the productivity of existing cultivated land through irrigation, drainage and flood control, and by increasing the area under high-yielding varieties of rice and other crops.

2.06 The average farm size in Korea is about 0.9 ha, of which 0.5 ha is paddy land, while the remainder is upland used for crops, such as barley, maize, soybeans, fruit, vegetables, tobacco, mulberries (for

---

/1 Yields of rice and barley are expressed in terms of polished grain after milling, assuming a milling yield of 67% for rice and 75% for barley.

silkworm production) and other cash crops. Nearly two-thirds of farm households have less than one ha of cropland but only 4% of farm households are landless. Most farmers own the land they cultivate. This equitable distribution of land ownership is the result of the Farmland Reform Laws of 1945 and 1950, which imposed a ceiling of 3.0 ha on cultivated land per household.

Rural Incomes and Employment

2.07 Government policy of raising and stabilizing prices of major farm products and subsidizing farm inputs had the effect of raising rural household incomes relative to urban incomes over the last five years. However, it is expected that productivity gains in mining and manufacturing will continue to outstrip those in agriculture, and it is unlikely that the terms of trade for agriculture will improve much in the future due to the need to hold down food prices and reduce budget deficits. To prevent a relative deterioration of rural incomes, it will therefore be necessary to improve productivity in agriculture through investments in irrigation and land development, and to stimulate opportunities for off-farm employment in rural areas.

2.08 Since the late 1960s, rapid growth in employment opportunities in manufacturing and services has led to a decline in the percentage of the work force engaged in agriculture, but the number of agricultural workers has slightly increased. The farming population is now fully occupied from April through November and labor shortages are common during planting and harvesting of the rice and barley crops. The use of small-powered implements such as tillers, threshers and sprayers is growing rapidly to alleviate labor shortages. There continues, however, to be considerable underemployment during the winter months.

Project Formulation

2.09 The Yong San Gang, with a drainage area of over 3,000 sq km, is the fourth largest river in Korea. Located in the southwestern part of Korea, the basin has a milder climate and longer growing season than other parts of Korea but is subject to damaging droughts and floods. In the late 1960s, several severe droughts prompted intensive studies and investigations of the river's irrigation potential and this led, in 1970, to the preparation of a project for irrigation development on several of the Yong San Gang river's major tributaries. A first-stage development to benefit 33,000 ha, Young San Gang Irrigation Project Stage I, commenced in 1972. It includes construction of four storage dams, canal systems, and on-farm development comprising tertiary canals and drains, land levelling, farm roads, and where necessary rearrangement of farm boundaries. The Bank is assisting the Government in financing the project, through a loan of US$45 million under Loan 795/Credit 283-KO. This project will be completed in 1978, about 18 months later than anticipated at appraisal. The delay was caused by difficulties in maintaining the required level of budget allocations during a period of rapid inflation. Apart from this problem, which has now been overcome, ADC's engineering and administration of project implementation has been of a high standard.

2.10 The proposed second-stage project would develop the lower basin below the town of Na Ju, (Map 12066) which contains large areas of presently cultivated land and uncultivated tidal flats. However, the river is tidal for a distance of some 60 km from its mouth, and under present conditions the river flows are rendered unusable for irrigation by salt water intrusion. Flooding is also a problem in low-lying areas along the lower reaches of the river because high tides impede surface run-off following heavy rains.

2.11 The key to development of the lower basin is therefore the proposed estuary dam which would serve as a barrier to tidal inflow, and make it possible to use the substantial runoff of the Yong San Gang river (averaging nearly 2,000 million cu m per year) for irrigation. In addition to the estuary dam, the Stage II project would include the construction of pumping stations, irrigation systems, and land development around the periphery of the fresh-water reservoir formed by the estuary dam. The dam would also open up possibilities for diverting river flows to lands surrounding the Mu An Bay to the west, and the Hae Nam Bay to the south. There is a potential for irrigation of more than 50,000 ha in these areas (about 25,000 ha would be reclaimed tidal flats) and ample water would be available since the Stage II project would use just over 10% of the river's annual runoff. The proposed study would investigate the feasibility of future irrigation and tidal reclamation in these areas.

2.12 With increasing pressure on Korea's limited land resources for industrial and urban development, any increase in food grain production has to be achieved by raising yields on existing land and, where possible, by developing uncultivated uplands and tidal flats. Although yields of rice are already high, there is considerable scope for improvement through irrigation and land development (para. 3.09). Also, with better drainage and more timely irrigation, the cropped area and yields for the winter barley crop can be increased significantly. The project's per hectare cost of US$5,500 is similar to other Bank-financed irrigation projects in Korea, but higher than projects of a similar nature in other Asian countries with the exception of Japan. This is due to the high costs of building canals in rugged topography and also the intensive modes of on-farm development needed to satisfy the Korean farmers' high standard of farm management and water control. The cost per farm family of US$3,900 is somewhat lower, however, than other recent Bank-financed projects in the region, involving a large element of new facilities. It is also to be noted that newly developed land accounts for about 25% of the area served by the project. Furthermore, the estuary dam and sluice (30% of the project cost) will provide a water supply for future stages of development.

3. THE PROJECT AREA

Location

3.01 The project is located in the southwestern part of Korea, about 300 km south of Seoul. It encompasses parts of four counties in Jeonla Nam province. The largest town in the project area is the port of Mok Po with a population of over 200,000. The provincial capital of Gwangju, with a population of over 500,000 lies about 50 km to the northwest of the project area. The proposed estuary dam, built across the Yong San Gang river about 4 km upstream of Mok Po, would create a freshwater lake as the chief source of irrigation water for the project area. The project lands (Map 12066), extending along both sides of the reservoir for about 30 km upstream from the dam, would consist of 16 independent irrigation units, each with its own pumping station. The project would irrigate 20,700 ha of which 5,500 ha would be reclaimed tidal flats. The estuary dam would include a navigation lock to pass the occasional small vessels, mostly oil tankers, which use the river at present.

Climate and Hydrology

3.02 Korea lies in the path of warm, moist southeasterly air currents in the summer, and a northwesterly flow of cold, dry air from the Asian land mass in the winter. The southern location of the project moderates the extremes of climate found further north in Korea. The summer extends from May to September with temperatures reaching 30°C. December and January are the coldest months with temperatures often below freezing. The project area has about 210 frost-free days. Annual precipitation averages about 1,240 mm with two-thirds occuring during the rainy season (May through September). Even in the summer, rainfall is unreliable, especially during the critical rice transplanting period (June). In addition, droughts occur sometimes in August and September. Irrigation is therefore required to obtain optimum yields from high-yielding varieties of rice. Annex 1 presents climatological data.

3.03 Streamflow data for the period 1940-1972 are available for the Yong San Gang river at Na Ju where the river regime is unaffected by tides. Average annual runoff at Na Ju is about 1,300 million cu m. It is estimated that the drainage area of the river between Na Ju and the estuary dam would contribute about 650 million cu m annually, so the annual inflow to the proposed estuary reservoir would be about 1,950 million cu m (Annex 1). About 70% of the runoff occurs in the period May through September.

3.04 In its lower reaches, extending some 60 km from the river mouth, the Yong San Gang river is tidal. At spring tides, high water is about +3.7 m and low water about +0.5 (all levels in this report refer to the Mok Po Harbor Datum). Tidal intrusion renders the flows of the Yong San Gang river, in its lower reaches, unsuitable for irrigation. The tides also impede drainage of low-lying paddy lands bordering the river and, during floods, large areas of cultivated land are inundated.

Topography, Land Use and Soils

3.05 A dominant feature of the project is the estuary of the Yong San Gang river where most of the land is presently uncultivated because of tidal inundation. The "hinterlands", the term used in the feasibility report to denote the areas outside of the tidal influence, consist of low, rolling hills, interspersed by broad tracts of paddy land. The lower slopes of the hills are intensively used for cultivation of a wide range of upland crops, and the higher slopes are forested. The tidal lands to be reclaimed would be between elevations +1.5 m and +3.5 m after allowing for about 0.5 m of subsidence during reclamation. Most of the hinterlands which would benefit from the project are between +4 m and +15 m with small areas at higher elevations. About two-thirds of the project area has slopes between 0 and 2%, one-quarter between 2% and 5%, and most of the remainder between 5% and 10%.

3.06 The soils of the existing ricelands, silty clay loams and clay loams, are good rice soils without any significant limitations. Upland soils, loams and clay loams, have fairly high acidity and their productivity could be increased by applications of lime. The soils of the tidal lands are silty clays, with a clay content of 40-45%. In their present condition they are highly saline and have low permeabilities. Leaching of these soils for a period of one to three years would remove the salts. Thereafter these soils would be well suited to rice cultivation and, if adequately drained, for other crops.

3.07 Present and projected land use for the area benefitting from the project is summarized below. The principal changes as a result of the project would be as follows:

PRESENT AND PROJECTED LAND USE

	Present	With Project
	(ha)	
Fully irrigated paddy	-	14,150
Partially irrigated paddy	5,200	-
Rainfed paddy	5,700	-
Irrigated upland	-	1,050
Rainfed upland	3,700	-
Forest	600	-
Cultivated tidal flats	-	5,500
Uncultivated tidal flats	5,500	-
	20,700	20,700

Farm Size and Land Tenure

3.08 About 24,900 farm families, consisting on the average of six persons, have all or part of their holdings within the 15,200 ha of hinterland to be included in the project. These families farm a total of 23,300 ha; thus the average farm size is just over 0.9 ha of which

about 0.6 ha would benefit from the project. The distribution of holdings according to farm size is shown below. All farms are owner-operated and, as is the case throughout Korea, all farm holdings are restricted to 3 ha under the Land Reform Act of 1950. The tidal flats are Government lands and after reclamation would be sold in plots of 1 ha and 2 ha to individual farmers. A breakdown of farm holdings in the project area is presented below:

Farm Size (ha)	Farm Holdings (No.)	(%)	Total Farm Area (ha)	(%)	Inside Project Area (ha)	(%)	Outside Project Area (ha)	(%)
up to 0.3	4,000	16	767	3	468	3	299	4
0.3 - 0.5	4,420	18	1,836	8	1,148	8	688	8
0.5 - 1.0	7,830	31	6,076	26	4,112	27	1,964	24
1.0 - 2.0	6,880	27	9,699	42	6,140	40	3,559	44
2.0 - 3.0	1,770	8	4,922	21	3,332	22	1,590	20
Total	24,900	100	23,300	100	15,200	100	8,100	100

Agriculture

3.09 Of the 10,900 ha of riceland, 5,700 ha are dependent on rainfall and 5,200 ha are irrigated from numerous small reservoirs. Land consolidation (para 4.08) has been carried out on 3,300 ha of the irrigated land. Yields are depressed in most years by droughts, especially in the rainfed areas, but also in the irrigated areas where existing reservoirs cannot meet the demands during spells of dry weather. Traditional rice varieties with yields averaging 2.7 ton/ha are grown in the rainfed areas. On the irrigated lands, high-yielding varieties (HYVs) with yields averaging 3.5 ton/ha are grown on about 50% of the area, and traditional varieties on the remainder average just over 3 ton/ha. The most widely used HYV is "Tongil", a short stiff-strawed, nitrogen-responsive variety introduced in 1972. With a reliable irrigation supply, a higher proportion of the land would be planted to HYV's and overall yields of 4.5 to 5 ton/ha would be attainable. Under good conditions, many Korean farmers have achieved yields of 6 ton/ha with the Tongil variety.

3.10 Naked barley, a variety in which the husk is not attached to the kernel, is planted on about 30% of the riceland as a winter crop. The crop does not tolerate excessive soil moisture and is generally limited to the better drained areas. Yields are about 2 ton/ha. At present, any water remaining in the reservoirs at the end of the rice crop is retained until the next rice growing season, and consequently the barley is not irrigated. With an adequate water supply, barley could be irrigated in April and early May when the crop is normally short of water. Yields of 3 ton/ha would then be possible through irrigation and wider use of recently developed high-yielding varieties.

3.11 The upland areas included in the project comprise 3,700 ha of cultivated land and 600 ha of forest. The summer crops on the uplands include soybeans, tobacco, and a wide range of vegetables. Naked barley is the main winter crop with some rape seed. The annual cropping intensity on the uplands is about 150%. The areas planted to barley are limited to about 50% because it conflicts with the planting and harvesting of the more profitable summer crops. Despite the intensive cropping of uplands, the per hectare return is less than for a rice crop. Consequently, farmers favor conversion of uplands to irrigated paddy where possible. Upland crops are not irrigated at present, and they suffer to some extent from droughts. With irrigation, yields of upland crops could be increased by 20% to 40%.

3.12 Most farmers own approximately equal areas of lowland and upland. Farming is highly labor intensive and most land preparation is by draft bullocks. In recent years, however, there has been a steady increase in the use of powered implements such as tillers, sprayers and threshers. Fertilizers and pesticides are used on nearly all crops with fairly high application rates on rice, barley and the higher value upland crops. Herbicides are little used at present, although they are becoming more widely accepted to alleviate labor shortages.

3.13 Despite the relatively high yields and intensive land use in the project area there is a considerable potential for further increases in agricultural production through irrigation and land development. Rice farmers throughout Korea have shown their ability to take full advantage of irrigation and drainage facilities. The provision of a timely and reliable water supply would increase rice yields and also have the effect of reducing peak labor demands since crop calendars would no longer be governed by rainfall. Better timing of the rice crop would also lead to an increase in the area planted to barley. In irrigated areas, land consolidation would have a number of advantages: higher yields through better water control; lower labor requirements as a result of easier access and conditions more suited to mechanical land preparation; and an increased area under barley due to better drainage.

Existing Infrastructure

3.14 There are about 60 small reservoirs and ponds in the project area formed by earth dams ranging in height from 5 m to 16 m. The total storage capacity of the reservoirs is 25 million cu m with nearly 50% of the capacity accounted for by the five largest reservoirs. Many of the reservoirs consist of small ponds constructed at the head of the paddy terraces with the main purpose of providing water for seedbeds. During prolonged droughts, the ponds are rapidly depleted and are unable to meet irrigation requirements in their service areas.

3.15 The project area is encircled by paved, all-weather highways connecting the county towns. Mok Po, the largest city in the project area, is connected by paved national highway to Gwangju, and then by expressway (partly along Jeonju-Busan Highway, financed by the Bank under Loan 769-KO) to Seoul in the north and Busan in the east. The larger towns within the project area are served by gravel-surfaced county roads, and access roads to the villages are being upgraded as part of the Saemaeul (New Community) Movement, a nation-wide rural development program. The Bank's Second and Third Highway Projects (Loans 956-KO and 1203-KO) are further improving roads within the region. The Mok Po - Gwangju railway crosses the western side of the project area. These road and rail systems adequately meet the transportation needs of the project. With the reclamation of tidal lands, the estuary reservoir will also provide for water-borne transportation of inputs and commodities. A Bank-financed project, the Secondary Cities Regional Project (Loan 1070-KO), is providing an organizational framework for regional investment planning and development of an industrial belt in urban areas along the region's south-eastern coast.

3.16 About 50% of the farm households have electricity. Wells are used for domestic water supply; the quality of water is good but only the larger villages have piped systems. A considerable increase in the number of households with electricity and piped water supplies is likely over the next few years through the programs being carried out under the Saemaeul Movement.

4. THE PROJECT

Project Description

4.01 The proposed project is the second stage of a plan for irrigation, drainage and land development in the lower reaches of the Yong San Gang. The project would benefit 20,700 ha througn irrigation of the entire area, reclamation of 5,500 ha uncultivated tidal flats and land development on 11,900 ha (land consolidation has already been carried out on 3,300 ha to be irrigated by the project). Rice would be the main crop in the summer, followed by a winter crop of barley on about 70% of the area. The principal features of the project are summarized below and further details are given in Annex 2:

(a) constructing an estuary dam across the mouth of the Yong San Gang, consisting of a 4,500 m long embankment, a 240 m wide concrete sluice and a navigation lock;

(b) constructing a 4,000 m long sea dike;

(c) constructing irrigation facilities comprising 16 pumping stations, and 315 km of main and secondary canals;

(d) reclaiming 5,500 ha of tidal land including land levelling and construction of canals, drains and farm roads;

(e) land development comprising land consolidation on 3,200 ha of existing paddy, conversion of 3,250 ha of upland to irrigated paddy, development of 1,050 ha of upland for irrigation, and tertiary canals and drains on 4,400 ha of existing paddy;

(f) constructing project buildings, access roads and a temporary pier;

(g) providing the services of consultants to assist in project implementation and in preparation of a feasibility study for future development stages of the Yong San Gang Basin.

Estuary Dam

4.02 The estuary dam, which would be located about 10 km upstream of the river mouth, would exclude tides from the lower reaches of the Yong San Gang and thereby create a fresh-water reservoir to serve as a source of irrigation water for the project area. For most of the year, when river flows are low, the pool level upstream of the dam would be held at +1.0 m (Mok Po Harbor Datum) in contrast to the present situation in which the high tide levels are between +3 and +4 m. The lower water levels would permit reclamation of about 5,500 ha of tidal flats and allow better drainage of about 800 ha of cultivated land in low-lying areas. During floods, the level would rise above +1.0 m for short periods because flood waters would be stored during the upper part of the tidal cycle when tide levels downstream of the dam are higher than the pool level. The effect of fluctuating reservoir levels on the reclaimed tidal lands is discussed in Annex 4.

4.03 The main embankment closing the river channel would be about 2,000 m long with a maximum height above the river bed of 20 m. Two dams of similar design have been constructed successfully by ADC in the Bank-financed Pyongtaek-Kumgang Irrigation Project (Loan 600-KO). The downstream portion of the dam would consist of dumped rock and the upstream portion would consist of sand protected with a layer of rock. An 8 m wide road would be located on a 20 m wide berm on the upstream side of the dam. Over a part of its length, the damsite is overlain by a layer of silt. To provide a more stable foundation, this would be removed and replaced by sand to a depth of about 6 m under the rockfill section. The tidal flats on the left bank of the river would be closed by a 2,500 m long earth embankment with a height of about 3 m. This embankment would also carry the access road to the damsite. The two embankments would together contain about 3.5 million cu m of material.

4.04 The sluice and navigation lock would be founded on rock on the left bank of the main channel. The sluice would contain eight, 30 m by 14.3 m single-leaf, vertical-lift gates. The navigation lock would be 30 m long and 10 m wide with double-leaf control gates at each end. The sluice and navigation lock would contain about 40,000 cu m of concrete.

Sea Dike

4.05 A sea dike, extending downstream of the estuary dam along the left bank of the river, would be constructed to reclaim 830 ha of tidal flats (para 4.12). The dike would be 4,000 m long and about 8 m high. The body of the dike would be compacted earth with a rock zone on the seaward face. A sluice would be constructed at the downstream end of the dike to permit drainage of the reclaimed area at low tides.

Pumping Stations

4.06 Each of the 16 irrigation units forming the project area would be served by its own pumping station. Thirteen stations, with an average lift of 10 m, would be sited on the edge of the reservoir, and three, with an average lift of 28 m, would be located inland to serve about 3,000 ha of higher land. The total installed capacity of the pumping stations would be about 15,000 HP. Facilities to supply power to the pumps would include 95 km of 22 kV distribution lines, and four substations containing 12,500 kVA of transformer capacity.

Main and Secondary Canals

4.07 The 16 irrigation units would each be served by a system of main and secondary canals. Altogether there would be 165 km of main canals and 150 km of secondary canals. The soils on the canal alignments are relatively impervious and canal lining would be needed only in short sections. About 40 km of the main canals and 20 km of the secondary canals would consist of flumes, tunnels and culverts. The main canals would serve areas of 300 ha or more, and areas served by secondary canals would average about 150 ha.

Land Development

4.08 Land Consolidation. Land consolidation has already been carried out on 3,300 ha and would be provided by the project on 3,200 ha of existing paddy land where slopes are less than 2%. On steeper land, consolidation cannot generally be justified because earth moving costs become prohibitive. Land consolidation, which consists of replacing the existing uneven pattern of small irregular plots with larger level plots in a rectangular grid of ditches, farm roads and drains, has been carried out on large areas of irrigated land in Korea. For the farmer, the advantages of land consolidation are that (a) it facilitates mechanical land preparation, (b) it allows easier access to the fields and improved standards of farm management, and (c) it allows more efficient control of irrigation and drainage. The improvements in crop and water management lead to higher rice yields. Also, more timely land preparation combined with effective drainage at the end of the rice-growing season facilitates the planting of a winter barley crop. Boundary rearrangement leads to minor changes in size of individual holdings, but there is no change of ownership. Up to the late 1960s most of the land

consolidation in Korea was carried out on large blocks of flat land (less than 0.5% slope), and topography was not a significant factor in the designs. As land consolidation came to be applied to steeper land (up to 2% slope) design procedures were modified to take account of topography in order to minimize earth-work quantities. The Bank has participated in the evolution of design principles for land consolidation through its supervision of ongoing Bank-financed projects.

4.09 Conversion of Uplands to Paddy. In areas to be irrigated by the project works, 3,000 ha of cultivated uplands and 250 ha of forest would be converted to paddy cultivation. The areas to be developed have slopes up to 10% and they would be converted into a series of horizontal benches with widths ranging from 10 to 20 m depending on the slopes. Uplands to be converted have been carefully selected to ensure that soils are suited to paddy cultivation and to avoid disturbing high-value crops and orchards.

4.10 Upland Irrigation. An area of 1,050 ha of uplands, of which 700 ha are presently cultivated and 350 ha are forest, would be developed for irrigation of upland crops where soils are too shallow to be benched for paddy cultivation. About 30% of the area has slopes below 5%, and 70% has slopes between 5% and 10%. Development would include some land clearing and grading. The area consists of small plots close to the main and secondary canals, and water conveyance and distribution would be left to the farmers.

4.11 Tertiary Canals and Drains. On 4,400 ha of existing paddy land where slopes are too steep for land consolidation, the existing tertiary canals and drains would be improved on 1,900 ha and new systems would be constructed on 2,500 ha. The main and secondary drainage systems would also be repaired and realigned in a block of 850 ha within the area served by existing tertiaries. Construction and improvement of quaternary canals would be carried out by the farmers. In Korea, it is common practice for farmers to join together in construction of on-farm distribution systems.

Tidal Reclamation

4.12 The estuary dam and sea dike would eliminate tidal inundation of a large area of uncultivated tidal flats. The net area proposed for reclamation is 5,500 ha (including 830 ha protected by the sea dike), after allowing for 15% of the land to be taken up by ditches, drains, and roads. During reclamation the land is expected to subside by about 0.5 m, and the ground level of the reclaimed land after subsidence would be between +1.5 m and +3.5 m. Development of the tidal lands would be similar to that provided in the land consolidation areas and would involve land leveling and construction of a rectangular grid of irrigation ditches, drains, and farm roads. Temporary drains about 1.0 m deep and at spacings of about 20 m would be provided to permit the salts in the soil to be leached out by flooding and draining. In some areas where

soils have a fairly high clay content, a lower-cost drainage system may be feasible using mole drains at about 6 m spacing. It would take about a year for the soils to be desalinized sufficiently to plant the first rice crop.

4.13 As explained in Annex 4, reservoir levels would rise during floods and cause some inundation of the reclaimed lands for short periods. Hydrologic and agronomic analyses indicate that the depth and duration of flooding would not cause significant damage to the rice crop, except when exceptionally high floods coincide with the critical flowering stage of the rice crop. It will be necessary, however to verify these results by checking the mathematical simulation of reservoir hydrology by field observation in the first one or two years of reservoir operation. Reclamation of the higher parts of the tidal flats would begin during this period while the economic and technical feasibility of reclaiming the lower areas is under further study. Assurances were obtained that before inviting bids for reclamation of tidal lands below elevation +3 m, ADC would submit to the Bank for review an economic and technical analysis of the reclamation of such lands.

Water Supply, Demand, and Quality

4.14 The estimated average annual inflow to the estuary reservoir is about 1,950 million cu m, compared to an annual demand of approximately 160 million cu m for irrigation and other purposes. The reservoir, with a gross storage below +1.0 m of 250 million cu m, would supplement the river flow in months when it falls below the water demand. Operation studies for the period 1940-72 show that the maximum annual draft on storage was about 60 million cu m (Annex 3).

4.15 Final closure of the estuary dam would take place during a period of low river flow and salt water would be trapped in the reservoir. In the following flood season the salt water would be flushed out and studies by ADC and its consultants indicate that the salinity of the water above the sill of the sluice, at -7.0 m, would drop quickly to about 500 ppm which would be suitable for irrigation and many industrial purposes. It would be some time, however, before the salinity of the reservoir water would reach that of the natural river flow which is about 100 ppm. Sediment inflow to the reservoir is estimated to average about 1.2 million cu m/year (Annex 1). A substantial part of this inflow would be carried through the reservoir since flow velocities would be sufficient to keep a large part of the load in suspension. With a dead storage capacity of over 70 million cu m below the sill of the sluice dam, and assuming 50% of the sediment to be deposited, it would be over 100 years before any depletion of the active storage would occur.

Status of Designs

4.16 The design of the major engineering works - estuary dam, sea dike, pumping station, and irrigation canals - are in sufficient detail to provide a basis for accurate quantity estimates. The designs are based on up-to-date

1:4,000 maps and a thorough investigation of soils, foundation conditions, and sources of construction materials. In preparing these designs, ADC has drawn from its experience on the Pyongtaek-Kumgang Irrigation Project (Loan 600-KO) and Yong San Gang Irrigation Project:Stage I (Loan 795/Credit 283-KO). Detailed designs of sample areas have been made for each of the various forms of land development and for tidal reclamation, and these have formed a basis for quantity estimates. Before proceeding with detailed engineering and preparation of bid documents, a further review of the designs would be carried out by consultants to be employed by ADC (para. 5.03), with particular emphasis on the estuary dam, sluice and navigation lock.

Implementation Schedule

4.17 The project would be implemented over a period of seven years, including one year of pre-construction activities. Construction of the access road and the embankment across the left bank tidal flats, to provide access to the main river channel, began in October 1976. A contract for the estuary dam and sea dike, including the sluice and navigation lock would be awarded in late 1977. The estuary dam would be closed in early 1981, salt water would be flushed out of the reservoir during the 1981 flood season, and pumping for irrigation would begin in 1982. Construction of pumping stations, irrigation canals, and land development would begin in 1979 and be largely completed by mid-1981. Reclamation of the tidal lands behind the sea dike would take about two years beginning in 1980. Tidal land reclamation in areas bordering the reservoir would begin in 1981 after closure of the estuary dam and continue until late 1983.

Cost Estimates

4.18 The total project cost is estimated at US$167 million, of which US$87 million or 52% is foreign exchange. The relatively high foreign exchange component reflects the large volumes of earth and rock movement for which virtually all equipment and fuel has to be imported. Construction costs are based on quantity and unit price estimates prepared by ADC. Unit prices were calculated using a standard government procedure which, for each work item, estimates equipment use (depreciation and operation), labor, materials and contractor's profit. The unit prices, which include about 10% for taxes and duties, are in line with recent bid prices for similar work. Physical contingencies of 20% have been applied to the base cost estimates for the estuary dam to reflect uncertainties inherent in underwater work under tidal conditions. Similarly, a physical contingency of 20% has been applied to tidal reclamation where field conditions cannot be adequately assessed before the estuary dam is closed. Physical contingencies of 15% have been applied to civil works, materials and equipment for all other features of the project. Engineering and administration amounts to about 12% of the construction cost (including physical contingencies). The base cost estimate, expressed in January 1977 prices, was obtained by increasing January 1976 estimates by 15% for civil works and 12% for equipment and services. Costs due to expected price increases over the implementation period amount to about 33% of total project costs and assume the following annual rates of price escalation:

	Escalation Rate (%)		
	1977-79	1980-82	1983-84
Civil Works	12	10	8
Equipment & Services	10	8	7

Details of the project costs are presented in Annex 5 and summarized below:

	Local	Foreign	Total	Local	Foreign	Total	Foreign Exchange	% Base Cost
	(Won B)			(US$ M)			(%)	(%)
Civil Works								
Access Road	0.2	0.1	0.3	0.3	0.3	0.6	45	1
Estuary Dam	2.2	3.4	5.6	4.6	6.9	11.5	60	12
Sluice & Lock	1.1	1.6	2.7	2.2	3.3	5.5	60	5
Sea Dike	0.3	0.6	0.9	0.8	1.2	2.0	60	2
Pump Stations	0.6	0.5	1.1	1.3	1.0	2.3	45	2
Canals	3.7	3.0	6.7	7.5	6.2	13.7	45	14
Land Development	3.2	2.6	5.8	6.6	5.4	12.0	45	12
Tidal Reclamation	3.9	3.2	7.1	8.1	6.6	14.7	45	15
Buildings	0.2	0.1	0.3	0.4	0.3	0.7	45	1
Subtotal	15.4	15.1	30.5	31.8	31.2	63.0	50	64
Equipment & Materials								
Sluice Gates	0.5	4.7	5.2	1.1	9.6	10.7	90	11
Pump Stat. Equip.	0.2	2.0	2.2	0.4	4.0	4.4	90	4
Furnished Materials	0.6	1.3	1.9	1.2	2.8	4.0	70	4
Misc. Equipment	-	0.2	0.2	0.1	0.3	0.4	85	1
Subtotal	1.3	8.2	9.5	2.8	16.7	19.5	86	20
Right-of-Way	1.6	-	1.6	3.3	0	3.3	0	3
Consulting Services	0.1	0.5	0.6	0.2	1.1	1.3	85	2
Engin. & Admin.	4.5	0.7	5.2	9.1	1.6	10.7	15	11
Base Cost Estimate	22.9	24.5	47.4	47.2	50.6	97.8	52	100
Physical Contingencies	2.8	4.0	6.8	5.8	8.2	14.0	59	14
Expected Price Increases	13.1	13.7	26.8	27.0	28.2	55.2	52	56
Total Project Cost	38.8	42.2	81.0	80.0	87.0	167.0	52	170

Financing

4.19 The proposed Bank Loan of US$95 million would finance the project's foreign exchange requirements of US$87 million and interest and other charges on the Bank loan of US$8 million. Local expenditures, representing the estimated balance of project costs, would be met through annual Government budgetary allocations to ADC.

Procurement

4.20 Contracts for civil works construction and the supply of equipment and materials, except as noted in para 4.21, would be awarded on the basis of international competitive bidding in accordance with Bank Group Guidelines. The total value of all civil works contracts (including physical contingencies but excluding price contingencies) would be about US$74 million. The estuary dam, sluice, navigation lock and sea dike would be awarded as a single contract with an approximate value of US$22 million. Other civil works would be packaged together by areas to form about ten contracts with an average value of about US$5 million. Major equipment contracts would be the manufacture and installation of sluice gates (US$12 million) and pumping station equipment (US$5 million). Contracts for cement (US$2.4 million) and reinforcing steel (US$2.2 million) would be divided into contracts of about US$0.5 million in order to keep the supply of materials in line with requirements.

4.21 The domestic construction industry has grown rapidly in recent years and has demonstrated considerable capacity and competence to perform major public works in Korea as well as overseas. Most local contractors are well equipped and are expected to be the successful bidders on all civil works contracts under the project. ADC's policy is to supply contractors with the cement and steel to be incorporated in the works. Materials and equipment would be procured on behalf of ADC by the Office of Supply, Republic of Korea (OSROK). A preference limited to 15% of the c.i.f. price of imported goods or the customs duty, whichever is lower, would be extended to local manufacturers in the evaluation of bids. Contracts for the construction of the access road together with the left embankment of the estuary dam (US$2.5 million), and for buildings and other site facilities (US$0.8 million) would be awarded after local competitive bidding. Miscellaneous equipment (US$100,000) would be purchased through normal government procurement procedures.

Disbursements

4.22 Disbursements would be made at the rate of 100% against the foreign exchange cost of directly imported equipment and materials, or at the rate of 100% of ex-factory costs for equipment and materials manufactured locally. For consultants' services, disbursements would equal 100% of total expenditures. Disbursements for civil works carried out by contractors would be at 50% of total expenditures, to be disbursed against monthly contractors' progress payments. It is expected that disbursements would be completed by June 1984. Estimated schedules of expenditures and disbursements are shown in Annex 6, and the allocation of the proceeds of the loan is shown in Annex 7.

Accounts and Audits

4.23 Assurances were obtained that ADC would maintain separate accounts for the project and would employ independent auditors, acceptable to the Bank to audit project accounts annually; and that the audited accounts, together with the auditor's comments, would be sent to the Bank within four months of the close of each financial year.

Environmental Effects

4.24 The project would improve water quality in the lower reach of the Yong San Gang through elimination of sea-water intrusion. This would create a large source of irrigation water for use in the proposed project area and potential developments to the south and west of the project area. The impact of the project on fisheries in the estuary of the Yong San Gang and on sedimentation in Mok Po harbor have been studied by ADC and its consultants. A survey by ADC showed that about 800 households in the vicinity of the project engage in fishing to supplement farm income, but nearly all of the fishing is in shallow coastal waters. Therefore construction of the estuary dam will have no significant effect on fisheries. As regards effects on Mok Po harbor, a study by an expert in sedimentation concluded that the estuary dam would not increase and might, in fact, reduce the annual dredging requirement (about 130,000 cu m) in the harbor.

5. ORGANIZATION AND MANAGEMENT

Organization

5.01 The Agricultural Development Corporation (ADC), a semi-autonomous agency operating under the Ministry of Agriculture and Fisheries (MAF), would be responsible for project implementation. ADC was created by the Rural Modernization Promotion Law (Law No. 2199) of January 12, 1970, which merged the Union of Land Improvement Associations (ULIA) and the Ground Water Development Corporation. The predecessor institution of the ULIA was formed in July 1940. The main activities of ADC are the promotion of agriculture through development of land and water resources, and the provision of technical assistance to Farm Land Improvement Associations (FLIA) (para 5.12). ADC is headed by a president, who is assisted by a vice president, and a six-man board of directors. The president, who nominates all his staff including department heads, is appointed by the President of the Republic of Korea, while the vice president, auditor and directors are appointed by the Minister of Agriculture and Fisheries (Chart No. 15825).

Project Implementation

5.02 Responsibility for designs, procurement and construction supervision would rest with ADC's Yong San Gang Project Office, which is presently engaged in implementation of the first-stage project and was primarily

responsible for the Stage II feasibility study. Most of the staff now engaged on Stage I will be employed on Stage II and additional staff will be assigned to the project as necessary. The project headquarters, now at Gwangju, will be moved to new buildings to be constructed at Mok Po. This approach is in line with ADC's normal policy whereby special units, under a project manager, are set up with the necessary technical and administrative staff to implement specific projects. The office would be under the general supervision of one of ADC's directors.

5.03 ADC would employ consulting firms to assist in project implementation and in carrying out feasibility studies for future development of the Yong San Gang Basin. The estimated consultant input is 120 man-months for project implementation and 80 man-months for the feasibility studies. The estimated cost is US$6,600 per consultant man-month. In employing these consultants, ADC would be supplementing its own senior technical staff who face a considerable workload from ongoing and planned projects and ADC's own technical assistance activities. Assurances were obtained that ADC would employ the above consultants on terms and conditions acceptable to the Bank.

5.04 The reclaimed tidal land would be sold in plots of 1.0 ha and 2.0 ha to persons with farming experience. A majority of the purchasers would be farmers, mostly from other parts of Korea, whose land has been purchased for public works projects or for industrial development. Assurances were obtained that, before disposal of reclaimed tidal lands, ADC would submit to the Bank for review a disposal plan including (a) eligibility criteria for selection of purchasers and (b) terms and conditions for sale of the lands (para 5.13).

5.05 Land acquisition for right-of-way and property compensation on ADC projects is handled by the provincial authorities with funds provided by ADC. Assurances were obtained that land and rights to land and property would be acquired in a timely manner to avoid any delays in project construction.

Agriculture Supporting Services

5.06 Agricultural services in the project area, described below, are well organized and would adequately support the farmers in realizing the benefits of improved irrigation and land development.

5.07 Research and Extension. The Office of Rural Development (ORD) is the agency in MAF responsible for research and extension. ORD's extension work is carried out through province, county and district offices. The Jeonla Nam Province ORD operates an experimental farm, conducts field trials, multiplies foundation seed, and supervises the county ORD's. Each of the four county ORD's serving the project area has 12-15 specialists in crops, livestock, soils, plant protection, farm management, and oversees two or three branch offices each staffed by four to six general extension agents. Excluding specialists, there is one extension worker for 300-400 farmers in the 15,200 ha of presently cultivated land. ORD would employ additional staff to serve the 5,500 ha of tidal land to be reclaimed; an assurance to this effect was obtained from the Government.

5.08 Cooperatives. Almost all supplies of inputs and credit originating from Government sources are supplied through the cooperative system. It also handles marketing of a number of crops. Some 90% of farmers in the project area are members of cooperatives serving one or more villages. These village cooperatives are successively grouped into county cooperative federations and ultimately the National Agricultural Cooperatives Federation (NACF). While the Government effectively channels inputs and credits and assists farmers in marketing farm products through the cooperatives, these also serve the farmers in making their needs known to the Government. Other farmer organizations in the project area are the Farm Land Improvement Associations (FLIA) which operate and maintain irrigation and drainage works (para. 5.12).

5.09 Fertilizer. Annual fertilizer use in the project area is presently about 5,000 nutrient tons (50% nitrogen, 26% phosphate, and 24% potash). At full development, annual consumption would rise to about 7,000 nutrient tons. NACF currently supplies all fertilizer through the village cooperatives and there would be no difficulty in meeting the additonal demand.

5.10 Seeds. The Jeonla Nam ORD multiplies foundation rice, barley, wheat, soybean and potato seed to produce registered seed at the provincial ORD seed farm. Selected seed growers in the villages then use the registered seed to produce certified seed, which they sell to farmers. At full development the project would use approximately 100 tons of certified rice seed and 100 tons of certified barley seed annually. A new national system for quality seed supply presently being established with financial assistance from the Bank (Loan 942-KO) is aimed at improving quality control and expanding processing facilities. No problems are expected in obtaining the quantities of seed needed for the project.

5.11 Credit. An estimated 15% of project area farmers finance their requirements of farm inputs and hired labor from their own resources. The remainder use credit from the NACF, money lenders, millers or relatives. The NACF supplies approximately 50% of the farmers' production credit needs, providing six-month loans at 1% interest per month. NACF's annual production loans in the area amount to some Won 15,000 million (US$3.1 million), and are limited by budgetary constraints. Credit from other sources is usually much more expensive, with money lenders charging 3%-5% interest per month. At full development, about 26,000 farmers would require an estimated Won 3,200 million (US$6.6 million) production credit annually. The NACF project area operations would have to expand by more than 100% to supply this sum. An additional US$3.7 million of longer term credit would be required for all farm machinery purchases. Administratively, there would be no difficulty in handling the increased volume of credit, provided the funds are made available. Because of the necessity for production credit to finance the larger volume of farm inputs under the project, assurances were obtained that the Government would make the necessary arrangements to finance the farmers' requirements of farm equipment, inputs, and hired labor.

Operation and Maintenance

5.12 Responsibility for operation and maintenance (O&M) of existing irrigation projects in Korea rests with the Farm Land Improvement Associations (FLIA). These associations operate as independent units although their annual operating budgets must be approved either by the Provincial Government or the MAF, depending on the size of the project. Most FLIAs also engage extension workers to assist their members. Three FLIAs, presently operating 5,200 ha in the project area, would be expanded to cover the additional areas to be developed by the project. The FLIAs would operate and maintain the irrigation systems, schedule water deliveries, allocate and collect project charges, and enter into cooperative arrangements with other agencies, such as NACF and ORD, for various kinds of assistance to the farmers. The estuary dam, sluice, navigation lock and pumping stations would be operated and maintained by ADC, but the costs would be borne by the FLIAs. The annual cost of management, operation and maintenance is estimated at Won 35,000/ha (US$72/ha) which includes US$15/ha for pumping, US$25/ha for maintenance, and US$32/ha for salaries and other expenses. It is to be noted that the project is staffed not only to operate and maintain the works but also to collect water charges and assist in organizing supporting services. Salaries are also set at a high enough level to attract qualified and experienced personnel. An assurance was obtained that ADC would prepare by December 1980, and submit to the Bank for review and comment, a detailed plan for the operation and maintenance of the project, including proposals for turning over the irrigation service area works to the FLIAs.

Cost and Benefit Recovery

5.13 Korea has a well established system of charges applying to government-planned land development projects. These charges are split into recurrent or O&M costs, and capital repayments. While farmers must pay full annual O&M costs, the capital repayment terms vary according to the type of land development. For example, for irrigation works farmers repay 30% of capital costs over 35 years at 3.5% interest per year, with an initial five-year grace period followed by 30 years of repayment. For tidal reclamation, farmers buy the developed land by repaying 100% of capital costs (US$6,600/ha) over not more than thirteen years at 7% interest per year with an initial three-year grace period followed by ten years of repayments. In addition farmers also pay production taxes of 6% of the gross value of production on all foodgrain production above 1.4 ton/farm, and 6% of the gross value of production on upland crop production above Won 85,000/ha.

5.14 In determining the extent of cost recovery and the relation of project charges to benefits, two indices have been used, which are defined as follows for the present project:

(a) Cost Recovery Index: the ratio of the present worth of incremental project charges paid by project farmers to the present worth of incremental project construction and operation and maintenance costs; and

(b) Rent Recovery Index: the ratio of the present worth of incremental project charges paid by a typical farm family to the present worth of incremental "project rent" accruing to the family before paying project charges, where "project rent" is defined as net incremental income less the incremental cost of the value of family labor, general taxes, depreciation, returns to management and incremental investments, allowances for uncertainty and water fee collection costs.

All project charges, costs and benefits are measured at present values discounted at 10% annual rate of interest over the 50-year evaluation period, and in terms of 1977 constant prices (Annex 11).

5.15 In the cost recovery analysis, US$105.4 million construction costs, (base cost estimate plus physical contingencies of US$111.8 million less feasibility studies and taxes) are charged against the project. Annual incremental O&M costs are Won 33,600 (US$69)/ha. The present value of construction and O&M costs, discounted at 10%, is US$79.2 million. At full project development, and during the period of maximum capital repayments, incremental project charges total US$8.0 million per year. Discounted at 10% and assuming no inflation over the project's life, their net present value totals US$32.3 million, giving a 41% cost recovery for the project. At annual inflation rates of 5% and 10%, the corresponding cost recovery indices are 34% and 30%.

5.16 In the rent recovery analysis, indices are calculated for the existing farms, and for the proposed new farms on the reclaimed tidal land. For the existing farms, three farm sizes, 0.3 ha, 1.0 ha, and 2.0 ha are used to represent small, average, and large farms. Two situations are considered, one where the farms are entirely rainfed at present, the second where they are partially irrigated. For the tidal reclamation, the proposed farms would be 1.0 ha and 2.0 ha. Rent recovery varies from 28% to 50% on the existing farms, and from 71% to 100% on the proposed tidal land farms (Annex 11).

5.17 Under the Government's present repayment policy, farmers would pay approximately 30% to 40% of project rent. This is considered satisfactory because:

(a) although government pricing and subsidy policies have raised rural incomes relative to urban incomes over the past five years, it is unlikely that terms of trade for agriculture will improve much in the future. The proposed level of charges is therefore consistent with the objective of preventing a widening gap between urban and rural incomes;

(b) the absolute level of project charges and general taxes at full development is considerable, varying from US$245 to US$375/ha on the existing farmland; and

(c) the collection of water charges in Korea are commonly greater than 98% of assessments.

5.18 Based on experience gained in selling tidal lands under the Pyongtaek-Kumgang Irrigation Project (Loan 600-KO), the proposed annual charges for reclaimed tidal lands of about US$995/ha are about as high as farmers would be willing to pay. Thus the rent recovery rates of 70% to 100% are satisfactory. Eligible applicants for the tidal lands would most likely come from one of the following two categories. First, farmers who have been displaced from reservoir areas or whose land has been acquired for industrial purposes. Second, farmers who have small but valuable holdings and are willing to sell them in exchange for larger though initially somewhat less productive land. Since the development cost of tidal land is less than the market value of prime agricultural land, both groups of farmers should have sufficient capital resources at their disposal to meet the high annual repayment costs (approximately US$923/ha plus O&M charges of US$72/ha), as well as finance the cost of new housing and additional farming implements.

5.19 Assurances were obtained from the Government that project farmers would contribute to the capital and annual costs of the project facilities at the levels described in para. 5.13.

6. PRODUCTION, PRICES AND FARM INCOMES

Production

6.01 The project would increase agricultural production through reclamation of uncultivated land, and more intensive cropping and higher yields on presently cultivated land. The cultivable area would increase from 14,600 ha to 20,700 ha through reclamation of 600 ha of forest and 5,500 ha of tidal land. At present 5,200 ha of paddy is partially irrigated but, as a result of the project, the entire cultivable area would be fully irrigated. The annual cropping intensity for the project area would increase from 150% to 177%. Average yields of rice would increase to 4.6 ton/ha per crop on the rice land and 4.1 ton/ha per crop on the tidal land; and barley yields to 2.9 ton/ha per crop. Farmers are expected to achieve these yields five years from the time adequate and reliable irrigation is established. At full development, about five years after completion of project works, annual rice production would reach 87,600 tons compared to 32,000 tons at present. Barley production would increase to 43,600 tons compared to 14,100 tons at present.

Prices

6.02 All prices have been adjusted to January 1977 levels; where possible crop prices for economic analysis have been based on the Bank's projections of 1985 world market prices. Thus, the world market price was used for rice, soybeans, tobacco and fertilizer. In the absence of price forecasts for polished barley for human consumption, a price equal to 85% of that projected for wheat flour was used because, based on observed price trends, this is the price ratio between the two products on the local market. For other crops, and for farm income analysis, average farmgate prices for the last five years (adjusted for inflation) have been used.

Farm Incomes

6.03 For the purpose of farm income analysis, three farm models (0.3 ha, 1.0 ha and 2.0 ha) were examined for the presently cultivated land and two farm models for the reclaimed tidal lands (1.0 ha and 2.0 ha). For the present condition, land use and cropping patterns broadly reflect averages for cultivated land in the project area. As existing farmers have about one-third of their holdings outside of the project area, the project would affect on average two-thirds of the area of the existing farms. The existing farms were examined under two present operating conditions: (a) the entire area rainfed, and (b) the paddy land partially irrigated. The future condition with the project assumes that the existing farmlands would have irrigation facilities for 67% of the net cultivable area, and the reclaimed tidal land for 100% of the net cultivable area. The results of the analysis are summarized below and shown in further detail in Annex 10. Net farm income is equal to the gross value of production less cash inputs, hired labor costs, taxes, and irrigation O&M charges and capital repayments; plus income earned off-farm or from nonfarming sources. Excluding the initial grace periods, capital repayments would be over 30 years for the existing farmlands, and over ten years for the reclaimed tidal lands.

Farm Type	Farm Size (ha)	Cropping Intensity Present (%)	Cropping Intensity W/Project (%)	Farm Income/a Present (Won '000)	Farm Income/a W/Project (Won '000) /b	Farm Income/a Present (US$)	Farm Income/a W/Project (US$) /b
Riceland & Upland							
Rainfed	0.3	153	180	295	410	610	850
	1.0	152	174	755	1,140	1,560	2,350
	2.0	154	172	1,340	2,085	2,760	4,300
Partially Irrigated	0.3	157	180	325	410	670	850
	1.0	154	174	810	1,140	1,670	2,350
	2.0	156	172	1,435	2,085	2,960	4,300
Reclaimed Tidal Land	1.0	-	180	325/c	935	670	1,930
	2.0	-	180	810	1,390	1,670	2,870

/a Rounded to nearest Won 5,000 and US$10, and includes off-farm and nonagricultural income.

/b This represents income with the project during the capital repayment period (that is, 30 years for existing farmlands, and ten years for reclaimed tidal lands).

/c At present the families who would occupy the tidal lands are assumed to be earning income, either from farms or from salaries.

6.04 Present net farm incomes vary from Won 295,000 (US$610) on a 0.3 ha rainfed farm to Won 1,435,000 (US$2,960) on a 2.0 ha partially irrigated farm. Similarly at full development net farm income would vary from Won 410,000 (US$850) on 0.3 ha to Won 2,085,000 (US$4,300) on 2.0 ha. This represents a 40%-45% income increase, and even allowing for the additional cost of family farm labor and management (Annex 11), indicates that the farmers would have sufficient financial incentive to achieve the projected yields and cropping intensities.

6.05 Although comparisons of farm incomes based on farm budgets with income data based on national accounts aggregates must be interpreted with caution, they do present a rough picture of the relative position of project beneficiaries. With an estimated six persons per family and one family per farm, present per capita farm income (US$100-US$495) is about 20%-85% of the estimated per capita GNP of US$585. Providing the farming population remains constant, at full project development in 1989 the projected per capita farm income (US$140-US$715) is estimated to be some 15%-70% of the then per capita GNP. The project would enable farmers in the area to roughly maintain the relative position of their incomes with regard to the national average per capita income. Without the project this income gap would widen.

6.06 About 45% of the project's farm families (0.6 ha farm or less) are presently at or below the estimated absolute poverty level of around US$175 (1977 prices). At full agricultural development the project would increase this group's incomes on average by 40%.

7. BENEFITS, JUSTIFICATION AND RISKS

7.01 The proposed project would increase yields and production on 20,700 ha through irrigation and land development, including reclaiming of 6,100 ha of forest and tidal land. It would directly benefit some 29,000 farm families or approximately 174,000 people. Although not included in the economic benefits, the project would provide, through the estuary dam and reservoir, a road link between Mok Po and the eastern river side and, providing the reservoir salinity levels fall sufficiently, a possible source of industrial and municipal water for Mok Po city. Providing they are feasible the dam could also divert irrigation flows for future developments in the west and south. The project would support the Government's policies to attain self-sufficiency in rice and barley production, and reduce income disparities between rural and urban areas.

7.02 The project's overall economic rate of return would be 13%, using a fifty-year evaluation period; full project benefits being attained by 1989, five years after completion of construction; farm-gate prices for rice, soybean, tobacco and fertilizer based on the Bank's commodity price forecasts for 1985 expressed in January 1977 constant prices; a shadow foreign exchange rate; and an average shadow wage rate for unskilled labor of Won 1,600 per man-day (Annex 12).

7.03 The project's economic rate of return showed little sensitivity to variations in the cost estimate or assumptions made concerning the timing of agricultural benefits. It showed most sensitivity to a reduction

in the level of benefits, but in none of the cases tested did the rate of return for the entire project fall below 10%. On the other hand, if project benefits turn out to be 25% higher than forecast because of higher commodity prices, the rate of return would be 15%.

7.04 At full agricultural development the project would result in rice import savings of Won 10,600 million (US$22 million) annually at the projected world market price c.i.f. Incheon/Busan (Annex 12). After deducting the incremental cost of imported fertilizers, chemicals, fuel and other farm inputs, annual net foreign exchange savings would amount to about Won 7,300 million (US$15 million).

7.05 Given ADC's experience with projects of similar scope and complexity, no organization or management problems are expected. Rapid inflation in 1973 and 1974 led to sizable cost overruns on projects initiated in the early 1970s. Inflation is now being brought under control and larger provisions for price increases have been made for this project and other projects recently financed by the Bank. The estuary dam is technically the most challenging feature of the project, but ADC's experience with similar works, combined with detailed investigations, should keep unforeseen quantity and cost increases within the allowance of 20% for physical contingencies.

8. AGREEMENTS TO BE REACHED AND RECOMMENDATION

8.01 Assurances were obtained during negotiations on the following principal points:

(a) Before inviting bids for reclamation of tidal lands below elevation +3m, ADC would submit to the Bank for review an economic and technical analysis of the reclamation of such lands (para. 4.13);

(b) ADC would maintain separate accounts for the project and would employ independent auditors acceptable to the Bank, to audit project accounts annually; and the audited accounts together with the auditors' comments, would be sent to the Bank within four months of the close of each financial year (para. 4.23);

(c) ADC would employ consultants to assist in project implementation and a feasibility study for future development on terms and conditions acceptable to the Bank (para. 5.03);

(d) ADC would prepare a disposal plan for reclaimed tidal lands and submit it to the Bank for review before disposal of such lands (para. 5.04);

(e) ADC would make the necessary arrangements to ensure the purchase of land and the rights to land and property in a timely manner to avoid any delay in project construction (para. 5.05);

(f) ORD would employ additional staff to provide agricultural extension service for the tidal lands reclaimed under the project (para. 5.07);

(g) The Government would make the necessary arrangements to finance the farmers' requirements for farm equipment, inputs, and hired labor (para. 5.11);

(h) ADC would prepare by December 1980 and submit to the Bank for review a detailed plan for the operation and maintenance of the project including proposals for turning over the irrigation service area works to the FLIAs (para. 5.12); and

(i) Project farmers would contribute to the capital and annual costs of the project facilities at the levels described in para. 5.13 (para. 5.19).

8.02 With the above assurances, the proposed project is suitable for a Bank loan of US$95 million for a period of 17 years including three and one-half years of grace to the Agricultural Development Corporation with the guarantee of the Republic of Korea.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Climate and Hydrology

Climate

1. Climatological data for Gwangju, which is representative of the project area, are shown in Table 1. Although 60% of the annual rainfall occurs in the June-September rice growing season, monthly rainfall varies widely and in most years there are periods of 20-30 days when rainfall is well below crop requirements. Temperatures reach 28oC in the summer months and fall below freezing in January and February. The frost-free period is about 210 days.

Hydrology

2. Streamflows. Runoff records for the Yong San Gang have been maintained since 1962 at Na Ju, just above the point where the river enters the lower basin. ADC has estimated runoff for the period 1940-61 by a rainfall-runoff correlation. Average annual runoff at Na Ju for the period 1940-1972 is 1,300 million cu m; monthly runoff at Na Ju for the period 1962-72 is shown in Table 2.

3. The drainage area above Na Ju is 2,063 sq km, hence the average annual unit runoff is 630 mm, or about 50% of the annual rainfall. At the site of the proposed estuary dam, the drainage area is 3,471 sq km or 168% of the area above Na Ju. Annual runoff at the estuary dam, which for practical purposes can be considered as inflow to the reservoir, has been assumed as 150% of the runoff at Na Ju. This reflects the flatter terrain and the large area of paddy which retains rainfall in the lower basin, and where unit runoff would be slightly less than the area above Na Ju. Thus, average annual reservoir inflow would be about 1,950 million cu m.

4. Floods. The maximum recorded flood at Na Ju in August 1974 reached a peak discharge of 3,850 cu m/sec and had a five-day volume of 650 million cu m. This flood was estimated to be approximately equal to a 100-year event. A flood routing study was carried out by ADC to assess the effect of such a flood on water levels upstream of the estuary dam. The study showed that, with a sluice of the dimensions proposed (Annex 2), the estuary dam would not cause a significant increase in water levels above those observed during the 1974 event. Further studies showed that a larger sluice would not materially reduce water levels, but a reduction in sluice capacity would significantly increase flood levels. The proposed sluice would safely pass a much higher flood than the 1974 event without overtopping of the estuary dam.

5. Annex 4 describes the studies made to assess the effect on the reclaimed tidal lands of flood inflows to the estuary reservoir. For these studies the five-day volumes of independent flood events in each year were taken from daily runoff data at Na Ju for the period 1940-1972. These were then increased by 50% to obtain estimated inflow to the reservoir (para. 3).

6. Tides. Tide levels downstream at the site of the estuary dam summarized below, are based on the Mok Po Harbor Datum (MHD):

	Meters (MHD)
High water, spring tide	+3.7
High water, mean tide	+3.4
High water, neap tide	+3.0
Low water, neap tide	+1.3
Low water, mean tide	+0.9
Low water, spring tide	+0.5

7. Exceptional tides can exceed the above limits. High water for a 100-year tide is estimated at +4.8 m, and low water at -0.8 m. The crest of the estuary dam has been set at +8.0 m, so that it would be safe against a 100-year high tide combined with a 30 m/sec (108 km/h) onshore wind.

8. Sedimentation. A relationship between suspended sediment load and river flow was derived from a ten-month period of sediment sampling at Na Ju in 1967. This relationship, applied to the runoff record for the period 1940-72, resulted in an estimated average annual suspended sediment load of 500,000 cu m. Increasing this in proportion to the drainage areas, the sediment inflow to the estuary reservoir would be about 800,000 cu m. The bed load, which cannot be measured in practice, was calculated to be 400,000 cu m, or 30% of the total sediment load of 1,200,000 cu m. The trap efficiency of the reservoir cannot be estimated with any precision but would be quite low because flow velocities would continue to be fairly high during floods. Assuming a relatively high trap efficiency of 50% the annual sediment deposit of 0.6 million cu m would not significantly reduce the gross storage capacity of 250 million cu m during the life of the project.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Climatological Data /1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Precipitation (mm)													
Average	40	40	65	90	95	160	240	200	175	50	50	35	1,240
Maximum	90	100	220	215	225	540	550	360	510	180	175	75	
Minimum	4	6	7	21	12	48	36	28	-	5	4	3	
Temperature (^{o}C)													
Mean	1.2	2.5	6.0	11.7	16.2	20.9	24.8	26.4	22.0	16.2	10.2	4.7	
Mean Maximum	4.5	8.5	8.7	14.5	18.2	25.4	26.5	27.8	23.2	17.8	21.1	16.3	
Mean Minimum	-1.8	-0.8	3.0	10.6	4.3	18.7	23.0	24.4	20.2	14.4	8.3	0.8	
Humidity (%)	72	71	71	74	76	81	85	81	78	71	71	71	
Pan Evaporation (mm)	47	55	86	110	138	140	140	168	123	112	75	54	1,248

/1 At Gwangju: Period of observation 1940-72

ANNEX 1
Table 1

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Monthly Runoff at Na Ju (Mm^3)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1962	26	26	21	117	17	48	351	494	594	74	33	20	1,821
1963	21	32	61	149	229	1,296	904	89	42	33	23	23	2,902
1964	19	73	42	153	114	23	160	99	292	34	23	18	1,050
1965	45	54	43	48	63	35	862	178	74	61	98	69	1,630
1966	48	48	288	96	113	82	326	286	259	56	50	49	1,701
1967	48	46	65	92	41	21	187	24	17	62	57	48	708
1968	38	32	46	61	23	13	14	151	55	124	46	42	645
1969	42	57	25	212	235	20	224	403	658	42	18	24	1,960
1970	38	24	33	51	62	63	745	122	504	86	43	36	1,807
1971	50	71	55	38	32	225	830	407	115	49	23	14	1,909
1972	54	81	259	93	256	40	829	740	211	54	125	117	2,859
Avg. (1962-72)	39	49	85	101	108	170	494	272	256	61	49	42	1,726
Avg. (1940-72)													1,300

ANNEX 1
Table 2

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Project Works

Estuary Dam

1. The estuary dam would serve as a barrier to tidal inflows which presently render the waters of the Yong San Gang unusable for irrigation as far upstream as 60 km from the river mouth. With the dam in place, the flow of the Yong San Gang, which averages nearly 2,000 million cu m per year, would be available for irrigation of the project area and for diversion to other areas which may be developed in the future to the west and south of the project area. The fresh-water reservoir, with a gross storage of about 250 million cu m, would supplement river flows in months when demand exceeds the river flow. Elimination of high tides in the lower reaches of the river would also have significant benefits through reclamation of 5,500 ha of uncultivated tidal land, and improved drainage of some 850 ha of low-lying rice land.

2. Design and Construction. ADC and their consultants investigated three possible alignments for the estuary dam: Alignment 1, the selected alignment about 4 km upstream of Mok Po; Alignment 2, about 2 km further downstream; and Alignment 3, just upstream of Mok Po. Although the main channel is wider at the selected site than the other alternatives, it has the advantages of a rock ledge for siting the sluice, a higher bed level, and shallower depth of silt overlying bedrock.

3. The dam would consist of a 2,000 m section across the main channel with a maximum height of 20 m, and 2,500 m section across the left bank tidal flats with a maximum height of 3 m. Map 12270(R) shows a plan and typical cross-sections of the proposed dam. The top of the dam at +8 m is set high enough to prevent overtopping under a combination of high tides and high onshore winds. The dam has a considerable bed width, about 200 m at the maximum section, to minimize seepage and prevent "piping" of the foundation. The maximum head across the dam would be about 6m with a high tide of +4 m and with the inside pool level drawn down to -2 m in the dry season. This would be a rare event since the pool would seldom be drawn down below zero, and the normal head across the dam would be about 4 m. The main structural feature of the dam is the rockfill section on the seaward face, referred to in the feasibility report as the "stone mound." The face of this would be protected by stone set in a matrix of asphalt. The body of the dam on the reservoir side would be of river sand with stone protection.

4. Bedrock over much of the main channel is at about -20 m, and is overlain by silts, clays, and sandy silts to depths of 8 to 15 m. The silt layer which occurs mostly in the center of the channel to depths of 5 to 8 m would be removed under the stone mound and replaced by river sand. At the site of the sluice and navigation lock on the left bank, the rock is at -10 m at the lowest point. The overburden of silt and clay would be removed and the structures founded on rock.

5. The construction of the dam and the sluice would proceed in parallel so that the sluice could be used to pass the river flow during final closure of the dam. The first stage in construction of the dam would be the dredging of the silt layer and backfilling with sand. The sand would then be protected against scour by a heavy plastic "mattress" weighted by a layer of rock. The rock mound would then be placed, starting on both banks until a closure section is left in the mound with a level of -2 m and a width of 200 m. Final closure would be timed to take place in the period between mean tide and neap tide. All construction equipment would be mobilized to haul and place rocks of up to 1,000 kg in the closure section. Similar techniques were successfully employed in the closure of two dams in the Pyongtaek-Kumgang Project (Loan 600-KO).

6. The sluice would have 14.3 m x 30 m vertical-lift gates and a sill level of -7 m. ADC investigated a wide range of sluice dimensions and that proposed is close to the optimum; a larger sluice would not significantly reduce upstream flood levels and a smaller sluice would be a constraint on flood releases and cause prolonged inundation of the reclaimed tidal lands. During floods, the gates would have to open and close twice a day (open at low tide and close at high tide). The hoisting mechanisms would be designed to provide a lifting speed of 0.3 m/minute.

7. The site was investigated by 11 borings to determine the depth of rock and characteristics of the overburden. In-place tests of the foundation were made at 24 locations using the Dutch Cone Apparatus and numerous laboratory tests were made on samples obtained from the borings. Materials investigations revealed ample deposits of rock, earth-fill and river sand for dam construction in the vicinity of the site. A granite outcrop near the dam site would be used as a source of both coarse and fine aggregate for concrete; there are no deposits of sand suitable for fine aggregate.

8. A navigation lock would be provided to allow normal traffic, mostly small oil tankers, to pass the dam at any stage of the tide. The lock chamber would be 30 m x 10 m and be controlled at each end by double-leaf, vertical-lift gates. Large vessels used during construction would, on completion of the work, pass downstream through a sluice opening at low water.

The Dae Bul Sea Dike

9. The sea dike, constructed to reclaim tidal flats with a gross area of about 1,100 ha, would be 4,000 m long and about 8 m high. A typical cross-section is shown in Map 12270(R). A sluice with six, 3 m x 3 m gates, located at the south end of the dike, would permit drainage of the area at low tides. The net area of land developed for farming would be about 830 ha, after deducting land taken up for canals, drains and roads. The area would be irrigated from the San Ho pumping station located just upstream of the dam in the estuary reservoir.

Pumping Stations

10. The project area would be served by 16 pumping stations with a total installed capacity of about 15,000 HP. Thirteen of the stations would be sited around the edge of the reservoir to serve the tidal flats and the inland areas. The maximum pumping head would be about 9 m for the tidal flats and 14 m for the inland areas. Because of the difference in lift, separate sets of pumps, each with two or three units, would be provided for each area served by a pumping station. Reserve capacity would not be provided, but adequate spare parts would be kept on hand to ensure prompt repairs. Three pumping stations would be constructed to serve high-level canals feeding some 3,000 ha; maximum lifts would be about 30 m. Facilities to supply power to the pumping stations would include 95 km of 22 kV transmission lines and four substations containing 12,500 kVa of transformer capacity. Preliminary designs have been prepared for all of the pumping stations and associated electrical works.

Main and Secondary Irrigation Canals

11. The project area would be divided into 16 irrigation units, each served by a system of main and secondary canals. Main canals would serve areas of over 300 ha and secondary canals would serve areas averaging 150 ha. Soils are relatively impervious on the canal alignments and only a few short sections would be lined with concrete. As indicated below, numerous canal structures would be required because of the irregular topography:

	Total Length	Earth Section	Flume	Tunnel	Culvert
	(km)				
Main Canals	164	125	14	8	17
Secondary Canals	150	130	4	3	13

12. Plans, profiles and the type and location of structures were prepared using 1:4,000 scale maps with 1 m contour intervals. Additional topographic surveys were made to check the designs of the main canals. For the secondary canals, checking was limited to field inspections of the alignment.

Land Consolidation and Tertiary Canals

13. The project would irrigate 10,900 ha of existing paddy fields. Land consolidation has already been carried out on 3,300 ha, and would be provided by the project on a further 3,200 ha where slopes are less than 2%. On the 4,400 ha which will be without land consolidation, existing tertiary canals and drains will be improved on 1,900 ha which are at present partially irrigated and new tertiaries would be constructed on 2,500 ha which at present are rainfed. Construction and improvement of quaternary canals would be carried out by the farmers. In Korea, it is common practice for the farmers to join together in the construction of on-farm distribution systems. On a block of 850 ha of presently irrigated land, drainage systems would be improved by repair and realignment of main and secondary drains. Drainage problems in this area, created by high tides, would be eliminated by the construction of the estuary dam.

14. Land consolidation has been carried out on about 200,000 ha in Korea over the past 20 years. Priority was given to large, flat blocks of land with slopes not exceeding 0.5%. Under these conditions, earth-moving quantities were low and uniform standards for the layout of the drains and farm roads were developed. However, land consolidation is now increasingly being carried out where slopes are steeper (0.5%-2.0%) and topography is more irregular. Such conditions have been encountered in recent Bank-financed projects /1 and attempts to follow standard design procedures led initially to excessive earthwork quantities. ADC, its consultants, and Bank staff have devoted considerable attention to the problem. As a result, design principles have been evolved and are being applied which aim at minimizing earthwork quantities by adjusting layout to topography.

15. Of the 3,200 ha of land consolidation, about 80% has slopes below 0.5%. The ditch-to-drain spacing would be 100-150 m, and individual plots would be about 30 m wide. Farm roads, 4 m wide, would be located alongside the ditches. ADC has prepared detailed designs for four sample areas, each with different land slopes in the range 0-2%, to provide a basis for quantity and cost estimates.

/1 Pyongtaek-Kumgang Irrigation Project (Loan 600-KO) and Yong San Gang Irrigation Project: Stage I (Loan 795/Credit 283-KO).

Conversion of Uplands to Paddy

16. Of the 3,250 ha of uplands to be converted to paddy, 3,000 ha are presently cultivated and 250 ha are uncultivated. Some 1,300 ha have slopes in the 0-5% range and the remainder between 5% and 10%. The land would be converted into a series of horizontal benches with widths ranging from 10 m to 20 m depending on slope. The areas to be developed would generally be narrow strips of land averaging about 150 m wide commanded by the secondary canals. Tertiary canals and drains would be spaced at 150 m to 200 m. This type of development has been successfully carried out by ADC on a number of projects in recent years. For estimating purposes, designs were prepared from sample areas covering a total of 180 ha.

Upland Irrigation

17. Of the 1,050 ha of uplands to be developed for irrigation of crops other than rice, 700 ha are presently cultivated and 350 ha are uncultivated forest. About 300 ha have slopes in the 0-5% range and 750 ha between 5% and 10%. Development would include some land clearing and grading. The area consists of small plots close to the main and secondary canals, and water conveyance and distribution would be left to the farmers.

Tidal Reclamation

18. With the estuary dam and sea dike in place, a large area of tidal flats would no longer be inundated by tides and would become available for reclamation. Table 1 shows the distribution of the tidal lands according to ground elevations. Experience elsewhere in Korea has shown that subsidence of about 0.5 m occurs during the process of reclamation. Therefore, in Table 1 and the following discussion, the ground levels referred to are those obtained by deducting 0.5 m from existing levels based on the Mok Po Harbor Datum. The total net area to be developed would be 5,500 ha as described below. For planning purposes ADC divided the area into 16 blocks.

19. Blocks 1 and 2. These two blocks, with a gross area of 1,105 ha, would be protected from tidal inundation by the Dae Bul Sea Dike. Lands above +1.25 m are considered available for reclamation. This would allow gravity drainage at low tide, except for a few days in each month during neap tides when low water would be about +1.3 m. The net area reclaimed after deduction for roads, ditches, drains, etc., would be 830 ha.

20. Blocks 3-12, 14 and 15. These blocks, with a total gross area of 5,972 ha, border the estuary reservoir. Since the reservoir will be at +1.0 m, except during floods, the lowest ground level for land to be reclaimed has been chosen as +1.5 m. The net area reclaimed would be 4,410 ha. A high groundwater table in the areas up to +2.0 elevation should not be a serious constraint to agricultural production since the main crop will be rice; also the groundwater would be of good quality once the salts have been leached from the soil. During floods, the reclaimed lands would be inundated for short periods as discussed in Annex 4.

21. Block 13. This area of 423 ha, on the right bank of the estuary reservoir, has over 200 ha between levels +1.0 m and +1.5 m. All of the areas above +1 m would be developed by enclosing the area with a dike and providing drainage pumps. Block 13 would be developed in this way to serve as a guide for reclamation of similar low-lying areas in the project area and elsewhere in Korea.

22. Irrigation and Drainage. The reclaimed area would be levelled and a rectangular grid of canals, drains and roads would be constructed. The layout would be much the same as in areas with land consolidation. The ditch to drain spacing would be 160 m. The 4 m wide farm roads spaced at 320 m would have a tertiary irrigation ditch on each side. Borders would be provided at about a 60 m spacing so that the individual plots would have an area of 1 ha. A feeder canal extending from the pumping station along the upper edge of the reclaimed area would supply the tertiary canals. A collector drain would be provided to carry away the flow from the tertiary drains.

23. Reclamation Methods. Temporary drains, about 1.0 m deep and at 20 m spacing, would be constructed perpendicular to the tertiary drains. In some areas where soils have a fairly high clay content, a lower-cost drainage system may be feasible using mole drains at about 6 m spacing. After completion of the canals and drains the area would be flooded with fresh water. Material from the drains would be used to form dikes to hold the water on the land. The salts would be leached out by the flow of water through the soil profile into the drains. It is estimated that it would take about one year for desalinization to proceed to the point where the first rice crop would be planted. Yields in the first year would be low but would improve over three years to levels comparable to long-established rice lands.

ANNEX 2
Table 1

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Tidal Reclamation

Elevation After Subsidence (m above MHD)	(Area (ha) Reservoir	Block 13	Sea Dike	Total
0.5 - 1.0	48	119	7	
1.0 - 1.25	192	74	124 /1	
1.25 - 1.50	382	128	78	
1.5 - 2.0	1,872	73	286	
2.0 - 2.5	1,754	22	502	
2.5 - 3.0	955	7	108	
3.0 - 3.5	641	-	-	
above 3.5	128	-	-	
Total Gross Area	5,972	423	1,105	7,500
Proposed for Reclamation:				
Gross Area	5,350	304	974	6,628
Net Area	4,410	260	830	5,500

/1 Areas below the line would be reclaimed.

KOREA

YONG SAN GANG IRRIGATION PROJECT: II

Water Demand, Supply and Quality

Irrigation Demands

1. Annual water requirements for rice for the period 1963-73 are shown in Table 1. Crop consumptive use was estimated by multiplying observed pan evaporation in the project area by crop coefficients based on recent experimental data in Korea. Effective rainfall for each month in the growing season was estimated from daily rainfall records. For the period 1963-73, effective rainfall during the growing season averaged 73% of total rainfall. The average irrigation requirement for the period is 5,350 cu m/ha. A typical calculation of monthly demands in an average rainfall year is shown in Table 2.

2. The loss due to seepage and operational waste in the main canals and laterals is estimated at 15%. Below the tertiary outlet the chief source of loss would be deep percolation, which has been allowed for in estimating the farm irrigation requirement. In addition, a loss due to operational waste of 10% in the tertiary systems has been assumed. After taking account of the above losses, the average annual diversion requirement (that is the requirement at the head of the main canals) is 6,990 cu m/ha. Of the 20,700 ha served by the project, 19,650 ha would be paddy and 1,050 ha would be upland crops. Thus, the average annual diversion requirement would be about 140 million cu m (assuming upland crop demands are 50% of paddy requirements); in a dry year the annual demand would be about 190 million cu m.

Domestic, Municipal And Industrial Demand

3. The city of Mok Po is presently supplied from the Yong San Gang at Na Ju through a pumping plant and a 55 km long pipeline. During most of the year the river flow far exceeds the pumping requirement for Mok Po. However, by the early 1980's, it will no longer be possible to meet Mok Po demands during periods of low river flow in the winter months (November-March). Also, demands for the city and new industries in the vicinity of Mok Po will exceed the capacity of the existing pipeline. A reservoir is therefore under construction at Dae Dong, 45 km north of Mok Po, to augment the existing deliveries from Na Ju. Projections of industrial growth in the Mok Po area indicate, however, that additional sources of supply will have to be developed by the 1990s. As explained below (para. 5), the salinity of water in the estuary reservoir, particularly in the lower reaches near Mok Po, may be too high for domestic and municipal use but would be acceptable for many industrial purposes. Preliminary estimates indicate that daily withdrawals from the reservoir for industrial use may reach 50,000 cu m (an annual demand of 18 million cu m) by the mid-1990s.

Water Supply

4. Of the annual demand (dry year) of 190 million cu m, about 30 million cu m would be supplied by existing reservoirs. The residual of 160 million cu m would be spread over the four-month period, June through September. The minimum reservoir inflow for this period is 272 million cu m (1951), and the average is 1,490 million cu m. On rare occasions the monthly inflow would be less than the irrigation demand, but the deficit would be easily made up through withdrawals from the estuary reservoir. The demand for industrial water would also be easily satisfied from the reservoir during periods of low inflow (November through March). Operation studies for the period 1940-1972 show that the maximum withdrawal from storage would be about 60 million cu m.

Water Quality

5. Final closure of the estuary dam would take place in the 1980/81 low flow season. Salt water trapped in the reservoir would mostly be flushed out during the 1981 flood season. Studies by ADC and their consultants indicate that the salinity of reservoir water at the end of the flood season would drop to about 500 ppm. This estimate is supported by experience in the Pyongtaek-Kumgang Project. It is expected that the salinity of the reservoir would gradually approach that of the natural river flow which is about 100 ppm, but how long this would take cannot be predicted with any certainty.

ANNEX 3
Table 1

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Annual Irrigation Demands

Year	Crop Water Requirement	Effective Rainfall	Irrigation Requirement	Diversion Requirement
	(mm)			(cu m /ha)
1963	1,110	585	535	6,990
1964	1,110	875	245	3,200
1965	1,110	510	610	7,970
1966	1,110	464	655	8,560
1967	1,110	525	595	7,780
1968	1,110	385	735	9,610
1969	1,110	805	315	4,120
1970	1,110	600	520	6,800
1971	1,110	685	435	5,690
1972	1,110	560	560	7,320
1973	1,110	440	680	8,890
		Average	535	6,990

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Irrigation Requirements (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Land Preparation & Nursery /1						120							120
Transplanting						50							50
Ponding /2							50						50
Consumptive Use /3							167	235	160				562
Percolation						34	102	102	102				340
Crop Water Requirement						204	319	337	262				1,122
Rainfall /4	40	40	65	90	95	160	240	200	170	50	50	35	1,235
Effective Rainfall						120	180	150	128				578
Irrigation Requirement						84	139	187	134				544
Diversion Requirement						109	181	243	174				707

/1 Water required for nursery, soil saturation and replenishment of evaporating water during land preparation.

/2 Depth maintained at 60 mm during growing season.

/3 Derived as follows:

	Pan Evap.	Crop Coeff.	Cons. Use
July	139	1.2	167
August	168	1.4	235
September	123	1.3	160

/4 Average rainfall at Gwangju.

ANNEX 3
Table 2

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Effect of Floods on Reclaimed Tidal Lands

Flood Levels in Estuary Reservoir

1. The estuary reservoir would normally be maintained at +1.0 m, but there would be a rise in reservoir levels during floods. Levels would be determined primarily by the volume of flood inflows rather than peak discharges. ADC made operations studies of floods with five-day inflow volumes of 650, 450, 250 and 150 million cu m as shown in Figure 1. These studies assume spring tide conditions downstream of the estuary dam; levels in the reservoir would be lower under neap or mean tide conditions. The sluice gates were assumed to be open whenever the reservoir level was higher than the outside tide level, and closed when the tide level was higher than the reservoir.

2. In practice, the flood levels over the tidal lands would lag behind the rise and fall of the levels in the main channel. As a result, the peaks and troughs shown in Figure 1 would to some extent be smoothed out, that is, the depth of flooding would be less than shown but the duration would be somewhat longer.

3. Effect of Floods on Rice Production. Table 1, based on research in Japan, shows estimated yield reductions due to floods at three stages of crop growth; vegetative, booting/flowering and heading/ripening. Loss of production in the reclaimed area subject to overbank flooding (Blocks 3-12, 14 and 15, see Annex 2) for floods up to 900 million cu m is shown in Figure 2 for the three crop growth stages.

4. The method used to derive Figure 2 was as follows:

(a) The total net area was subdivided according to ground level as shown in Annex 2, Table 1 as follows:

Ground Level	Net Area (ha)	% of Total
1.5 - 2.0 m	1,540	35
2.0 - 2.5 m	1,440	33
2.5 - 3.0 m	790	18
3.0 - 3.5 m	530	12
above 3.5 m	110	2
	4,410	100

(b) The portion of each subdivision where the crop would be submerged by the floods shown in Figure 1 was estimated taking into account the height of the plant (70 cm at booting/flowering and 100 cm at heading/ripening).

(c) Based on Table 1, the yield loss in areas inundated was assumed as follows (flooding was 24 hours or less in all cases);

vegetative	10%
booting/flowering	50%
heading/ripening	30%

(d) For each growth stage, the percentage loss in production for the 4,410 ha was computed and plotted to obtain the curves shown in Figure 2.

5. Figure 2 was used to estimate annual production, as a percentage of potential production, for the period 1940-1972 (Table 2). Following reclamation and desalinization, the potential average yield at full development for the tidal lands is estimated at 5 ton/ha, or potential production on the 4,430 ha of 22,150 tons. Estimated average annual production over the period would be 88% of the potential (19,500 tons). According to the analysis the minimum production for the period was 58% of the potential in 1965 when three floods occured during the booting/flowering stage.

6. The above estimates of the effects of floods are based on conservative judgments of areas inundated and reductions in yields. However, the underlying hydrologic analysis is a simplified representation of the complex hydraulics of the reservoir. Field observations will therefore be made in the flood seasons immediately following closure of the estuary dam to check the calculated fluctuations in water levels. Even if no large floods occur during this period, observations of moderate floods in the 150-250 million cu m range would provide valuable information.

ANNEX 4
Table 1

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Reduction in Rice Yields Due to Flooding

Growth Stage	Type of Flooding (24-48 hours)	Yield Loss
Vegetative	Overhead flooding with clear or muddy water	10%
Booting/Flowering	Clear water with leaf apex exposed	10%
	Muddy water with leaf apex exposed	20%
	Overhead flooding with clear water	25%
	Overhead flooding with muddy water	70% (50% for periods less than 12 hours)
Heading/Ripening:	Overhead flooding with clear water	15%
	Overhead flooding with muddy water	30%

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Effect of Floods on Reclaimed Tidal Land

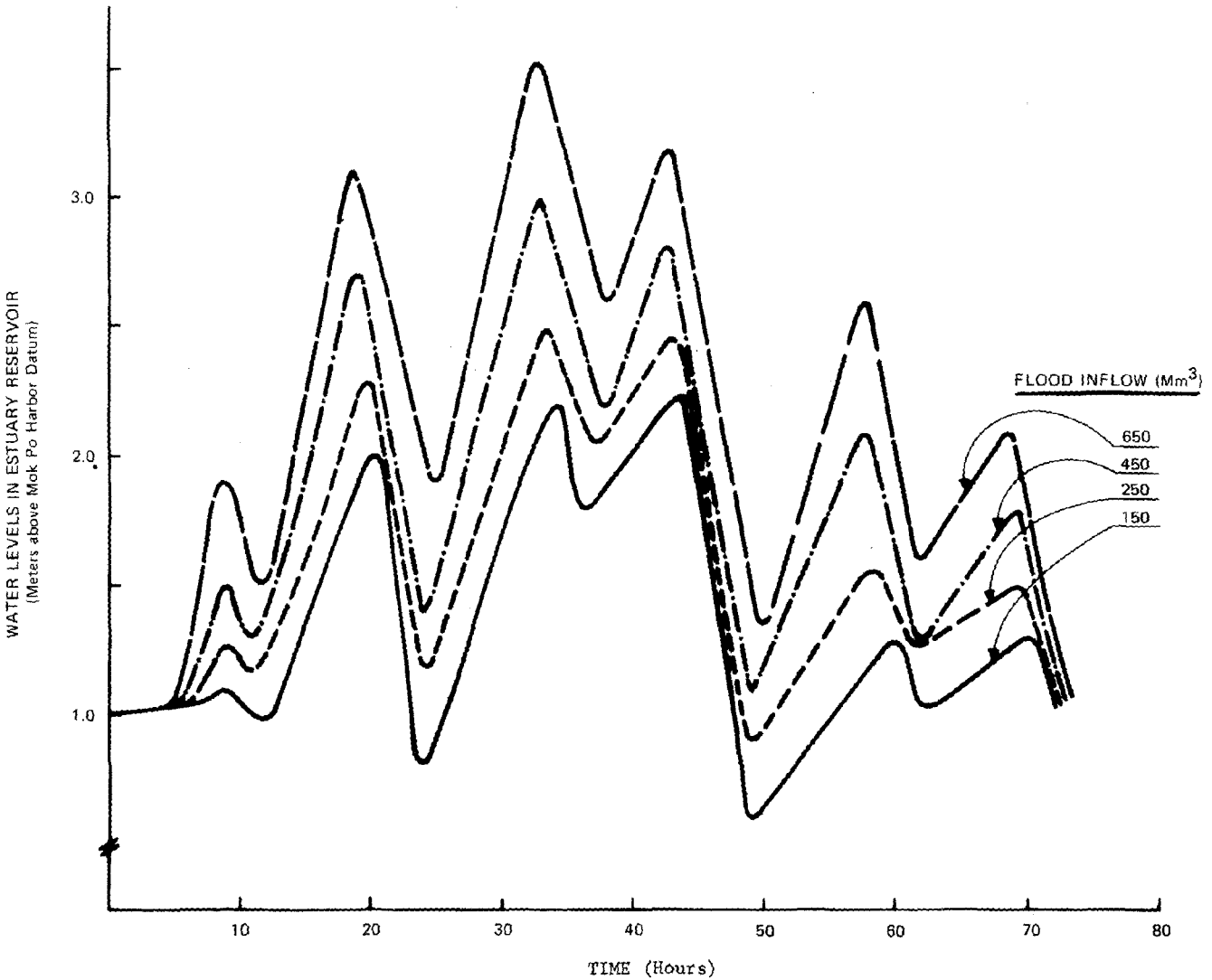
Year	Vegetative May 20-July 19 /1 Flood Mm^3	Vegetative May 20-July 19 /2 Loss Factor %	Booting/Flowering July 20-August 10 Flood Mm^3	Booting/Flowering July 20-August 10 Loss Factor %	Heading/Ripening August 11-September 15 Flood Mm^3	Heading/Ripening August 11-September 15 Loss Factor %	Annual Production as % of Potential /3
1962			315	90	392	98	81
"			232	93	297	99	
1963	900	91	343	88			59
"	605	92					
"	395	92					
"	355	93					
"	275	93					
1964			183	95	260	100	95
1965			489	78	112	100	58
"			447	81			
"			256	92			
1966	266	93			330	98	91
1967	116	95					95
1968							100
1969	227	94	479	79	225	100	70
"	197	95					
1970	786	91			338	98	88
"					309	99	
1971	315	94	710	80	381	98	74
1972	816	91			483	95	72
"	303	94			412	94	
"	318	94			155	100	
						Avg. (1962-72)	80
						Avg. (1940-72)	88

/1 Flood inflow to reservoir is equal to 1.5 times flood inflow at Na Ju.

/2 Percent of potential production.

/3 Multiple of all loss factors for floods occurring in the year.

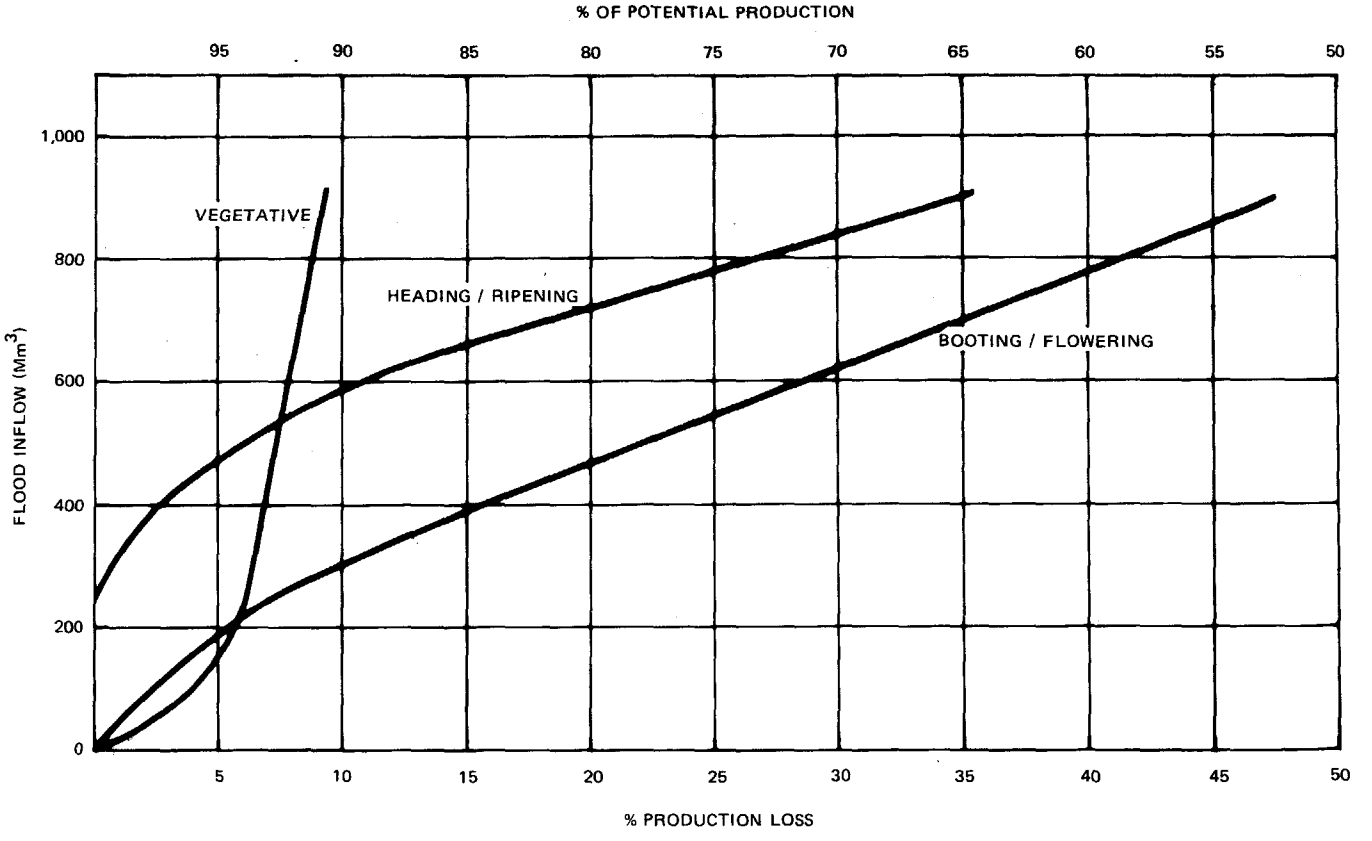
KOREA
YONG SAN GANG IRRIGATION PROJECT: STAGE II
Flood Levels in Estuary Reservoir



World Bank-16130

ANNEX 4
Fig. 1

KOREA
YONG SAN GANG IRRIGATION PROJECT: STAGE II
Reduction in Rice Yield Due to Flooding



World Bank-16227

ANNEX 4
Fig. 2

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Cost Estimates

1. The principal engineering features of the project - estuary dam, sluice, navigation lock, sea dike, pumping stations and canals - have been designed in sufficient detail to permit accurate quantity estimates. ADC used a standard government procedure to estimate unit prices for each work item. This procedure is set out in a handbook published by the Government in January of each year. For a wide range of construction activities, the handbook provides labor and equipment inputs; prices for labor materials and equipment; and various coefficients and factors to be employed in the estimating process. The unit prices computed by ADC for the project works take into account the revision to basic prices published by the Government through November 1975 and therefore can be considered as representing January 1976 price levels. These were then raised to January 1977 levels by adding 15% for civil works and 12% for equipment and services. The computed prices are in line with unit prices (adjusted for price escalation) quoted by contractors for ongoing Bank-financed projects. A check of the ADC quantity estimates showed them to be adequate.

2. For land development works and tidal reclamation, ADC prepared detailed designs and quantity estimates for sample areas. Unit prices were derived as above and overall per hectare costs were obtained. For land consolidation and development of upland areas, the per hectare costs varied according to land slope, and these were then applied to project areas according to slope categories. The per hectare costs derived by ADC are consistent with recent bid prices on Bank-financed projects in Korea.

3. ADC has surveyed the areas of land to be acquired for construction of project works. Unit costs for land acquisition in January 1977 prices are:

	Won M/ha	US$/ha
Paddy	5.4	11,130
Cultivated Upland	2.8	5,770
Uncultivated Upland	0.9	1,860

Compensation would also be paid for houses and farm buildings and for the removal and relocation of graves. These costs would, however, be small in relation to costs for land acquisition.

4. Costs for engineering, construction supervision and administration were estimated by applying the following percentages:

	Design	Supervision	Admin.	Total
	----(% of cost including contingencies)---			
Civil Works /1	3	7	2	12
Equipment	1.5	3.5	2	7
Land Acquisition	-	-	5	5

/1 Including furnished materials.

5. Physical contingencies amount to 20% of the base cost estimate for the estuary dam, sluice, navigation lock and sea dike to allow for uncertainties inherent in underwater construction under tidal conditions. Similarly, a physical contingency of 20% has been used for tidal reclamation where earthmoving requirements and soil conditions cannot be accurately assessed until closure of the estuary dam. Physical contingencies of 15% have been applied to construction costs for all other work items.

6. Expected price increases (Table 3) were computed by applying the following percentages for annual price escalation:

	1977-79	1980-82	1983-84
Civil Works	12	10	8
Equipment & Services	10	8	7

7. Project cost estimates are summarized in Table 1 and further details for individual project features are given in Table 2. ADC's estimates are based on detailed bills of quantities containing several hundred work items. Table 2 presents these estimates in a condensed form to show the main cost elements of the project features.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Cost Summary

	Local	Foreign	Total	Local	Foreign	Total	Foreign Exchange	% of Base Cost
	(Won M)			(US$ M)			(%)	
Civil Works								
Access Road	150	130	280	0.3	0.3	0.6	45	1
Estuary Dam	2,230	3,350	5,580	4.6	6.9	11.5	60	12
Sluice and Navigation Lock	1,080	1,610	2,690	2.2	3.3	5.5	60	5
Sea Dike	390	570	960	0.8	1.2	2.0	60	2
Pumping Stations	610	500	1,110	1.3	1.0	2.3	45	2
Main & Secondary Canals	3,670	3,000	6,670	7.5	6.2	13.7	45	14
Land Development	3,190	2,610	5,800	6.6	5.4	12.0	45	12
Tidal Reclamation	3,920	3,200	7,120	8.1	6.6	14.7	45	15
Buildings & Temp. Works	180	150	330	0.4	0.3	0.7	45	1
Sub-total	15,420	15,120	30,540	31.8	31.2	63.0		64
Equipment & Materials								
Sluice Gates	520	4,680	5,200	1.1	9.6	10.7	90	11
Pumping Station Equipment	210	1,940	2,150	0.4	4.0	4.4	90	4
Furnished Materials	580	1,340	1,920	1.2	2.8	4.0	70	4
Miscellaneous Equipment	50	150	200	0.1	0.3	0.4	85	1
Sub-total	1,360	8,110	9,470	2.8	16.7	19.5		20
Right-of-Way	1,600	-	1,600	3.3	-	3.3	0	3
Consulting Services	100	530	630	0.2	1.1	1.3	85	2
Engineering & Administration	4,410	780	5,190	9.1	1.6	10.7	15	11
Base Cost	22,890	24,540	47,430	47.2	50.6	97.8		100
Physical Contingencies	2,810	3,980	6,790	5.8	8.2	14.0		14
Expected Price Increase	13,090	13,680	26,770	27.0	28.2	55.2		56
Total Project Cost	38,790	42,200	80,990	80.0	87.0	167.0		170

ANNEX 5
Table 1

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Cost Estimates

Items	Unit	Quantities	Unit Price (Won)	Amount (Won M)
Access Road				
Earth Excavation	m^3	118,000	250	30
Rock Excavation	m^3	78,000	2,360	184
Earthfill	m^3	31,000	310	10
Gravel Surfacing	m^2	12,000	3,000	36
Culverts & Bridges	L.S.			10
Miscellaneous	L.S.			10
Base Cost				280
Physical Contingencies (15%)				40
Total				320
Estuary Dam				
Dredging Foundation	m^3	670,000	360	242
Sand Replacement	m^3	825,000	320	264
Mattress	m^2	165,000	1,950	322
Riprap	m^3	760,000	2,320	1,763
Sand Fill	m^3	1,880,000	640	1,203
Filter Material	m^3	230,000	2,150	495
Gabions	m^2	44,000	8,360	368
Stone Pitching	m^3	82,000	2,470	202
Earthfill	m^2	160,000	1,400	224
Asphalt concrete	m^2	48,000	2,520	120
Asphalt grout	m^2	30,000	4,580	137
Miscellaneous	L.S.			240
Base Cost				5,580
Physical Contingencies (20%)				1,120
Total				6,700

Item	Unit	Quantity	Unit Price (Won)	Amount (Won M)
Sluice & Navigation Lock				
Civil Works				
Channel Excavation:				
Silt & Clay	m^3	2,920,000	360	1,051
Rock	m^3	140,000	5,570	780
Excavation for Structures:				
Silt & Clay	m^3	100,000	290	29
Rock	m^3	135,000	1,930	260
Concrete	m^3	42,000	5,640	237
Formwork	m^2	24,000	1,740	42
Steel Reinforcement	tons	2,500	11,150	28
Steel in Bridge	tons	490	210,000	103
Cofferdam	L.S.	-	-	120
Miscellaneous	L.S.	-	-	40
Total Base Cost				2,690
Physical Contingencies (20%)				540
Total				3,230
Gates & Hoists				
Sluice Gates	No.	8	530 Million	4,240
Floating Gate	No.	2	300 "	600
Lock Gate	No.	2	150 "	300
Electrical Work	L.S.			60
Total Base Cost				5,200
Physical Contingencies (15%)				780
Total				5,980
Dae Bul Sea Dike				
Riprap	m^3	180,000	1,600	290
Mattress	m^2	12,000	1,950	23
Earth Fill	m^3	320,000	900	288
Stone Pitching	m^2	38,000	2,470	94
Asphalt Concrete	m^2	50,000	2,570	126
Drainage Sluice (incl. gates)	L.S.			75
Cofferdam for Sluice	L.S.			30
Miscellaneous	L.S.			34
Total Base Cost				960
Physical Contingencies (20%)				190
Total				1,150

Cost Estimates

Item	Unit	Quantity	Unit Price (Won)	Amount (Won M)
Pumping Stations				
Civil Works				
Foundations	L.S.			220
Superstructures	L.S.			480
Intake Channels	L.S.			290
Access Roads	L.S.			120
Sub-total				1,110
Mechanical & Electrical				
Pumps	L.S.			380
Motors	L.S.			300
Pipelines	L.S.			145
Power Lines	L.S.			615
Substation Equipment	L.S.			345
Controls	L.S.			160
Miscellaneous	L.S.			205
Sub-total				2,150
Base Cost				3,260
Physical Contingencies (15%)				490
Total				3,750

Main and Secondary Canals

Item	Amount (Won M)		
	Main Canals	Secondary Canals	Total
Earthwork	1,240	1,150	2,390
Flumes	440	110	550
Siphons & Culverts	920	425	1,345
Tunnels	995	460	1,455
Miscellaneous Structures	160	400	560
Bridges	80	130	210
Access Roads	160	-	160
Total Base Cost			6,670
Physical Contingencies (15%)			1,000
Total			7,670

Cost Estimates

Land Development

	Slope (%)	Area (ha)	Cost/ha (Won '000)	Amount (Won M)
Land Consolidation	0 - 0.5	2,580	500	1,290
	0.5- 1.0	210	580	122
	1.0- 1.5	230	660	150
	1.5- 2.0	180	720	130
Sub-total		3,200		1,692
Conversion of Uplands	0 - 5	1,290	550	710
	5 - 7	1,020	690	704
	7 - 10	940	980	921
Sub-total		3,250		2,335
Upland Irrigation	0 - 5	400	350	140
	5 - 7	210	450	95
	7 - 10	440	500	220
Sub-total		1,050		455
Tertiary Canals and Drains				
New Canals & Drains		2,500	270	675
Improvement of Existing Systems		1,900	220	420
Drainage Improvements		850	240	205
Sub-total				1,300
Base Cost				5,782
Physical Contingencies (15%)				888
Total				6,670

Tidal Reclamation

Item	Cost/ha (Won '000)	Area (ha)	Amount (Won M)
Feeder Canals & Roads	180	5,500	990
Tertiary Canals & Roads	110	"	605
Collector Drains	210	"	1,155
Tertiary Drains	80	"	440
Temporary Drains	195	"	1,072
Land Levelling	375	"	2,060
Structures	145	"	798
Sub-total	1,295		
Base Cost			7,120
Physical Contingencies (20%)			1,420
Total			8,540

Cost Estimates

Buildings and Temporary Works

Item	Amount (Won M)
Project Office	120
Estuary Dam Office	35
Construction Office	30
Construction Pier	80
Construction Roads	45
Power Facilities	20
Base Cost	330
Physical Contingencies (15%)	50
Total	380

Furnished Materials

Item	Unit	Quantity	Unit Price (Won)	Amount (Won M)
Cement	tons	55,600	17,500	975
Reinforcing Steel	tons	8,400	112,500	945
Base Cost				1,920
Physical Contingencies (15%)				290
Total				2,210

Right-of-Way

Item	Area (ha)	Cost/ha (Won '000)	Amount (Won M)
Cultivated Paddy	100	5,400	540
Cultivated Upland	170	2,800	476
Forest	150	900	135
Compensation	-	-	449
Base Cost			1,600

Cost Estimates

Miscellaneous Equipment

Item	No.	Unit Price (Won '000)	Amount (Won M)
For Project Implementation			
Field vehicles	8	2,500	20
Survey vessel	1	30,000	30
Survey equipment	L.S.		15
Laboratory equipment	L.S.		15
Field radios	L.S.		25
Subtotal			105
For Feasibility Studies			
Field vehicles	8	2,500	20
Survey vessels	2	30,000	60
Survey equipment	L.S.		15
Subtotal			95
Total			200

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Expected Price Increases

	Total	Calendar Years 1977	1978	1979	1980	1981	1982	1983
				(US$ M)				
Civil Works	74.1	2.5	5.4	15.1	16.6	15.0	8.9	10.6
Equipment, Materials & Services	37.7	1.1	4.4	8.1	12.2	6.1	3.9	1.9
Total (incl. physical contingencies)	111.8	3.6	9.8	23.2	28.8	21.1	12.8	12.5
Expected Price Increases:								
Civil works	40.4	0.1	1.0	5.0	7.8	9.2	7.0	10.3
Equipment, materials & services	14.8	0.1	0.7	2.2	4.7	3.1	2.4	1.6
Total	55.2	0.2	1.7	7.2	12.5	12.3	9.4	11.9
Total Project Cost	167.0	3.8	11.5	30.4	41.3	33.4	22.4	24.4
Annual Escalation Rates (%)								
Civil works		12	12	12	10	10	10	8
Equipment, materials & services		10	10	10	8	8	8	7

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Estimated Schedule of Expenditures

	Total[/1]	Calendar Years 1977	1978	1979	1980	1981	1982	1983
	(US$ M)							
Civil Works								
Access Road	0.7	0.7	-	-	-	-	-	-
Estuary Dam	13.8	1.3	2.7	4.0	4.5	1.3	-	-
Sluice and Navigation Lock	6.7	-	2.0	3.6	1.1	-	-	-
Sea Dike	2.4	-	0.4	1.0	1.0	-	-	-
Pumping Stations	2.6	-	-	0.6	1.0	1.0	-	-
Main & Secondary Canals	15.8	-	-	3.9	6.0	5.0	0.9	-
Land Development	13.7	-	-	2.0	2.5	4.0	3.0	2.2
Tidal Reclamation	17.6	-	-	-	0.5	3.7	5.0	8.4
Buildings & Temp. Works	0.8	0.5	0.3	-	-	-	-	-
Subtotal	74.1	2.5	5.4	15.1	16.6	15.0	8.9	10.6
Equipment & Materials								
Sluice Gates	12.3	-	2.0	4.0	6.3	-	-	-
Pumping Station Equipment	5.1	-	-	-	1.5	2.1	1.5	-
Furnished Materials	4.6	-	0.5	1.2	1.0	1.0	0.5	0.4
Miscellaneous Equipment	0.4	0.4	-	-	-	-	-	-
Sub-total	22.4	0.4	2.5	5.2	8.8	3.1	2.0	0.4
Right-of-Way	3.3	0.2	0.4	1.0	1.0	0.7	-	-
Consulting Services	1.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1
Engineering & Admin.	10.7	0.2	1.2	1.7	2.2	2.2	1.8	1.4
Total	111.8	3.7	9.9	23.3	29.1	21.2	12.9	12.7
Expected Price Increases	55.2	0.2	1.7	7.2	12.5	12.3	9.4	11.9
Total Project Cost	167.0	3.8	11.5	30.4	41.3	33.4	22.2	24.4

/1 Includes physical contingencies.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Estimated Schedule of Disbursements

IBRD Fiscal Year and Semester	Accumulated Disbursements --(US$ '000 Equivalent)--
Fiscal Year 1977	
1st	-
2nd	200
Fiscal Year 1978	
1st	1,600
2nd	4,200
Fiscal Year 1979	
1st	8,900
2nd	14,000
Fiscal Year 1980	
1st	25,500
2nd	34,200
Fiscal Year 1981	
1st	46,000
2nd	59,000
Fiscal Year 1982	
1st	67,600
2nd	77,300
Fiscal Year 1983	
1st	82,700
2nd	88,200
Fiscal Year 1984	
1st	93,600
2nd	95,000

ANNEX 7
Table 1

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Proposed Allocation of Loan Proceeds

	Category	Cost		
		Total	Foreign	Proposed Loan
		US$ Million		
1.	Civil Works:			
	Base Cost	63.0	31.2	
	Expected Price Increases	40.8	20.4	
	Subtotal	103.8	51.6	52.0
	Disbursements will be 50% of total expenditures.			
2.	Equipment & Materials:			
	Sluice Gates	10.7	9.6	
	Pumping Station Equipment	4.4	4.0	
	Furnished Materials	4.0	2.8	
	Miscellaneous Equipment	0.4	0.3	
	Expected Price Increases	7.4	6.3	
	Subtotal	26.9	23.0	23.0
	Disbursements will be 100% of foreign expenditures for directly imported equipment and materials and 100% of ex-factory cost for locally manufactured equipment and materials.			
3.	Consulting Services:			
	Project Implementation	0.9	0.9	
	Feasibility Studies	0.5	0.5	
	Subtotal	1.4	1.4	1.4
	Disbursements will be 100% of total expenditures.			
4.	Interest and other charges on loan accrued on or before June 15, 1981	8.0	8.0	8.0
5.	Unallocated:			
	Physical Contingencies	14.0	8.2	10.6
	Right-of-Way	3.3	0	
	Engineering & Supervision	10.9	1.5	
	Expected Price Increases	6.7	1.3	
	Subtotal	34.9	11.0	
	Total	167.0	95.0	95.0

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Consulting Services

A. Project Implementation

1. Terms of reference for the consulting services required to assist ADC in implementing the project are summarized below:

2. Part 1

(a) Review of designs and cost estimates for the estuary dam, sluice and navigation lock, with particular reference to:

(i) design and construction procedures for the embankment across the main channel;

(ii) appropriate span of the sluice gates and their design, taking into account the need for frequent opening and closing during floods;

(iii) structural design of the piers and foundations of the sluice;

(iv) quantity estimates, unit prices and overall costs; and

(v) construction schedule.

(b) Review and summarize quantities, unit prices, and costs for the main and secondary canals and pumping stations on the basis of the designs prepared by ADC. The designs should be reviewed in sufficient detail to ensure that all necessary structures are included in the cost estimate.

(c) The services under Part I should be completed within three months from the date ADC notifies the consultants to proceed.

3. Part 2

(a) Preparation of bidding documents and evaluation of bids.

(b) Supervision of construction of the estuary dam, sluice and navigation lock.

(c) Inspection and acceptance of equipment and materials procured for the project.

(d) The deployment of specialists to advise ADC on particular aspects of the project, including reclamation and development of tidal lands, and the design of irrigation systems for upland areas.

4. The estimate of man-month inputs shown in Table 1 is intended to serve as a guide to the consultant in preparing his proposal and would be developed in more detail during negotiations with the selected firm. The estimate assumes that consulting services would be required over a period of five years. Some key personnel would be on permanent assignments in Korea of varying durations during this period and others would be deployed on short-term assignments. Staff to be employed on the project in Korea should have an adequate command of spoken and written English.

B. Feasibility Study for Future Development of the Yong San Gang Basin

1. Consultants would be employed by ADC to assist in carrying out the above feasibility study. Detailed terms of reference would be prepared by ADC in consultation with the Bank, taking into account the technical staff available for the study within ADC. This annex outlines the proposed phasing and timing of the study and presents a preliminary estimate of the required input of consultants.

2. The construction of an estuary dam on the Yong San Gang will create a source of water for irrigation development in areas to the south and west of the Stage II project area. A feasibility study for future development of these areas will be carried out in three phases as described below.

3. Phase 1: Project Selection

The two future stages of development of the Yong San Gang Basin to the south (Hae Nam Bay) and the west (Mu An Bay) would have the following main features:

(a) sea dikes at the entrance to the bays to exclude tides and allow reclamation of tidal flats;

(b) diversion channels linking the bays to the estuary reservoir;

(c) pumping stations and canal systems to serve presently cultivated lands and reclaimed tidal flats; and

(d) other forms of land development (land consolidation, conversion of uplands to paddy).

4. Preliminary studies place the development potential for Hae Nam Bay at 21,000 ha (9,500 ha of tidal flats) and Mu An Bay at 30,000 ha (15,000 ha of tidal flats). Both schemes would involve such large investments that they would have to be developed in sequence rather than in parallel. Therefore, the first step in the study would be to decide which scheme has priority, and would require costs and benefits to be assessed in sufficient detail to form a basis for such a decision. This phase of the study should also investigate the feasibility of displacing, with fresh water from the Yong San Gang, the large volume of salt water trapped in the tidal basin by the sea dikes. Also of importance would be an assessment of the social and economic impact of disturbing the existing shallow water aquaculture in the project areas.

5. Phase 2: Project Formulation

After selection of the area to be developed, the next step would be to formulate the project in further detail. This would involve optimization of the various elements of the project (that is, capacity of diversion channels, sluice capacities, alternative dike locations).

6. Phase 3: Project Preparation

The final step in the feasibility study would be detailed preparation of the project. Costs and benefits would be assessed in sufficient detail to form a basis for an investment decision by the Government and external financing agencies.

7. Timetable

A proposed timetable for the study is as follows:

Phase 1: January - December 1978
Phase 2: January - June 1979
Phase 3: July 1979 - March 1980

Consultant Personnel

8. Table 2 shows the estimated man-months of different specialists ADC would require to assist it in carrying out the study.

ANNEX 8
Table 1

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Estimated Manpower Requirements: Project Implementation

Field of Specialty	Part 1 (Man-months)	Part 2 (Man-months)
Design (Estuary Dams)	3	8
Design (Hydraulic Structures)	3	6
Design (Canals)	3	-
Design (Gates)	3	6
Soils, Foundations, and Materials	3	6
Cost Estimates	3	-
Construction Planning	-	3
Construction Supervision	-	20
Equipment Inspection	-	12
Contracts and Specifications	-	6
Other Specialists	-	15
Project Sponsor and other Supervisory Staff	5	15
Total	23	97

ANNEX 8
Table 2

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Estimated Manpower Requirements: Feasibility Study

Field of Specialty	Study Phase			
	Phase 1	Phase 2	Phase 3	Total
	(Man-months)			
Project Planning /1	11	7	8	26
Technology	6	2	4	12
Design (Sea Dikes)	6	3	4	13
Design (Irrigation)	6	3	4	13
Cost Estimates	4	3	4	11
Project Economics	6	2	5	13
Agronomy	2	-	4	6
Environmental Studies	4	-	2	6
	45	20	35	100

/1 Includes direction and supervision of study.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Present and Projected Cropping Patterns and Production

1. The project would increase agricultural production on 20,700 ha by improved irrigation and drainage on 10,900 ha of existing paddy; irrigation of 3,700 ha of cultivated upland of which 3,250 ha would be converted to paddy; and reclamation and irrigation of 600 ha of forest and 5,500 ha of tidal flats. These changes in land use are summarized below:

Present and Projected Land Use

	Present	With Project
	(ha)	
Fully irrigated paddy	-	14,150
Partially irrigated paddy	5,200	-
Rainfed Paddy	5,700	-
Irrigated upland	-	1,050
Rainfed upland	3,700	-
Forest	600	-
Cultivated tidal flats	-	5,500
Uncultivated tidal flats	5,500	-
	20,700	20,700

2. Present and future yields are shown in Table 1 and discussed below. Table 2 shows present and future cropping patterns and production.

Present Cropping Patterns

3. Of the 10,900 ha of existing paddy land, 5,700 ha are rainfed, and 5,200 ha are partially irrigated from existing dams and ponds. Land consolidation has been carried out on about 3,300 ha of the partially irrigated land. All of the existing paddy lands are planted to rice in the summer. Rice is transplanted from seedbeds to previously puddled fields during the last two weeks of June, and harvested in late September and early October. High-yielding rice varieties (HYV's) are grown on about 50% of the partially irrigated lands, but because of drought risks the rainfed lands are devoted almost entirely to traditional varieties.

4. Barley is grown as a winter crop following the rice harvest. The crop is planted as soon as the soil is dry enough for land preparation (mid-October to mid-November) and harvested in May. Barley does not

tolerate excessive soil moisture and is therefore generally confined to the better drained lands. In areas with land consolidation, which includes a tertiary drainage system, barley is grown on about 40% of the land. On the remaining paddy lands, barley occupies about 30% of the area in the winter. In rainfed areas, barley plantings are also sometimes reduced in years when planting of the preceding rice crop is delayed by late rains.

5. The upland area included in the project covers 4,300 ha of which 3,700 ha are cultivated and 600 ha are under forest. Soybeans (40% of the cultivated area), vegetables (30%), sesame (15%), and tobacco (10-15%), are grown on the uplands in the summer. Barley occupies about 70% of the cultivated uplands in the winter together with small areas of rape seed. The area presently under forest is used as a source of fuelwood.

Future Cropping Patterns

6. Without the project there would be no significant change in cropping patterns. The area planted to HYV's on the partially irrigated paddy would possibly increase and wider use of early-maturing varieties might lead to some increase in the area of barley on the paddy lands.

7. With the project, the paddy land would increase to 14,150 ha through conversion of uplands, and the area would be fully irrigated. The area of paddy with land consolidation would increase from 3,300 ha to 6,850 ha. With a reliable supply of irrigation water the area under HYV's is expected to reach about 70% of the total paddy land. Irrigation, coupled with a larger area of land consolidation, would give the farmers better control of crop calendars and increase the percentage of paddy land under barley to about 70%.

8. The remaining area of cultivated upland (1,050 ha) would be irrigated and used more intensively than at present for production of high-value crops such as peppers, tobacco, and chinese cabbage; double-cropping of summer vegetables is also expected to increase.

9. The reclaimed tidal lands would be devoted to rice in the summer and barley in the winter. With an intensive irrigation and drainage system, over 60% of the area would be planted to HYV's and barley would be grown on about 65% of the area in the winter. Since most of the newly-settled farmers on the reclaimed tidal lands would not own upland areas, it is expected that about 800 ha of vegetables would be planted, mostly for their own consumption.

Yields and Production

10. A reliable supply of irrigation water would lead to yield increases for all crops presently grown in the project area. Average

yields of traditional rice varieties at present are 2.7 ton/ha /1 for rainfed paddy and 3.2 ton/ha for partially irrigated land. HYV's under partially irrigated conditions yield between 3.4 and 3.8 ton/ha. Improvements in water control as a result of the project would raise yields of traditional varieties to about 3.8 ton/ha, and HYV's to 4.5 to 5.0 ton/ha (the higher figure would apply to areas with land consolidation). Barley yields would also increase through irrigation as the crop is maturing. At present scarcity of water precludes irrigation of barley. Yields of up to 3 ton/ha /2 should be attainable compared to an average of 2 ton/ha at present. Vegetable yields which are currently depressed by untimely and often inadequate rainfall should significantly increase as a result of irrigation.

11. The increase in cropped areas and higher yields would raise rice production from 32,000 tons at present to 88,000 tons at full development (Table 2). Barley production would increase from 14,000 tons to 44,000 tons.

Development Constraints

12. The project would bring an increased cropping intensity, a 51% increase in labor requirements, an increase in mechanized land preparation and threshing, and a demand for more fertilizer, agro-chemicals, and facilities for drying, storage and processing. The most important issues are examined briefly.

13. Cropping Calendar. Chart No. 16100 shows the typical annual cropping activities in the project area. Two critical periods occur during the cropping season. The first is in June, when barley has to be harvested so that rice can be transplanted, the second in October when rice must be harvested as quickly as possible so that barley can be sown early enough to be established well before the onset of heavy frosts. With irrigation, both the rice and barley crops can be planted at the correct time, avoiding yield reductions due to late planting and interference with the following crop. Land consolidation would also improve drainage on ricelands, thus increasing the area which can be double-cropped to barley.

14. Labor Availability. The labor supply is presently a constraint during the "barley harvesting-rice transplanting," and "rice harvesting-barley planting" periods. With the project, the increased cropping intensity and production would substantially increase annual labor demand. In addition, the number of agricultural workers in the area has been declining

---

/1 Milled rice, assuming a 67% milling yield.

/2 Polished barley, assuming a 75% milling yield.

over recent years. Land consolidation, which would facilitate mechanization of land preparation, threshing and hauling, would help to offset this problem. In addition, rice and barley varieties are being bred for earlier maturity. This would increase the time available at the critical harvest and planting periods, easing peak labor demands.

15. Mechanization. About 20% of land preparation is now done by power tillers, the balance by animal drawn implements. There are few four-wheel tractors available. With land consolidation, improved water management and better access to fields under the project, power tillers and some four-wheel tractors would be used for an estimated 90% of rice land preparation, 90% of barley and 100% of other upland crop land preparation. Rice and barley are cut by hand and either stacked in the fields awaiting threshers, carried to threshers or hand threshed in the field. At present, 35% of rice and barley are mechanically threshed with the drum-loop type thresher. These are usually linked with the power take-off on the power tiller. Use of the power threshers is rapidly increasing and it is estimated that 85% of rice and 90% of the barley would be threshed mechanically in the future. The use of machine powered sprayers is also increasing rapidly and this is expected to continue in the future.

16. Drying, Storage and Processing. Farmers have sufficient sun drying areas in their villages or at their farms to handle the present crops. These can be easily expanded for the expected production increase. On the other hand, farmers have limited rice and barley storage capacity. NACF has 49 warehouses with a capacity of 21,000 tons in the project area and plans to build more as part of a nationwide program. There are also 12 private warehouses with a capacity of 4,200 tons. NACF's planned storage capacity would be sufficient to handle the expected production increases in the project area. There are 136 rice and barley mills, mainly privately owned, which have sufficient capacity (30,000 tons/year) to handle the present crop. However, additional milling capacity would be required at full project development. This would be provided either by the private sector or by the Government through the NACF.

Marketing

17. Over 90% of farmers in the project area belong to village or county cooperatives and thus can sell their surplus produce through the NACF. Nevertheless, most farmers sell to private traders. These traders are usually small scale with inadequate financing and deficient facilities. The market channels are diverse and frequently include middlemen. Government policy is to improve marketing channels by means of increased financial support for the cooperative organizations, particularly NACF. The government role in marketing is of considerable importance because it is involved in the implementation of price policy for farm inputs and produce, the encouragement of exports and the procurement of farm produce for government use. NACF presently markets some 25% of agricultural produce. The Government plans to increase this percentage in the future and to increase the range of NACF's marketing services, including modernizing processing and storage facilities.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Present and Projected Yields

	Present				Future Without Project				Future With Project		
	R	NC	C	C(F)	R	NC	C	C(F)	NC	C	TC /1
	ton/ha										
Traditional Rice	2.7	3.0	3.3	2.5	2.7	3.2	3.7	2.7	3.8	4.0	3.5
HYV Rice		3.4	3.8			3.6	4.0		4.5	5.0	4.4
Barley	1.9	2.0	2.2		2.1	2.2	2.4		2.8	3.0	3.0
Oil Crops:											
Soybeans	0.8				1.0				1.4		
Sesame	0.6				0.6				0.9		
Vegetable Crops:											
Sweet Potato	18.0				20.0				25.0		
Chinese Cabbage	17.0				18.0				33.0		
Radish	18.0				19.0				32.0		
Red Peppers	1.6				2.0				2.5		
Tobacco	1.8				2.0				2.5		
Rape Seed	1.8				1.9				2.3		
Millet	0.9				1.0				1.5		
Forest /2	2.5				2.5				-		

(All rice and barley yields are on polished basis.)

/1 R = Rainfed, NC = Irrigated (non-consolidated), C = Irrigated (consolidated), C(F) = Irrigated (consolidated) but subject to flooding, TC = Tidelands (consolidated).

/2 Produces fuelwood.

Note:

(a) For that portion of barley on upland, yields are same as NC. All other crops except barley on riceland, rice and 800 ha vegetables on tidelands are grown on upland soils. These are presently and in future without project rainfed but will be irrigated in future with the project.

(b) Yields for rice and barley in Tables 1 and 2 this annex are weighted averages as a result of grouping all areas into Rainfed or Irrigated.

(c) Yields for oil and vegetable crops appearing in Tables 1 and 2 are weighted averages combined from above individual crop yields.

ANNEX 9
Table 2

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Summary of Cropping Pattern and Production

	Cropped Area		Crop Production /1	
	Present	Future /2	Present	Future
	-------(ha)-------		------(tons)-----	
Irrigated				
Rice	5,200	19,650	16,600	87,600
Barley	1,950	15,040	4,100	43,600
Red Peppers	-	250	-	600
Tobacco	-	380	-	1,000
Oil Seeds	-	200	-	300
Vegetables	-	1,120		33,600
Subtotal	7,150	36,640		
Rainfed				
Rice	5,700	-	15,400	-
Barley	5,020	-	10,000	-
Red Peppers	250	-	400	-
Tobacco	470	-	800	-
Oil Seeds	2,070	-	1,400	-
Vegetables	1,290	-	23,000	-
Uncultivated Forest	600	-	1,500	-
Subtotal	15,400	-		
Total	22,550	36,640		
Cropping Intensity /3		150%		

/1 Production rounded to nearest 100 ton.

/2 At full project development in 1989.

/3 Based on net cultivable areas; present 14,600 ha (10,900 ha riceland, 3,700 ha upland, but not including forest); future with project, 20,700 ha (14,150 ha riceland, 5,500 ha reclaimed tidal land, and 1,050 ha upland).

KOREA

YONG SAN GANG IRRIGATION PROJECT STAGE II

Crop and Farm Budgets

1. Annex 9 contains the existing and proposed cropping patterns. This annex shows:

(a) Production costs for irrigated and rainfed crops at present and in the future "with" and "without" the project (Tables 1-3). Present production costs are based on the results of surveys conducted by ADC, and interviews in the area during appraisal. In the future without the project, fertilizer inputs would increase moderately (up to 13%), and agro-chemical use considerably (45% to 75%). Mechanical land preparation and threshing would also increase (5% to 20%) in rice and barley production. Future input levels for "with project" conditions are based on recommendations by the Office of Rural Development, and observed shifts to mechanized cultivating, threshing, and input-output hauling when irrigation and land consolidation are provided. Table 4 shows assumed input quantities used in the present and future situations;

(b) Crop budgets for the present and for the future "with" and "without" the project (Table 5). All prices have been adjusted to January 1977 levels. Prices used for rice, barley and tobacco are government purchase prices. As prices for other crops are subject to severe seasonal fluctuation, prices used were an average of farm gate prices over 1970-75 adjusted for inflation; and

(c) Farm budgets for typical family farms of 0.3 ha, 1.0 ha and 2.0 ha on the riceland and upland areas, and budgets for the proposed family farms of 1.0 ha and 2.0 ha on the reclaimed tidal land. Labor costs include only hired labor, not farm family labor, and were determined by calculating the excess of total monthly labor requirements over an estimated 45 man-days of family labor per farm per month. Hired farm labor is costed at Won 1,800 per day. As farm holdings are fragmented, the project would affect an average 67% of the existing farms' area. At present, the entire area of small farms (0.3 ha) is under cultivation, consisting of 67% riceland and 33% upland. The 1.0 ha and 2.0 ha farms include some 5% uncultivated forest, from 59% to 62% riceland, and 33% to 36% upland. With the project, all the existing farms would have irrigation facilities for 67% of their net cultivable areas. The remaining 33% would be rainfed. The uncultivated forest would be brought into production for rice and upland crops. In addition, the 0.3 ha farm would have a slightly higher cropping intensity than either the 1.0 ha or 2.0 ha farms. The reclaimed tidal land would be split into 1.0 ha and 2.0 ha farms and alloted between existing small farmers in the area, farmers whose land would be inundated by the proposed dam, persons with farming experience and the necessary financial backing to purchase the land, and war veterans. The tidal land farms would have irrigation facilities for their entire areas.

With the project, farmers would pay full O&M costs, estimated at Won 34,900 (US$72)/irrigated ha. They would also repay part of the project's capital costs, calculated for irrigation works as 30% of capital costs over 35 years at 3.5% interest per year, with an initial five-year grace period followed by 30 years of repayments; and for tidal land reclamation as 100% of capital costs over thirteen years at 7% interest per year, with an initial three-year grace period followed by ten years of repayments.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Crop Production Costs: Present /1

Cash Inputs /2 (Won '000/ha)	Rice				Barley				Red Pepper		Tobacco		Oil Seeds		Vegetables		Forest
	Rainfed		Irrig.		Rainfed		Partially Irrig.		Rainfed		Rainfed		Rainfed		Rainfed		Rainfed
Cultivation	27.5		27.5		11.8		11.8		12.3		15.4		10.8		13.9		-
Seed	9.1	(9.5)	7.2	(7.6)	12.8		12.8		19.8		21.3		7.0		22.4		-
Fertilizer	50.0	(37.8)	52.7	(39.7)	44.7	(34.3)	47.1	(36.0)	71.4	(53.6)	50.8	(37.8)	17.4	(13.7)	46.8	(34.7)	-
Agro-Chemicals	10.9	(10.7)	13.1	(12.8)	-	-	-	-	10.9	(10.7)	11.9	(11.7)	3.6	(3.5)	4.6	(4.4)	-
Harvesting	7.8	(8.3)	9.4	(9.7)	5.1	(5.6)	5.3	(5.8)	-	-	33.0		-	-	-	-	-
Other	9.7		11.1		6.6		7.0		19.6		44.6		3.2		16.3		-
Interest /3	-	(12.5)	-	(13.6)	-	(8.9)	-	(8.6)	-	(15.0)	-	(17.2)	-	(4.8)	-	(12.3)	-
Total Cash Inputs	115.0	(116.0)	121.0	(122.0)	81.0	(80.0)	84.0	(82.0)	134.0	(131.0)	177.0	(181.0)	42.0	(43.0)	104.0	(104.0)	-
Labor Inputs (man-days/ha)																	
Land Preparation	28		28		20		23		40		26		22		24		-
Planting	24		24		6		6		24		38		5		32		-
Crop Management	33		35		40		40		58		51		27		55		-
Harvesting	40		43		44		46		73		160		46		34		8
Total Labor Inputs	125		130		110		115		195		275		100		145		8

/1 Economic prices for use in economic analysis, and based on world market prices for rice, barley, soybean, tobacco and fertilizer. Figures in parentheses are financial prices for use in farm budgets, see Annex 12, Table 1 for individual prices used. All prices are in constant January 1977 levels.

/2 See Table 4 for physical input assumptions.

/3 Interest @ 2.5%/month on production credit for 6 months. Production credit needs calculated as 90% (cash inputs-harvesting costs).

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Crop Production Costs: Future Without Project /1

Cash Inputs /2 (Won '000/ha)	Rice				Barley				Red Pepper		Tobacco		Oil Seeds		Vegetables		Forest
	Rainfed		Irrig.		Rainfed		Partially Irrig.		Rainfed		Rainfed		Rainfed		Rainfed		Rainfed
Cultivation	27.9		28.9		12.4		15.3		12.3		15.4		10.8		13.8		-
Seed	8.3	(9.5)	6.9	(7.9)	12.8		12.8		19.8		21.3		7.0		22.4		-
Fertilizer	44.9	(39.0)	49.0	(42.3)	41.6	(36.3)	44.8	(39.0)	65.2	(56.2)	51.4	(44.5)	18.7	(16.5)	43.3	(37.7)	-
Agro-Chemicals	17.4	(17.0)	21.7	(21.3)	6.5	(6.4)	8.7	(8.5)	16.3	(16.0)	13.2	(19.2)	6.4	(6.3)	7.2	(7.0)	-
Harvesting	11.1	(12.7)	13.4	(15.4)	7.9	(8.8)	9.1	(8.3)	-	-	33.0		-	-	-	-	-
Other	11.4		13.1		7.8		9.3		21.4		44.7		4.1		17.3		-
Interest /3	-	(13.5)	-	(15.1)	-	(10.5)	-	(10.8)	-	(16.3)	-	(18.9)	-	(6.3)	-	(12.8)	-
Total Cash Inputs	121.0	(131.0)	133.0	(144.0)	89.0	(95.0)	100.0	(104.0)	135.0	(142.0)	179.0	(197.0)	47.0	(51.0)	104.0	(111.0)	-
Labor Inputs (man-days/ha)																	
Land Preparation	26		26		16		17		40		26		22		24		-
Planting	24		24		6		6		24		38		5		32		-
Crop Management	32		35		40		38		58		53		27		44		-
Harvesting	38		40		43		44		78		163		46		50		8
Total Labor Inputs	120		125		105		105		200		280		100		150		8

/1 See footnote No. 1, Table 1.
/2 See footnote No. 2, Table 1.
/3 See footnote No. 3, Table 1.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Crop Production Costs: Future with Project at Full Development /1

Cash Inputs (Won '000/ha) /2	Rice Irrigated (R)/3	Rice Irrigated (T) /3	Barley Irrigated	Red Pepper Irrigated	Tobacco Irrigated	Oil Seeds Irrigated	Vegetables Irrigated /4
Cultivation	31.7	33.0	20.9	22.0	22.0	22.0	22.0
Seed	8.7 (10.0)	8.7 (10.0)	12.8	19.8	21.3	7.8	27.3
Fertilizer	54.5 (47.0)	57.3 (48.6)	49.0 (42.3)	92.2 (79.9)	65.6 (57.7)	36.5 (32.4)	70.9 (62.4)
Agro-Chemicals	24.0 (23.4)	24.0 (23.4)	8.7 (8.5)	26.1 (25.6)	26.1 (25.6)	14.4 (14.1)	23.1 (22.6)
Harvesting	29.9 (34.3)	25.4 (29.1)	18.8 (20.8)	- -	40.7	- -	- -
Other	14.2	13.6	10.8	30.9	47.3	7.3	27.7
Interest /5	- (13.4)	- (14.3)	- (9.9)	- (18.8)	- (18.4)	- (9.4)	- (17.0)
Total Cash Inputs	163.0 (174.0)	162.0 (172.0)	121.0 (126.0)	191.0 (197.0)	223.0 (233.0)	88.0 (93.0)	171.0 (179.0)
Labor Inputs (man-day/ha)							
Land Preparation	23	16	13	30	14	10	12
Planting	24	24	6	24	40	5	32
Crop Management	35	35	38	86	61	27	50
Harvesting	38	35	33	100	200	48	86
Total Labor Inputs	120	110	90	240	315	90	180

/1 See footnote No. 1, Table 1.
/2 See footnote No. 2, Table 1.
/3 (R) = riceland; (T) = reclaimed tidal land.
/4 Barley and vegetable production costs are assumed similar for reclaimed tidal land and other areas.
/5 Interest @ 1%/month on production credit for 9 months. Production credit needs calculated as 90% of cash inputs.

KOREA

YONG SAN GANG IRRIGATION PROJECT STAGE II

Crop Production Costs: Physical Inputs

Inputs/ha			Rice			Barley		Red Pepper		Tobacco		Oil Seeds		Vegetables	
			Rainfed	Irrig.(R)/1	Irrig. (T)/1	Rainfed	Irrig./2	Rainfed	Irrig.	Rainfed	Irrig.	Rainfed	Irrig.	Rainfed	Irrig.
Present															
Cultivation:	- Mechanical	(%) 3/	20	20		20	20	-		-		-		-	
	- Animal	(%) 4/	80	80		80	80	100		100		100		100	
Seed:	-	(kg)	50	40		120	120	-		-		29		-	
Fertilizer:	- N (Nutrient kg)		115	120		100	110	175		80		25		100	
	- P (" ")		60	65		50	50	80		100		25		55	
	- K (" ")		55	60		40	40	70		90		25		60	
	- Compost	(kg) 5/	6,000	6,000		6,000	6,000	6,000		4,000		2,000		4,000	
	- Lime	(kg) 6/	-	-		250	-	-		-		400		300	
Threshing:	- Mechanical	(%)	35	35		35	35	-		-		-		-	
	- Manual	(%)	65	65		65	65	100		100		100		100	
Future Without Project															
Cultivation:	- Mechanical	(%)	25	40		25	40	-		-		-		-	
	- Animal	(%)	75	60		75	60	100		100		100		100	
Seed:	-	(kg)	50	40		120	120	-		-		29		-	
Fertilizer:	- N (Nutrient kg)		115	130		110	115	190		90		35		113	
	- P (" ")		60	70		50	60	80		110		29		55	
	- K (" ")		55	60		45	50	70		100		39		62	
	- Compost	(kg)	6,000	6,000		6,000	6,000	6,000		6,000		3,000		5,000	
	- Lime	(kg)	-	-		250	250	200		200		200		250	
Threshing:	- Mechanical	(%)	50	50		50	50	-		-		-		-	
	- Manual	(%)	50	50		50	50	100		100		100		100	
Future With Project															
Cultivation:	- Mechanical	(%)		80	100		90		100		100		100		100
	- Animal	(%)		20	-		10		-		-		-		-
Seed:	-	(kg)		50	50		120		-		-		34		-
Fertilizer:	- N (Nutrient kg)			145	175		130		250		110		53		150
	- P (" ")			80	85		70		120		120		68		100
	- K (" ")			70	80		60		120		170		58		150
	- Compost	(kg)		6,000	-		6,000		8,000		8,000		5,000		10,000
	- Lime	(kg)		-	-		-		600		600		880		600
Threshing:	- Mechanical	(%)		85	85		90		-		-		-		-
	- Manual	(%)		15	15		10		100		100		100		100

1/ (R) = Ricelands; (T) = Tidelands.
2/ Barley is partially irrigated in "Present" and "Future Without Project" situation.
3/ Contract price for complete mechanical preparation of riceland is Won 30,000/ha; other crops Won 20,000/ha.
4/ Hiring cost is Won 1,500/animal day.
5/ Compost is valued at Won 850/ton.
6/ Mechanical threshing charge is by quantity threshed; paddy 3% and barley 5%.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Crop Budgets /1

	Rice			Barley		Red Pepper		Tobacco		Oil Seeds		Vegetables		Forest
	Rainfed	Irrig. (R)/2	Irrig.(T)/2	Rainfed	Irrig.	Rainfed	Irrig.	Rainfed	Irrig.	Rainfed	Irrig.	Rainfed	Irrig.	Rainfed
Present														
Yield (ton/ha)	2.7	3.2		2.0	2.1	1.6		1.8		0.7		17.8		2.5
Farm-gate Price (Won '000/ha)	283	283		154	154	1,337		671		357		50		14
Gross Value of Production (Won '000/ha)	764	906		308	323	2,139		1,208		250		890		35
Production Costs Excluding Labor (Won '000/ha)	117	122		79	82	131		181		44		104		-
Net Value of Production, Excluding Labor (Won '000/ha)	647	784		229	241	2,008		1,027		206		786		35
Labor Requirements (man-day/ha)	125	130		110	115	195		275		100		145		8
Future Without Project														
Yield (ton/ha)	2.9	3.5		2.2	2.3	2.0		2.0		0.9		19.4		2.5
Farm-gate Price (Won '000/ha)	283	283		154	154	1,337		671		309		50		14
Gross Value of Production (Won '000/ha)	821	991		339	354	2,674		1,342		278		970		35
Production Costs, Excluding Labor (Won '000/ha)	131	144		95	104	142		197		51		111		-
Net Value of Production, Excluding Labor (Won '000/ha)	690	847		244	250	2,532		1,145		227		859		35
Labor Requirements (man-day/ha)	120	125		105	105	200		280		100		150		8
Future With Project														
Yield (ton/ha)		4.6	3.9		2.9		2.5		2.5		1.3		30	
Farm-gate Price (Won '000/ha)		283	283		154		1,337		671		260		46	
Gross Value of Production (Won '000/ha)		1,302	1,104		447		3,343		1,678		338		1,380	
Production Costs, Excluding Labor (Won '000/ha)		175	172		126		197		233		93		179	
Net Value of Production, Excluding Labor (Won '000/ha)		1,127	932		321		3,146		1,445		245		1,201	
Labor Requirements (man-day/ha)		120	110		90		240		315		90		160	

/1 Financial costs and prices are used, based on Table 1, Annex 12.
/2 (R) = riceland; (T) = reclaimed tidal land.

ANNEX 10
Table 5

KOREA

YONG SAM GANG IRRIGATION PROJECT: STAGE II

Farm Budgets

			Rice and Upland Areas									
			0.3 ha Farm					1.0 ha Farm				
			Present		Future[1]	W̄ Project	Future W	Present		Future[1]	W̄ Project	Future W
			Rainfed	Irrigated	Rainfed	Irrigated	Project	Rainfed	Irrigated	Rainfed	Irrigated	Project
Cropped Area:												
In Project Area	- Rice	(ha)	0.20	0.20	0.20	0.20	0.20	0.47	0.47	0.47	0.47	0.60
	- Barley	(ha)	0.07	0.08	0.07	0.09	0.15	0.28	0.30	0.28	0.33	0.51
	- Upland	(ha)	-	-	-	-	-	0.22	0.22	0.22	0.22	0.08
Outside Project Area	- Rice	(ha)	-	-	-	-	-	0.15	0.15	0.15	0.15	0.15
	- Barley	(ha)	0.08	0.08	0.08	0.08	0.08	0.20	0.20	0.20	0.20	0.20
	- Upland	(ha)	0.11	0.11	0.11	0.11	0.11	0.20	0.20	0.20	0.20	0.20
Total		(%)	0.46	0.47	0.46	0.48	0.54	1.52	1.54	1.52	1.57	1.74
Cropping Intensity		(%)	153	157	153	160	180	152	154	152	157	174
Crop Production	- Rice	(kg)	540	640	580	700	920	1,670	1,910	1,800	2,080	3,200
	- Barley	(kg)	300	330	330	380	610	960	1,020	1,060	1,180	1,920
	- Upland	(kg)	690	690	770	770	770	2,450	2,450	2,700	2,700	2,810
Gross Value of Production:												
In Project Area		(Won '000)	175	208	189	231	329	562	638	617	718	1,127
Outside Project Area		(Won '000)	98	98	113	113	113	311	311	348	348	348
Total		(Won '000)[2]	273	306	302	344	442	873	949	965	1,066	1,475
Production Costs, Excluding Labor		(Won '000)	44	46	51	51	71	143	148	164	176	239
Hired Labor		(Won '000)[3]	-	-	-	-	-	12	14	15	18	23
Taxes		(Won '000)[4]	4	4	5	5	6	28	33	34	40	63
Farm Income Before Project Charges		(Won '000)	225	256	246	288	365	690	754	752	832	1,150
Water Charges		(Won '000)[5]	-	3	-	3	7	-	8	-	8	23
Debt Service		(Won '000)	-	-	-	-	11	-	-	-	-	36
Net farm income		(Won '000)	225	253	246	285	347	690	746	752	824	1,091
Income from Non-Farming Activities		(Won '000)	70	70	70	70	65	65	65	65	65	50
Total Farm Income		(Won '000)	295	323	316	355	412	755	811	817	889	1,141
Total Labor Requirements		(man-days)	57	59	56	59	62	183	188	178	186	201

1/ W̄ = Future without project; W = Future with project.

2/ Based on Tables 1-3 and 5.

3/ Based on a maximum 45 man-days/month of family labor.

4/ Taxes on riceland - 6% of gross value of production after deducting 1.4 ton of foodgrain;
taxes on upland - 6% of gross value of production after deducting Won 85,000/ha.

5/ Irrigation O & M charges: "without project", US$31 (Won 15,000)/ha; "with project", US$72 (Won 34,900)/ha.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Farm Budgets[1/]

			Rice and Upland Areas (2.0 ha Farm)					Tideland Area	
			Present		Future W̄ Project		Future W	Future W	Future W
			Rainfed	Irrigated	Rainfed	Irrigated	Project	Project (1.0 ha Farm)	Project (2.0 ha Farm)
Cropped area:									
In Project Area	- Rice	(ha)	0.81	0.81	0.81	0.81	1.20	1.00	2.00
	- Barley	(ha)	0.64	0.67	0.64	0.72	1.01	0.65	1.30
	- Upland	(ha)	0.57	0.57	0.57	0.57	0.16	0.15	0.30
Outside Project Area	- Rice	(ha)	0.37	0.37	0.37	0.37	0.37	-	-
	- Barley	(ha)	0.37	0.37	0.37	0.37	0.37	-	-
	- Upland	(ha)	0.32	0.32	0.32	0.32	0.32	-	-
Total		(ha)	3.08	3.11	3.08	3.16	3.43	1.80	3.60
Cropping Intensity		(%)	154	156	154	158	172	180	180
Crop Production	- Rice	(kg)	3,190	3,590	3,420	3,910	6,590	3,900	7,800
	- Barley	(kg)	2,020	2,110	2,220	2,430	3,740	1,890	3,770
	- Upland	(kg)	5,260	5,260	5,790	5,790	5,060	4,500	9,000
Gross Value of Production:									
In Project Area		(Won '000)	1,143	1,272	1,263	1,434	2,249	1,633	3,265
Outside Project Area		(Won '000)	612	612	680	680	680	-	-
Total		(Won '000)	1,755	1,884	1,943	2,114	2,929	1,633	3,265
Production Costs, Excluding Labor		(Won '000)	287	296	329	351	475	280	559
Hired Labor		(Won '000)	108	111	111	114	147	9	220
Taxes		(Won '000)	80	88	92	103	148	71	166
Farm Income Before Project Charges		(Won '000)	1,280	1,389	1,411	1,546	2,159	1,273	2,320
Water Charges		(Won '000)	-	13	-	13	46	35	69
Debt Service		(Won '000)	-	-	-	-	72	451	902
Net Farm Income		(Won '000)	1,280	1,376	1,411	1,533	2,041	787	1,349
Income from Non-Farming Activities		(Won '000)	60	60	60	60	45	50	40
Total Farm Income		(Won '000)	1,340	1,436	1,471	1,593	2,086	837	1,389
Total Labor Requirements		(man-days)	371	380	364	376	395	196	391

1/ For footnotes, see Page 1.

KOREA

YONG SAN GANG IRRIGATION PROJECT STAGE II

Cost and Rent Recovery

1. The annex examines the implications for public revenues and farmers' incomes of the government's policies towards the recovery of the capital and recurrent costs of the project. In determining the extent of cost recovery and the relation of project charges to benefits, two indices have been used, which are defined as follows for the present project:

(a) Cost Recovery Index: the ratio of the present worth of incremental project charges paid by project farmers to present worth of incremental project construction and operation and maintenance costs; and

(b) Rent Recovery Index: the ratio of the present worth of incremental project charges paid by a typical farm family to the present worth of incremental "project rent" accruing to the family before paying project charges, where "project rent" is defined as net incremental income less the following incremental costs; the value of family labor, general taxes, depreciation of farm assets, returns to management and incremental investments, allowances for uncertainty, and water fee collection costs.

The upper limit of the rent recovery index is 100%, but it would normally be less than that because of political difficulties, tax disincentives, and costs of collecting taxes. Rent is a difficult concept to measure in practice but an attempt is made to determine reasonable quantitative estimates of its various components based on qualitative considerations.

2. All water charges, costs and benefits are measured at present values discounted at 10% annual rate of interest over the 50-year evaluation period, and in terms of 1977 constant prices. Costs and benefits represent financial flows and in determining the cost recovery index, project capital costs are net of taxes. To allow for inflation in calculating the cost and rent recovery indices, the annual debt service payments (because they are in nominal terms) are reduced by a fixed percentage per year.

3. Korea has a well established system of charges applying to government-planned land development projects. These charges are split into recurrent or O&M costs, and capital repayments. While farmers must pay full annual O&M costs, the capital repayment's terms vary according to the type of land development. For example, for irrigation works farmers

repay 30% of capital costs over 35 years at 3.5% interest per year, with an initial five-year grace period followed by 30 years of repayments; and for tidal land reclamation, farmers repay 100% of capital costs over 13 years at 7% interest per year with an initial three-year grace period followed by ten years of repayments.

4. In the cost recovery, US$105.4 million construction costs are charged against the project. Annual average incremental O&M costs are Won 33,600 (US$69)/ha. The present value of construction and O&M costs, discounted at 10%, is US$79.2 million. At full project development, incremental project charges total US$8.0 million per year. Discounted at 10% and assuming no inflation over the project's life, their net present value totals US$32.3 million, giving a 41% cost recovery for the entire project. At annual inflation rates of 5% and 10%, the corresponding cost recovery indices are 34% and 30%.

5. In the rent recovery analysis, indices are calculated for the existing farms, and for the proposed new farms on the reclaimed tidal land. For the existing farms, three farm sizes, 0.3 ha, 1.0 ha, and 2.0 ha are used to represent small, average, and large farms. Two situations are considered, one where the farms are rainfed in the future without the project, the second where they are partially irrigated. For the tidal reclamation, the proposed farms would be 1.0 ha and 2.0 ha. Farm budget data (Annex 10, Tables 5 and 6) are used to derive the net incremental income due to the project for each farm size.

6. In deciding project rent, farm depreciation was calculated at 3% of the incremental cost for buildings and 2% for land development works. Incremental family labor was valued at Won 1,600 per man-day, while the farmers' management was valued at 10% of gross incremental income. The return on the farmers' own investment was calculated at 10% of its market value, while an uncertainty allowance of 20% of gross incremental income was assumed for all farms. As farmers' organizations collect the project charges, the cost of this was subtracted also from project rent. Production taxes are 6% of the gross value of grain production in excess of 1.4 ton/farm on riceland; and 6% of the gross value production after deducting Won 85,000/ha on upland. Due to insufficient data, other taxes, such as import duties and sales tax, were not considered. Under these assumptions and discounting incremental project rent and charges over the 50-year evaluation period, rent recovery varied from 28% to 50% on the existing farms, and from 71% to 100% on the proposed tidal land farms (Table 1).

7. Assuming that all project rent is spent for consumption and not saved, the optimum water charges would be zero for those households with incomes below the absolute poverty level (US$175/capita), and 100% of the project rent for those with incomes above that level. At present an estimated 45% of the farmers (0.6 ha farm or less) have incomes below this level. At full project development an estimated 25% of the existing farmers (0.4 ha farm or less) would be below the absolute poverty level if it remains constant in real terms.

8. Under the Government's present repayment policy farmers would pay approximately 30% to 40% of project rent. This is considered satisfactory because:

(a) although government pricing and subsidy policies have raised rural incomes relative to urban incomes over the past five years, it is unlikely that terms of trade for agriculture will improve much in the future. The proposed level of charges is therefore consistent with the objective of preventing a widening gap between urban and rural incomes.

(b) the absolute level of project charges and general taxes at full development is considerable, varying from US$245 to US$375/ha on the existing farmland; and

(c) the collection of water charges in Korea are commonly greater than 98% of assessments.

9. Based on experience gained in selling tidal lands under the Pyongtaek-Kumgang Irrigation Project (Loan 600-KO), the proposed annual charges for reclaimed tidal lands of about US$995/ha are about as high as farmers would be willing to pay. Thus the rent recovery rates of 70% to 100% are satisfactory. Eligible applicants for the tidal lands would most likely come from one of the following two categories. First, farmers would have been displaced from reservoir areas or whose land has been acquired for industrial purposes. Second, farmers who have small but valuable holdings and are willing to sell them in exchange for larger though initially somewhat less productive land. Since the development cost of tidal land is less than the market value of prime agricultural land, both groups of farmers should have sufficient capital resources at their disposal to meet the high annual repayment costs (approximately US$923/ha plus O&M charges of US$72/ha), as well as finance the cost of new housing and additional farming implements.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Rent Recovery

	Typical Farm							
	Riceland & Upland Development						Tidal Land Reclamation	
	Rainfed Without Project			Partially Irrigated Without Project				
	0.3 ha	1.0 ha	2.0 ha	0.3 ha	1.0 ha	2.0 ha	1.0 ha	2.0 ha
	(Won '000)			(Won '000)			(Won '000)	
A. At Full Project Development[1]								
1. Incremental - Gross Value of Farm Production	140	510	986	98	409	815	1,317[2]	2,376[2]
2. - Less Cash Production Costs	20	83	182	15	68	157	238	585
3. - Equals Net Cash Income	120	427	804	83	341	658	1,079	1,791
4. - Less Depreciation[3]	6	18	33	6	15	30	23	39
5. - Less Imputed Family Labor Cost[4]	10	30	16	5	19	3	211	133
6. - Less Imputed Farmer's Management[5]	14	51	99	10	41	82	132	238
7. - Less Imputed Return on Own Capital[6]	8	24	48	7	22	44	43	68
8. - Less Allowance for Risk/Uncertainty[7]	28	102	177	20	82	163	263	475
9. - Less Allowance for Collection Cost[8]	3	3	3	3	3	3	3	3
10. - Less General Taxes	1	29	56	1	23	45	66	126
11. Equals Project Rent	50	170	372	31	136	288	338	709
12. Incremental - Water Charges (O & M)	7	23	46	4	15	33	32	61
13. - Capital Repayments	11	36	72	11	36	72	451	902
14. - Total Direct Charges [(12) + (13)]	18	59	118	15	51	105	483	963
B. Discounted Flows over Project Life[9]								
15. Project Rent	272	840	1,838	153	672	1,423	1,826	3,831
16. Water Charges	43	181	359	36	132	280	540	1,062
17. Capital Repayments[10]	27	131	261	40	131	261	1,293	2,586
18. Total Direct Charges [(16) + (17)]	70	312	620	54	263	541	1,833	3,648
19. Rent Recovery [(18) ÷ (15)]- at 0% inflation (%)	35	37	34	50	39	38	100	95
- at 5% inflation (%)	30	32	29	41	33	32	86	81
- at 10% inflation (%)	28	29	27	37	29	29	74	71

1/ Figures from Annex 10, Table 6.
2/ In calculating the incremental gross value of farm production for the tidal land farmers, in the without project situation the 1.0 ha farmer was assumed to have 0.3 ha of existing farmland partially irrigated, and similarly the 2.0 ha farmer to have 1.0 ha.
3/ Equipment @ 5% of cost; buildings @ 3%; land development @ 2%.
4/ At Won 1,600/man-days.
5/ At 10% of gross incremental value of production.
6/ At 10% of farmer's own incremental investment funds.
7/ At 20% of gross incremental value of production.
8/ An allowance for the cost of collecting project charges, which is done by farmer organizations.
9/ Net present value of project rent and charges, which are discounted @ 10% per year over the project life (50 years)
10/ Assuming a zero inflation rate.

KOREA

YONG SAN GANG IRRIGATION PROJECT STAGE II

Economic Analysis

Prices

1. All prices have been adjusted to January 1977 levels. All farm-inputs and output were evaluated at projected 1985 farm-gate prices expressed in January 1977 constant prices.

2. The farm-gate rice price is calculated as follows:

	US$/ton (milled basis)
Forecast 1985 world market price (in January 1977 constant dollars) /1	375
Ocean freight and insurance	36
Import price c.i.f. Incheon/Busan	411
Rice price, project area /2	411
Value of by-product (straw)	30
Farm-gate rice price	441 (Won 247,000) /3

/1 The commodity price forecast for Thai 5% broken f.o.b. Bangkok in 1985 (in terms of 1974 constant dollars) is US$295/ton. This price was adjusted to a January 1977 unit value by using a conversion factor equal to 127 (1974=100). Most of Korea's rice imports are of U.S. origin and are equivalent to or better than Thai 5% broken in quality.

/2 The value of port handling charges is taken as equal to the value of inland transport costs. The cost of milling has been assumed offset by the value of bran produced.

/3 Using a shadow foreign exchange rate of Won 560=US$1.

3. Since no world market price projection is available for barley intended for human consumption, polished barley was assumed to be worth 85% of the value of wheat flour, based on observed trends. This ratio reflects the taste preference of Korean consumers for wheat flour. Prices of soybean, tobacco and fertilizer are based on the Bank's projection of 1985 world market prices. For the remaining crops, which are not traded internationally, prices used were actual farm-gate prices averaged over five years (1971-75) and adjusted for inflation. All prices for internationally traded commodities were converted from an f.o.b. to a farm-gate basis by adding US$35/ton, to represent the average value of insurance, shipping and inland transport to the major market centers minus the cost of transporting the farm produce to the market centers. Table I shows all present and future prices used in the economic analysis and farm budget analysis.

Foreign Exchange

4. Due to the existence of import taxes, quantitative restrictions and export subsidies, the official exchange rate of Won 485=US$1 understates the cost to the economy of foreign exchange used in carrying out the project and savings through increased foodgrain production. According to the results of studies conducted by the Korea Development Institute, the effective rate of foreign exchange is about 15% higher than the nominal rate. Therefore, a shadow foreign exchange rate of Won 560=US$1 has been used to value the internationally traded commodities and the foreign exchange component of inputs and construction costs.

Labor Analysis

5. The demand for labor in the rural areas of Korea is highly seasonal in character. During the cropping season (April to October) there is little unemployment and in peak months (June and October) labor shortages may even develop. As the rural labor force is relatively mobile, the labor market works fairly efficiently and therefore the observed market wage rate for the hired labor provides a good estimate of the opportunity cost of farm labor during the cropping season. Thus labor has been valued at Won 1,800/man-day during the cropping season. During the winter season, there is little wage farm employment. There is, however, some self-employment, notably the weaving of bags from rice straw. The net income from this activity is about Won 500/man-day and the value has been used as the opportunity cost of unskilled labor in the winter months, November to March. For the purposes of this analysis, it was assumed that on the average, 85% of farm labor requirement occurs during the main season and 15% during the off-season. The resulting weighted average labor cost is Won 1,600/day.

Benefits

6. Benefits are estimated from the increased crop production resulting from irrigation and land development. Annex 10 shows the expected crop

production costs and labor requirements per ha, while Tables 2-4 give the expected crop yields, gross returns, and net returns (without accounting for labor) per ha. Chart 16100 shows the proposed cropping calendar. Table 5 shows the expected annual agricultural benefits at full agricultural development of the project.

Investment Costs

7. As calculated for the economic analysis and expressed in January 1977 prices, the total investment cost is US$95.6 million. This consists of civil works (US$58.5 million), engineering and administration, consulting services, equipment and other (US$36.7 million), and farmers own investment for the reclaimed tidal area (US$0.4 million). In determining the US$ value of investment costs, local costs were converted at the shadow exchange rate of US$1=Won 560 (para 4). Investment costs have been adjusted to exclude taxes and transfer payments (civil work's cost reduced 10%), and reflect the use of unskilled labor in off-season periods (civil work's cost reduced 5%). Costs include physical contingencies, but exclude price contingencies. Estimated annual O & M costs are US$67/irrigated ha (financial O & M cost is US$72/ha; the local cost portion is converted to US$ at the shadow exchange rate). US$1.0 million costs are incurred twice during the project evaluation period to replace the pumps. The investment costs do not include any allowance for the farmers' own investment in on-farm development in areas to be irrigated, as this is a small proportion of total costs, highly variable between different areas and thus difficult to quantify. As the work would be spread over several months and would be done at times when the farmer would be otherwise unemployed, the opportunity cost of this labor would be small and hence has been neglected.

Development Period

8. According to the project implementation schedule, the estuary dam would be closed in January 1981. Allowing one year for the water behind the estuary barrier to be sufficiently desalinated to allow pumping for irrigation, the 1982 rice crop would be the first grown under improved conditions. Excluding the tidal lands, project works would be completed so that farmers could irrigate a net 7,600 ha in 1982 and 15,200 ha in 1983. Commencing with the first crop grown under upgraded conditions, farmers would achieve the projected yield levels over five years in equal installments. The reclaimed tidal land would become available for cropping as follows: 400 ha in 1982, 2,030 ha in 1983; 3,630 ha in 1984; and 5,500 ha in 1985. Crop yields would reach their maximums over five years, and during this period the estimated rice yield per ha would be 1.0 ton, 2.5 ton; 3.5 ton; 3.9 ton; and 4.1 ton. The project would reach full development in 1989.

9. Using the foregoing assumptions and discounting the project's benefits and costs over 50 years the economic rate of return is 13% (Table 6).

Sensitivity Analysis

10. Sensitivity of the rate of return was tested to cost overruns; reductions and delays in benefits; a reduction in the tidal land reclaimed; and a 25% increase in project benefits. The effects of these changes in assumptions were as follows.

	Alternative	Rate of Return (%)
(a)	A 20% increase in construction costs	11
(b)	A two-year delay in reaching full project benefits	13
(c)	A combination of a 20% increase in construction costs and a two-year delay in reaching full project benefits	11
(d)	A 25% decrease in project benefits because farmers fail to attain projected yields and/or cropping intensities	10
(e)	The reclamation of 3,500 ha of tidal land instead of 5,500 ha	12
(f)	A 25% increase in project benefits due to higher commodity prices	15

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Input and Output Prices
(Won '000/ton)

	Present		Future	
	Financial	Economic	Financial	Economic
Crops				
HYV Rice	283	220	283	247
Local Variety Rice	283	220	283	247
Common Barley	154	140	154	140
Soybean	194	164	194	197
Tobacco	671	774	671	801
Red Pepper	1,337	1,337	1,337	1,337
Sesame	792	792	792	792
Chinese Cabbage	42	42	42	42
Sweet Potato	58	58	58	58
Radish	36	36	36	36
Fertilizers (Per nutrient ton)				
Nitrogen	179	246	179	211
Phosphoric Acid	149	210	149	184
Potassium	58	75	58	59
Lime (Per ton)	5.9	5.9	5.9	5.9
Agricultural Chemicals				
Pesticides	1,518	1,550	1,518	1,550
Seeds				
HYV Rice	190	180	237	207
Local Variety Rice	190	180	190	165
Common Barley	107	107	107	107
Soybean	213	213	213	213
Sesame	792	792	792	792
Radish	3,740	3,740	3,740	3,740
Sweet Potato	61	61	61	61
Red Pepper (Won/ha)	19,800	19,800	19,800	19,800
Chinese Cabbage (Won/ha)	25,850	25,850	25,850	25,850
Tobacco (Won/ha)	21,300	21,300	21,300	21,300

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Present Production from Project Area

	Area (ha)	Yield (ton/ha)	Farm Gate Price /1 (Won '000/ton)	Gross Value of Production	Production Cost /2 (Won '000/ha)	Net Value of Production	Net Return from Project Area (Won million)
Irrigated							
Rice	5,200	3.2	220	704	121	583	3,032
Barley /3	1,950	2.1	140	294	84	210	410
Sub-total	7,150						3,442
Rainfed							
Rice	5,700	2.7	220	594	115	479	2,730
Barley	5,020	2.0	140	280	81	199	999
Red Peppers	250	1.6	1,337	2,139	134	2,005	501
Tobacco	470	1.8	774	1,393	177	1,216	572
Oil Seeds /4	2,070	0.7	335	235	42	193	400
Vegetables /5	1,290	17.8	50	890	104	786	1,014
Uncultivated Forest /6	600	2.5	14	35	-	35	21
Sub-total	15,400						6,237
Total	22,550						9,679
Cropping Intensity /7	150%						

/1 Economic prices, see Table 1.

/2 Based on Annex 10, Table 1, excludes cost of labor.

/3 Grown on residual moisture after an irrigated rice crop.

/4 Includes by area soybeans 70%; sesame 30%.

/5 Includes by area sweet potato 57%; chinese cabbage 20%; radish 23%.

/6 Forest produces fuel wood.

/7 Based on net cultivable area of 14,600 ha (10,900 ha riceland, 3,700 ha upland), but not including forest.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Projected Future Production Without the Project

	Area (ha)	Yield (ton/ha)	Farm Gate Price /1 (Won '000/ton)	Gross Value of Production	Production Cost /2	Net Value of Production	Net Return from Project Area (Won million)
				(Won '000/ha)			
Irrigated							
Rice	5,200	3.5	247	865	133	732	3,806
Barley /3	2,250	2.3	140	322	100	222	500
Sub-total	7,450						4,306
Rainfed							
Rice	5,700	2.9	247	716	121	595	3,392
Barley	5,020	2.2	140	308	89	219	1,099
Red Peppers	300	2.0	1,337	2,674	135	2,539	762
Tobacco	470	2.0	801	1,602	179	1,423	669
Oil Seeds /4	2,020	0.9	312	281	47	234	473
Vegetables /5	1,290	19.4	50	970	104	866	1,117
Uncultivated Forest /6	600	2.5	14	35	-	35	21
Sub-total	15,400						7,533
Total	22,850						11,839
Cropping Intensity /7	152%						

/1 Economic prices, see Table 1.

/2 Based on Annex 10, Table 2, excludes cost of labor.

/3 Grown on residual moisture after an irrigated rice crop.

/4 Includes by area soybeans 70%; sesame 30%.

/5 Includes by area sweet potato 57%; chinese cabbage 20%; radish 23%.

/6 Forest produces fuel wood.

/7 Based on net cultivable area of 14,600 ha (10,900 ha riceland, 3,700 ha upland), but not including forest.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Projected Future Production with the Project at Full Development

	Area (ha)	Yield (ton/ha)	Farm Gate Price /1 (Won '000/ton)	Gross Value of Production	Production Cost /2	Net Value of Production	Net Return from Project Area (Won million)
				(Won '000/ha)			
Irrigated							
Rice /3	14,150	4.6	247	1,136	163	973	13,768
Rice /4	5,500	.4.1	247	1,013	162	851	4,681
Barley	15,040	2.9	140	406	121	285	4,286
Red Peppers	250	2.5	1,337	3,343	191	3,152	788
Tobacco	380	2.5	801	2,003	223	1,780	676
Oil Seeds /5	200	1.3	263	342	88	254	51
Vegetables /6	1,120	30.0	44	1,320	171	1,149	1,287
Total	36,640						25,537
Cropping Intensity /7	177%						

/1 Economic prices, see Table 1.

/2 Based on Annex 10, Table 3, excludes cost of labor.

/3 Composite rice yield calculated from 4.4 ton/ha on 7,650 ha non-consolidated; and 4.8 ton/ha on 6,500 ha consolidated.

/4 Reclaimed tidal land.

/5 Includes by area soybeans 85%; sesame 15%.

/6 Includes by area sweet potato 30%; chinese cabbage 30%; and radish 40%.

/7 Based on net cultivable area of 20,700 ha (14,150 ha riceland, 5,500 ha reclaimed tidal lands; and 1,050 ha uplands).

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Economic Analysis: Net Value of Agricultural Production at Full Project Development

Net Return to Project Area Without Costing Farm Labor /1 (Won million)		Incremental Net Return (Won million)	Less Incremental Farm Labor Cost /2 (Won million)	Incremental Net Value of Production (Won million)	(US$000)
Without Project	With Project				
11,839	25,537	13,698	2,192	11,506	20,546

/1 From Annex 9, Tables 2 and 3.

/2 Total labor requirements "with project" are 4.06 million man-days; "without project" 2.69 million man-days, giving an incremental farm labor requirement of 1.37 million man-days, which is costed at Won 1,600/man-day.

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Economic Costs and Benefits
(US$ million)

Year		Project Costs			Incremental Project Benefits
		Capital	O & M	Total	
1	(1977)	2.9	0	2.9	0
2	(1978)	8.6	0	8.6	0
3	(1979)	19.0	0	19.0	0
4	(1980)	24.7	0	24.7	0
5	(1981)	18.3	0	18.3	0
6	(1982)	10.7	0.8	11.5	1.2
7	(1983)	11.4	1.1	12.5	5.3
8	(1984)	0	1.3	1.3	9.0
9	(1985)	0	1.4	1.4	13.5
10	(1986)	0	1.4	1.4	17.6
11	(1987)	0	1.4	1.4	19.9
12	(1988)	0	1.4	1.4	20.3
13 - 24	(1989-2000)	0	1.4	1.4	20.5
25	(2001)	1.0	1.4	2.4	20.5
26 - 44	(2002-2020)	0	1.4	1.4	20.5
45	(2021)	1.0	1.4	2.4	20.5
46 - 49	(2022-2025)	0	1.4	1.4	20.5
50	(2026)	0	1.4	1.4	21.0
Economic Rate of Return					13%

KOREA

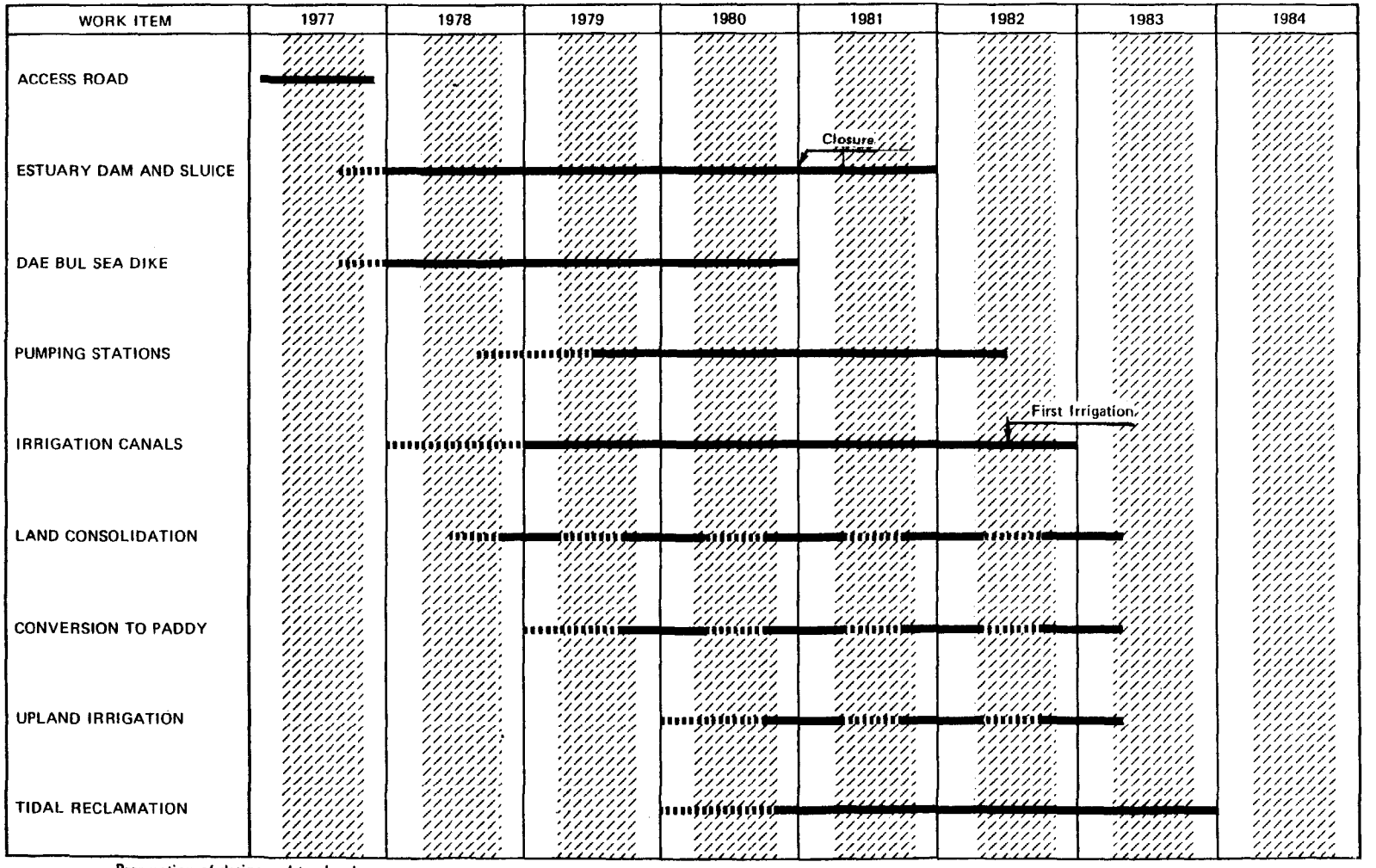
YONG SAN GANG IRRIGATION PROJECT: STAGE II

Schedule of Critical Events

Activity		Target Date
1. Consultants (Project Implementation)		
Invite Proposals		July 76
Selection		Aug. 76
Sign Contract for Part I		Sept. 76
Sign Contract for Part II		Jan. 77
2. Consultants (Feasibility Study)		
Invite Proposals		Aug. 77
Selection		Oct. 77
Sign Contract		Dec. 77
3. Civil Works		
	Invite Bids	Award Contract
Access Road	July 76	Sept. 76
Estuary Dam & Sluice	July 77	Dec. 77
Sea Dike	July 77	Dec. 77
Pumping Stations	Jan. 79	June 79
Canals	July 78 /1	Dec. 78
Land Development	May 78 /1	Sept. 78
Tidal Reclamation	May 80 /1	Sept. 80
4. Equipment & Materials		
Sluice Gates	Mar. 78	Sept. 79
Pumping Station Equipment	Sept.78	Feb. 79
Furnished Materials	Dec. 77 /1	Mar. 78

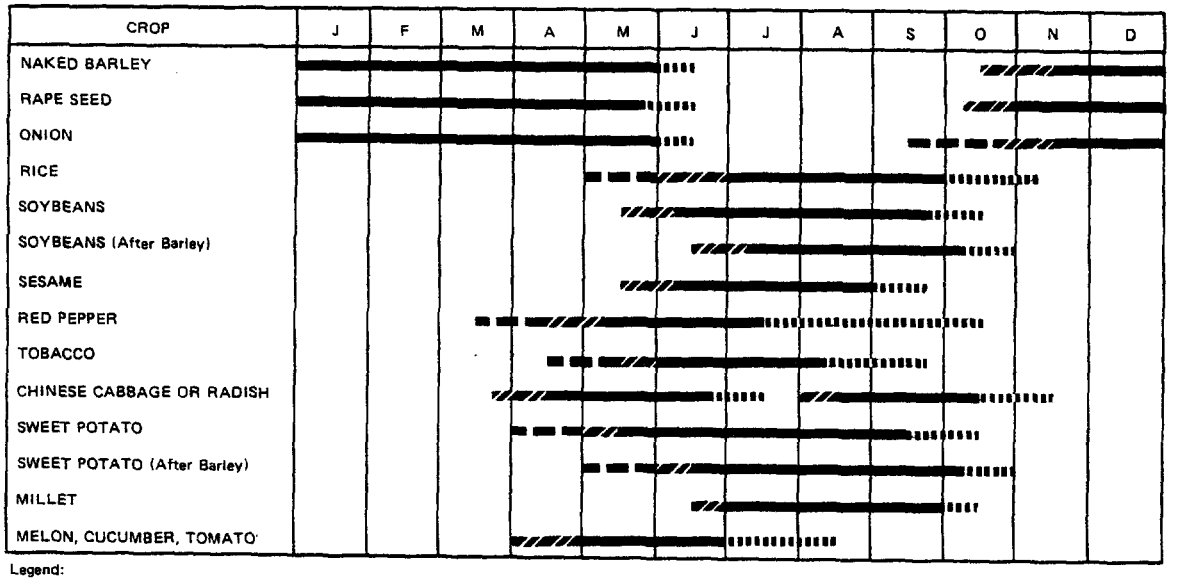
/1 First contract of several for same type of work.

KOREA
YONG SAN GANG PROJECT: STAGE II
Implementation Schedule



World Bank--16066

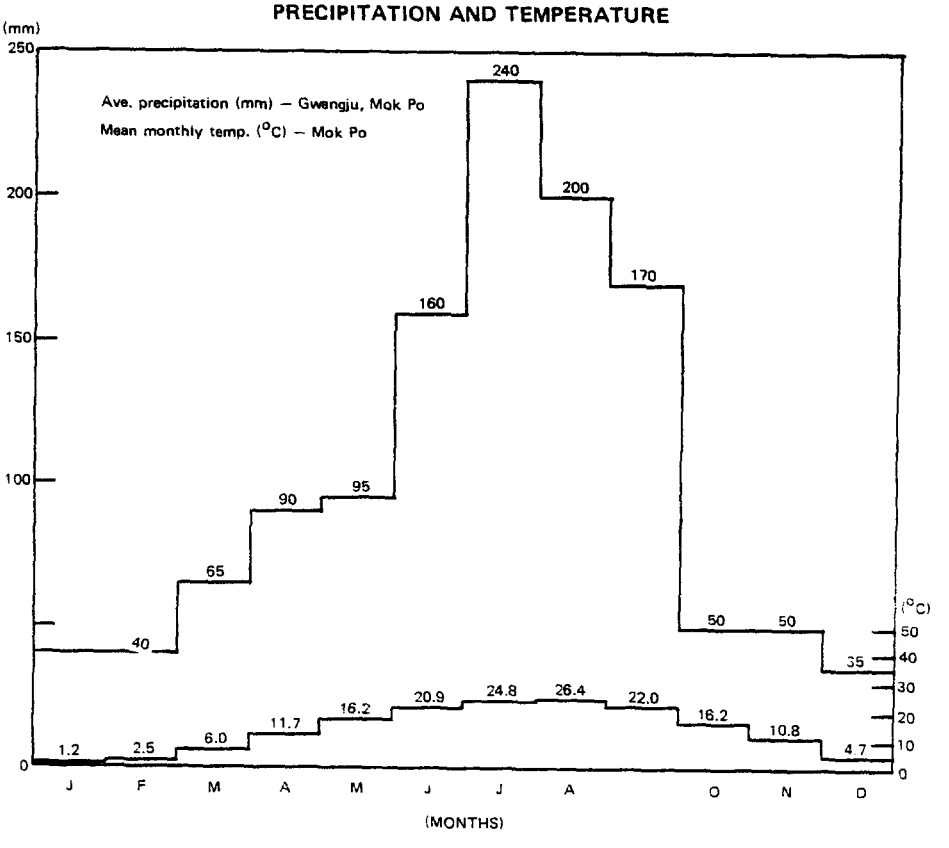
KOREA
YONG SAN GANG IRRIGATION PROJECT–STAGE II
Proposed Cropping Calendar



Legend:

- Nursery or Seedbed
- Sowing, Planting
- Vegetative Stage
- Harvest

PRECIPITATION AND TEMPERATURE

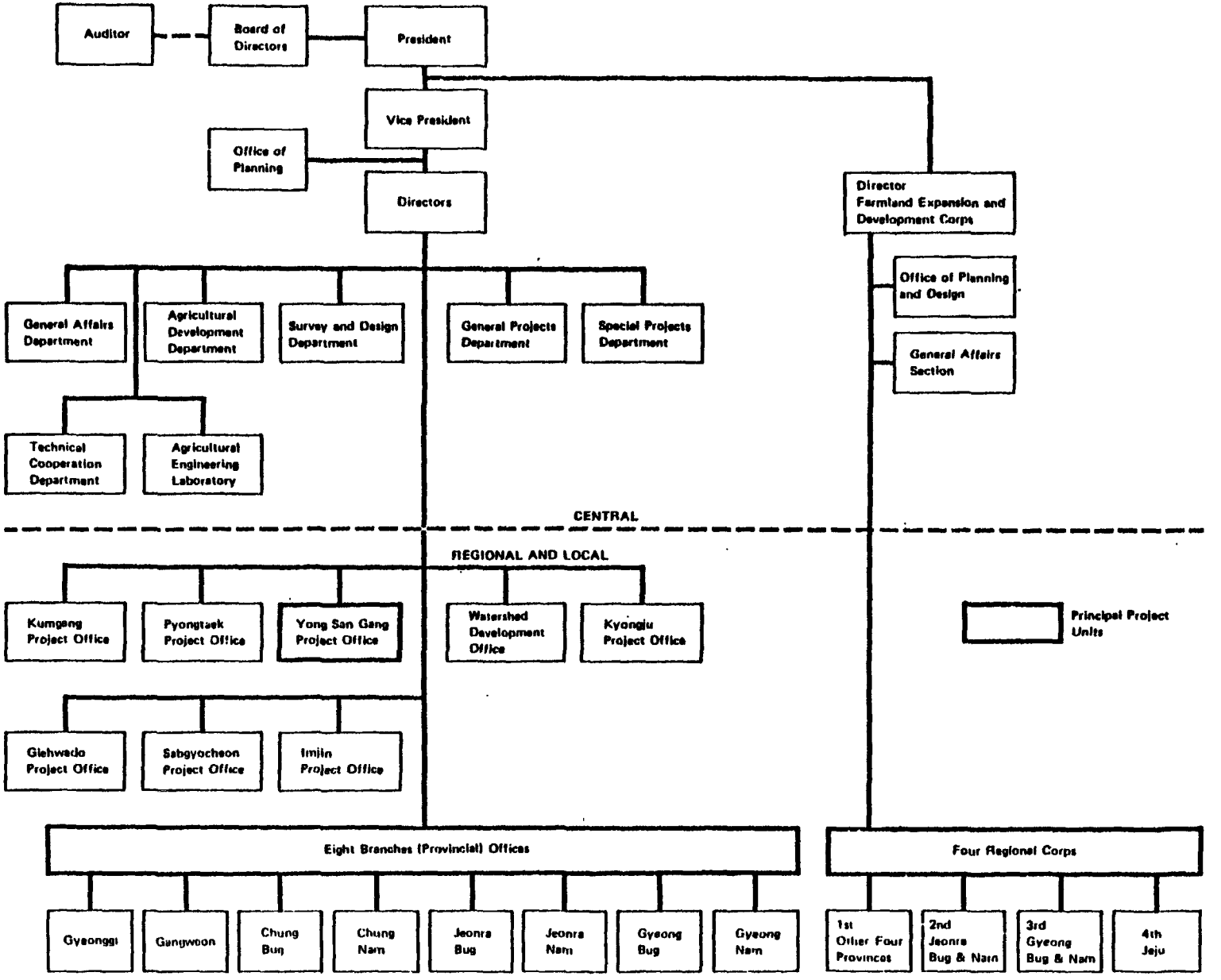


World Bank–16100

KOREA

YONG SAN GANG IRRIGATION PROJECT: STAGE II

Organization Chart of the Agricultural Development Corporation (Simplified)



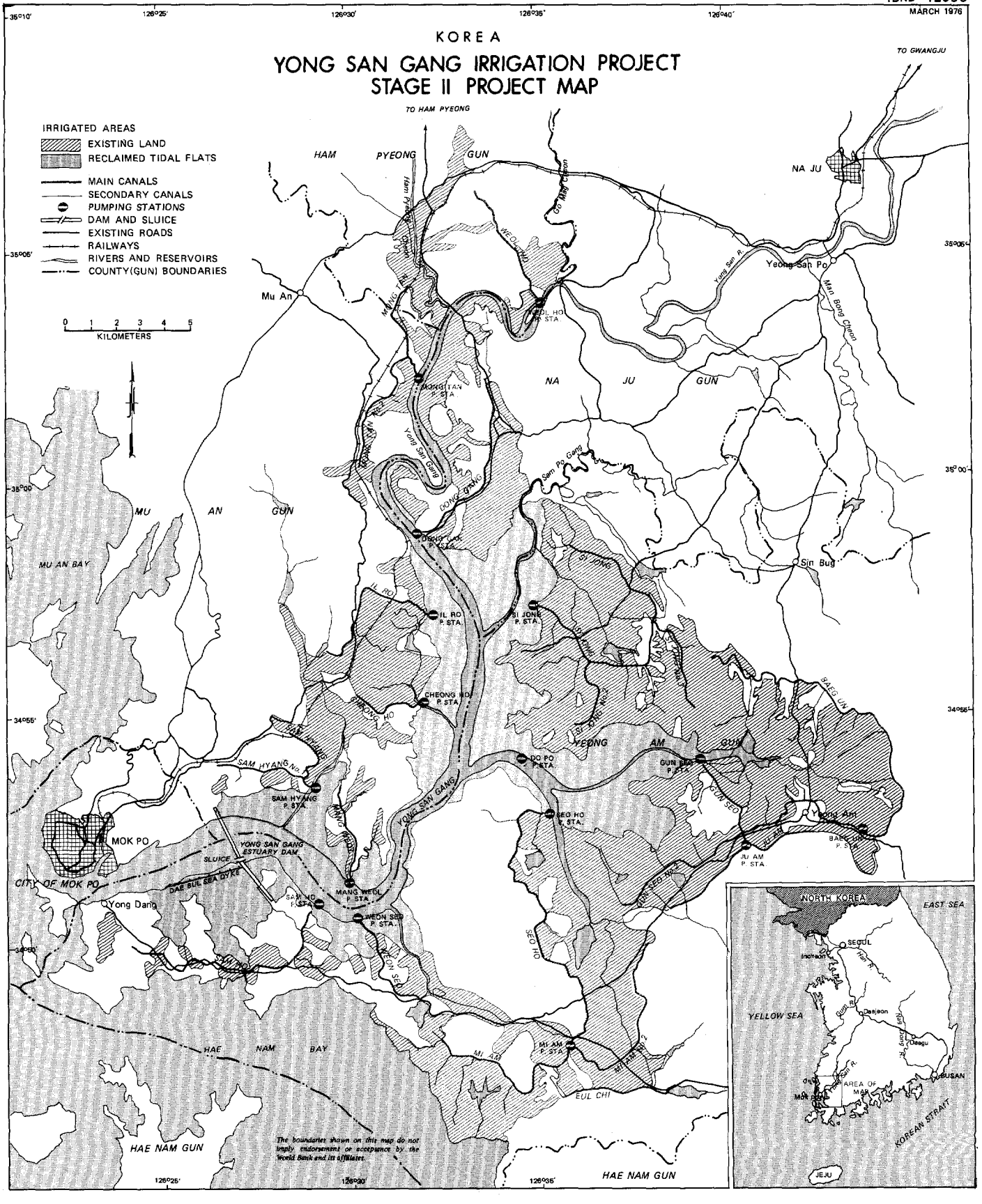
World Bank--15825

IBRD-12066

MARCH 1976

KOREA

YONG SAN GANG IRRIGATION PROJECT
STAGE II PROJECT MAP

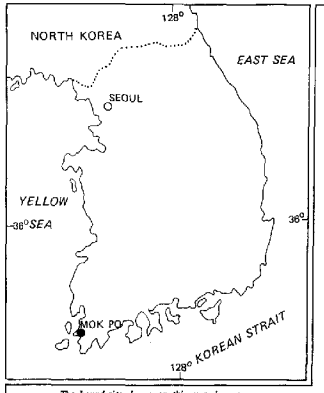


IBRD 12270R
OCTOBER 1976

KOREA

YONG SAN GANG IRRIGATION PROJECT - STAGE II

ESTUARY DAM NEAR MOK PO



The boundaries shown on this map do not imply endorsement or acceptance by the World Bank and its affiliates.