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Economic Analysis of an Iranian Water Development: The Sefeed Rood Project

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ECONOMIC ANALYSIS OF AN IRANIAN WATER DEVELOPMENT:

THE SEFEED ROOD PROJECT

by

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INTRODUCTION

This thesis is an evaluation of the methods and assumptions employed by those groups responsible for preparation of the original benefit/cost data describing the Sefeed Rood project. Benefit/cost ratios reported by the French engineering firm, Cotha Sogreah, and Plan Organization in a joint study range from 2:1 to 2.6:1 (6 and 10). A priori these seem suspect since the dam plus necessary canals and diversion works are obviously large and costly and only primary benefits are considered. The question is whether the potential benefits are likely to ever yield a positive return on investment and, if so, how long a pay-off period will be required.

The office of planning of Plan Organization of Iran has prepared separate benefit/cost data (unpublished) in 1964 for the same project in considerably greater detail.[1] Whereas, the French figures assumed technological duration ranging from 60 to 100 years for the various structures, the intent of the Plan Organization is to determine the length of time necessary to reach a break-even point. This turns out to be 1976 and implies an even quicker pay-off than assumed by the consulting engineers. The latter predicted the need for government subsidies for about 33 years before annual returns would exceed costs. Since construction began in the middle 1950's, the French data indicate break-even in 1988-1990 at the earliest. It must therefore be inferred that the Plan Organization data (reworked in 1964) are most likely to be "wrong" and subsequent analysis proceeds according to the following objectives:

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[1] All tables in Appendix are tables from this source (12). In turn, they are largely based on (6 and 10).

1. To determine the C/B ratio from published planning data.

2. To calculate additions or diminutions to published primary and secondary benefits.

3. To evaluate the published planning data in terms of official American procedures for primary and secondary benefits from water resource development.

4. To contrast the corrected net returns on investment in terms of project "break-even point" with official expectations.

Sequence of the Analysis

The remainder of this introductory part is devoted to the economic geography of Gillan Ostan and to a description of the engineering features of the Sefeed Rood project.

The second part opens with a summary of the Plan Organization benefit/cost data and a check of the original break-even date. A number of arithmetical errors are uncovered and corrected. An evaluation is then made of the values claimed for irrigation and power benefits. This is accomplished by comparing figures obtained from sources other than Plan Organization and the Sefeed Rood Water and Power Organization (S.R.W.P.O.). In particular, crop yields appear overstated and farm production costs appear low. If this is true, benefits are overstated. These corrections are followed by a comparison of the method of data presentation of the Plan Organization with officially adopted American standards.

New or revised estimates of irrigation and power benefits and costs are presented for the Sefeed Rood project in the third and final part. A revised benefit/cost ratio is computed along with a new payout period. Some general conclusions are drawn.

The Appendix consists of a translation from Farsi[2] of the benefit/cost evaluation data originally prepared by French consultants and Plan Organization. A number of translation difficulties are noted and resolved.

Economic Geography

In climate, population density, economic prosperity, and particularly in agricultural potentiality, the Gillan[3] region is immensly different from the rest of Iran. This is due, in part, to the vast and towering mountain range, the Alborz, that form a barrier between the warm, moist Caspian coastal lands to the north and the hotter and drier Iranian plateau to the south.

The main link between these two diverse regions is the Sefeed Rood Canyon, formed by the waters of the Sefeed Rood River. This river has its beginning in the Zagros mountain range to the southeast and flows northward to the Caspian Sea, cleaving a large canyon through the Alborz mountain range with an average flow rate of 40 kilometers an hour. It flows through the Gillan province (Ostan) and forms a delta of collected rocks and sand as it enters the Caspian.

Historically, the Sefeed Rood River has provided much of the water for the irrigation of rice and other Gillan croplands. But prior to the construction of the Sefeed Rood Dam, the river was only irrigating about 140,000 hectares of land. Of the annual flow, an average of only 1.7 million cubic meters was being used for irrigation, while approximately 2.3 million cubic meters of water flowed unimpeded into the Caspian Sea.

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[2]Language spoken in Iran (Persia).

[3]A northern Ostan (geographically comprobable to state) in Iran.

It was hoped that the construction of the dam would control and utilize this 2.3 million cubic meters of water to irrigate additional cropland. Another goal was to take advantage of the difference in the levels of the headwater and tailwater to generate electrical power to be utilized in the Gillan-Ghazveen and the Teheran areas.

In order to get the most utility from the dam, the construction of an irrigation system was necessary for both the upper and lower Sefeed Rood regions. In 1955, the Plan Organization contracted the irrigation layout to a French group. When completed and in full use, an additional 69,000 hectares of new land will be available for the cultivation of rice; and about 59,000 hectares of meadows and dry farm lands will be converted to irrigated cropland. In addition, about 110,000 hectares of existing rice lands will receive supplemental water.

Construction of the Sefeed Rood Dam was undertaken during the second seven year plan, beginning in 1957. The dam was inaugurated in 1963 and is the highest buttressed dam in the world. It is among the top 20 in terms of reservoir capacity holding 1.8 million cubic meters of water. The reservoir lakes have an area of 56 square kilometers and stretch for 26 and 13 kilometers respectively along the Ghezel Ozan and Shahrood Rivers (see map in pocket).

Climate

The climate of the Gillan Valley is a pleasant mild mediterranean. The average temperature ranges from 25 degrees centigrade during July and August to 9 degrees centigrade in February.

Due to the great size of the Alborz mountain range to the south of the Gillan Valley, the annual precipitation is more than 1,000 millimeters (37 to 60 inches). This usually falls in certain patterns; from November to February the average monthly precipitation is between 60 and 100 millimeters, from March to July the monthly average is between 20 and 50 millimeters, and from August to October between 150 and 200 millimeters per month. This year round rainfall would appear to be an adequate amount for crops, but there is not enough precipitation during the growing season. This, combined with high surface evaporation, reduces crop production and makes irrigation indispensible.

Geographical divisions

There are three large irrigation regions in the Gillan province: (a) Foomenat, or West Gillan, with a land area of 145,000 hectares; (b) the west bank of the Sefeed Rood River, or Central Gillan, with a land area of 92,000 hectares; and (c) the east side of the Sefeed Rood River, or East Gillan, with a land area of 108,000 hectares.

The main water sources of the Foomenat region are the quanats and the Foomenat and Alborz rivers. The Foomenat River is a collection of many small rivers that drain from the northern slopes of the Alborz mountains, and after passing through the Foomenat area, it pours into the Pahlavey Marsh or directly into the Caspian Sea.

The other two regions are irrigated from the Sefeed Rood River, along with several other smaller rivers. These include the Kohrood and Siahrood Rivers located to the east of the Sefeed Rood River, and the Disam and Shamrood located to the west of the Sefeed Rood River (refer to map). The Sefeed Rood River has a 56,000 square kilometer water basin to the north of Manjeel County and a smaller basin--about 900 square kilometers--between Manjeel and Tareek (see map). This river flows into many branches, both natural and artificial, and many canals have been made for irrigation purposes, especially on the west bank.

Vegetation and agriculture

In many areas of the Gillan province, the natural vegetation has been cleared and the land claimed for rice production. However, there are still plenty of meadows and forest lands that become marshes in the winter.

Some of the lands that are not agricultural lands are classified as:

1. Dense forests.

2. Depleted forests, the result of no practice of conservation (utilization of the forests has not been regulated).

3. Meadows, which could be used as grazing lands by cutting the trees, but in the fall they are flooded.

4. Lands that are covered with only annual grass species. This becomes a problem when overgrazed and the soil is bared.

5. Marshes and bamboo cane areas cover the lower level lands. Some of these marsh lands serve as water reservoirs for the lower land areas.

In areas where adequate water is available, intensive rice cultivation has been traditional. It is grown on 40 percent of all Gillan lands while dry farming--including tobacco, jute, tea, and peanuts--covers about 10 percent of the total acreage. The west bank of the Sefeed Rood River is mostly dry farm land--the crops including peanuts, tea, and berries.

The distribution of project acreage of the different crops in the Gillan Ostan is as follows:

Crop	Area in hectare
Rice	110,300
Berries	9,500
Tobacco	6,000
Vegetables	2,000
Others	18,000
Tea	9,400
Peanuts	2,000
Jute	2,000
Orchards	16,200
	173,400

There are approximately 500,000 animals in the Gillan area, most of these being cattle that are used for rice farming. These include cows, Indian cows (Sebus), and oxen. Sheep and goats that are raised and fattened in the Gillan Valley are from the local breeds.

Population

Gillan is one of the heavily populated areas in Iran. The 1956 census showed an average of 770,000 people on every 3,200 square kilometer of land, or an average of 225 people for every square kilometer. Considering the rate of population increase as 3 percent, in 10 years the population of Gillan will increase to approximately 1,020,000 people. Out of the above 770,000 people, 540,000 were farmers and harvested about 190,000 hectares of land. In other words, there are 285 farmers on every square kilometer of land under cultivation, or one farmer for every 3.07 hectares of farm land.

Two main groups of people inhabit the Gillan area--the Talleshey and the Geelaks. The Talleshey group are nomadic tribesmen living in the mountain areas and raise cattle and sheep and sometimes cultivate tea and rice. The Geelaks live in the lower areas and are mainly farmers, but a good many of them are employed in the cities doing handicraft work.

Description of Sefeed Rood Project

Wherever there is a stream of water, the surrounding land is under rice production. With over 110,000 hectares of the project land area used for the production of rice, one can appreciate the importance of water in this region. The present system of irrigation distributes 1.3 million cubic meters of water to 300,000 hectares of farm land and non-farm land from March through August.

Historic role of irrigation

One of the important limitations of the original Sefeed Rood River Dam was that it had to be repaired extensively every year during the period when the water flow was lowest, usually in March. In years that there was a heavy flow earlier than expected, there would be a delay in any needed repairs and therefore a delay in the irrigation and the production of the rice crop. On the other hand, the climatic conditions, especially low temperatures and heavy rain during the fall season, would shorten the rice growing season.

Another problem with the dam was the fact that it could not prevent the passage of silt and large sands into the irrigation ditches. This residue remained in the system, requiring extensive care in cleaning and repairing the ditches. Then, too, the lack of control of the flow rate of the river caused problems concerning proper distribution of the water. During the low water season there was not enough volume to irrigate all the land, and during the abundant water season there was over watering and flooding, causing some loss of crops.

In the original system of irrigation, most of the excess water or drainage water from the upper lands was utilized by the lower lands. There was no distinction between the irrigation network and the drainage system, and often one ditch would collect the drainage water from the plot above it and this water would be used to irrigate the plot below. This situation required every plot to be situated in such a way that it could get its water needs from higher plots. Therefore, in the regions of rice cultivation, there was no place for raising crops that required less water than the rice, and crop rotation was also hampered because other crops in rotation with rice could not get water other than at the time of rice planting seasons.

Another problem was that the drainage of excess surface water in a season of abundant water was a difficult task, especially in a large low land area.

At the present time, in the lower part of the river delta there are ponds that collect the excess water in the abundant water season and can furnish water for the lower level areas in the middle of the summer. However, a systematic and proper network of irrigation systems should eliminate the fear of a water shortage, and the land now covered by the ponds could be used for the cultivation of more rice.

Dams and canal systems

With the construction of the new Sefeed Rood Dam, the flood waters of the river will be collected in the dam reservoir, and this water may be used for the irrigation of the present rice lands during periods of water shortage. This water will also be used for the development of more farm lands.

The construction of the irrigation network of the Sefeed Rood was started in the beginning period of the third five-year plan in 1962 and consists of two main parts.

1. The upper region of the Sefeed Rood irrigation network. This area is called the Foomenat Valley (see map) and most of the land is not utilized for crop production at the present time due to unavailable water.

Where crops are produced, irrigation is haphazard and inefficient. The present Foomenat irrigation layout is far less extensive than that associated with the Sefeed Rood.

During slack water periods, there is a difference between the amount of water in the higher level farms and the lower ones. The higher farms are safe from the water shortages, but the lower level rice paddies are seriously affected by drought. The farmers on the lower levels have built ponds and reservoirs to store water, but they are not deep enough to meet requirements. Experience has shown that 1½ hectare of these pools or ponds will only irrigate 1 hectare of land.

The structures for the Foomenat region consist of the following and are detailed on the map.

a. Tareek Dam System. The purpose of this secondary dam is to raise the water level so it will enter the Foomenat Tunnel. It has a maximum capacity of 4.9 million cubic meters and can discharge up to 5,200 cubic meters per second, if necessary. In this dam there are four places planned for the installation of electric generators that will be capable of generating 22 million kilowatts of electricity annually. The length of the Foomenat Tunnel is 17 kilometers; the maximum discharge is 35 cubic meters per second. The Tareek Dam and the Foomenat Tunnel comprise a transfer system to shift Sefeed Rood water into the existing irrigation system in the upper region of Foomenat. The final part of the Tareek system is the 58 kilometer Foomenat Canal that distributes the Sefeed Rood water to the present ditches of the Foomenat area. This canal intersects several rivers along its path and feeds them. They, in turn, distribute the water to the Foomenat Valley. At the present time, the Foomenat region is irrigated by the Alborz River and a small capacity large surface area dry lake. These sources of water are not dependable, and as a result, each year there are heavy losses of crops, especially rice. The supplemental water will prevent this crop loss as well as enable farmers to convert meadows and reservoir ponds into croplands, thereby increasing agricultural production.

b. Shakharz Dam System. This dam will be built on the Shakharz River and will be mainly used for the irrigation of Jomeh Bazar (see map). This dam will raise water levels to feed the 5.37 kilometer Shakharz Canal.

2. The lower region of the Sefeed Rood irrigation network. A number of secondary structures are also required in the central and east Gillan regions. Again, the aim is to distribute water from the main reservoir to existing river beds. Water released from the bottom of the Sefeed Rood Dam follows the existing river bed until it backs up behind the Sangar Dam. Once the waters reach a certain level behind this dam, they are diverted into canals on the east and west banks of the Sefeed Rood.

a. Right Side Canal of Sangar Dam. This canal supplements irrigation on the right side of the Sefeed Rood delta and will ultimately join the Sham Rood River to provide irrigation for the Laheejam and Langerood area. Another dam will be built on this latter river several kilometers below the marsh shown on the map. The areas of north and northeast Langerood can be irrigated by a canal from the east side of the reservoir thus formed.

b. Left Side Canal of Sangar Dam. This canal will be 25 kilometers in length and will furnish water to the new irrigation layout that irrigates 23,000 hectares of meadows and finally ends in the Pessejohn River, fulfilling all the irrigation needs of Jameh Bazar.

Branching from the Left Side Canal is the Ahya Norood Canal. The length of this canal is 10.4 kilometers and runs north and south, parallel to the Sefeed Rood River, and takes care of the irrigation of the lower area of Khamam, Norood and Toosha.

Individual construction periods for these projects range from 15 to 45 months. None of the irrigation network projects were started until the beginning of the third five-year plan (1962). Some were finished in 1964, and others that were started in 1963 will be completed in 1967 (Table 1).

Table 1. Starting and finishing dates of the construction of the irrigation network of Sefeed Rood Dam.

No.	Construction work	Starting date	Finishing date	Period
I.	Construction of upper region of irrigation network			
	1. Foomenat Tunnel	Nov. 1962	Apr. 1966	42 months
	2. Foomenat Canal (first part)	Sept. 1964	May 1966	20 months
	3. Foomenat Canal Facilities (first part)	Nov. 1964	Mar. 1966	18 months
	4. Foomenat Canal (second part)	1965	1966	20 months
	Other construction of the dam and canal in connection with Foomenat Canal (second part)			
	1. Tareek Dam	1964	1966	30 months
	2. Shakharz	1966	1967	15 months
	3. Shakharz Canal	1966	1967	15 months
	Branch canals from Shakharz Canal	1967	After the third plan	--
II.	Construction of the lower part of irrigation network			
	1. Sangar Dam	1962	1964	24 months
	2. Left Canal of Sangar Dam	1962	1965	36 months
	3. Facilities of Left and Right Canals of Sangar Dam	1963	1964	20 months
	4. Noe Rood Canal	1964	1965	18 months
	5. Pesian Dam	1965	1966	15 months
	6. Bazar Jomeh	1965	1966	18 months
	7. Branched canals from Left Side Canal of Sangar Dam	1965	After third 5-year plan	--
	8. Branched canals from Jomeh Bazar Canal	1965	1967	--

Power generation

Provision for five turbines, each with a capacity of 17,500 kilowatts, have been made. Two of these are presently in operation. They generate 200 million kilowatts annually for the Gillan province.

In comparison, the total capacity of the Rasht and Bandar Pahlavi power stations, before the completion of the dam, amounted to only 4,600 kilowatts, or 11 million kilowatts per year. When the other three turbines are commissioned, a total of 429 million kilowatts per year will be available. It is expected that some 40 million kilowatts per year will be utilized by irrigation pumps in the Quazvin area, and the rest will be used to supply power for the Lushan cement plant, the Shomal tea mill, the Shilat fisheries, towns and villages in Gillan, as well as for Teheran.

The difference in the height of the headwaters and the lower level of the river under normal conditions is 80 meters. At the present time, this difference in the two levels is used for the generation of power. Gradually, when the irrigation network of the lower region of Sefeed Rood and the Foomenat Valley has been completed along with a complete electric power network for Gillan, the full utilization of the capacity of the reservoir will be made possible.

EVALUATION OF PUBLISHED PLANNING DATA

The kinds of project evaluation "errors" of which Plan Organization might be accused into two categories: those which are purely questions of fact and those which are subject to varying degrees of interpretation. In the former category are errors in arithmetic and unsystematic and inconsistent displays of data. The latter category includes hard to substantiate choices of product yields, prices, and input costs and the like.

In order to apprehend the effects of the arithmetic errors and interpretation changes which have been made, it is necessary to make constant references to the data translations contained in the Appendix. However, the summary of Plan Organization data presented immediately below provides a general frame of reference from which to consider the topics covered in this part.

Calculation of Benefit/Cost Ratio According to Plan Organization Data

Tables 2 and 3 summarize the data accepted by Plan Organization for calculation of the point in time when the Sefeed Rood project is expected to "break-even," i.e., where B/C = 1. The tables are arranged so that the compounded totals of benefits and costs of any year (6 or 12 percent rate) can be isolated and the benefit/cost ratio, as of that year, computed.

The Plan Organization estimated break-even using the above data as follows. Cost and benefit figures for each year shown are compounded separately at 12 and 6 percent rates of interest. The point in time where the sums of the 6 percent values reached a ratio close to unity is the end

Table 2. Summary of costs for Sefeed Rood project as mimeographed by Plan Organization

Year	Public & private irrigation costs		Public power cost		Total	Compounded at	
	Fixed	Current	Fixed	Current		12 percent	6 percent
1955	61.5	--	--	--	61.5	629	203
1956	455.6	--	--	--	455.4	4,066	1,390
1957	707.6	--	--	--	707.6	5,768	2,079
1958	705.9	--	--	--	705.9	5,137	1,957
1959	740.8	--	--	--	740.7	4,813	1,937
1960	619.0	--	225	--	844.0	4,896	2,062
1961	710.6	--	225	--	935.6	4,846	2,178
1962	591.2	21	--	6.9	619.1	2,852	1,369
1963	603.6	77	319	12.4	1,011.0	3,180	2,097
1964	11,504.0	140	159	31.0	1,484.0	5,471	2,901
1965	896.0	156	614	34.1	1,700.7	5,599	3,135
1966	706.5	227	534	37.5	1,505.0	4,324	2,618
1967	444.7	300	--	41.2	785.9	2,062	1,290
1968	335.2	373	--	45.3	753.5	1,765	1,167
1969	335,2	440	--	49.4	824.6	1,683	1,175
1970	335.2	507	--	53.5	895.7	1,673	1,239
1971	225.5	573	--	57.7	856.2	1,428	1,113
1972	225.5	639	--	61.8	926.3	1,379	1,136
1973	225.5	706	--	65.9	997.4	1,327	1,154
1974	225.5	772	--	70.1	1,067.6	1,266	1,165
1975	225.5	838	--	74.2	1,137.7	1,203	1,171
Total	10,516.0[a]	5,769[a]	2,076[b]	641,0[b]	19,002.0	65,367	34,556

[a]Appendix Table 28.
[b]Appendix Table 40.

of 1975. Computations of benefit/cost are made for power and irrigation individually. Then a combined ratio is calculated. Total benefit in irrigation compounded at 12 and 6 percent rate of interest is 40,880 and 29,445 million Rials. All costs compounded at the two interest rates are 57,241 and 29,538 million Rials. Benefit/cost ratios for irrigation are $\frac{40,880}{57,241} = .71417$ and $\frac{29,445}{29,538} = .99$ at the 12 and 6 percent rates, respectively.

Similarly, total benefit and cost ratios (million Rials) for power are

$\frac{7,105}{9,240} = .7689$ and $\frac{5,301}{5,004} = 1.0593.$

The combined benefit/cost ratios for power and irrigation are:

$\frac{47,985}{66,481} = .7217$ and $\frac{34,746}{34,542} = 1.005.$

Table 3. Summary of benefits for Sefeed Rood project as mimeographed by Plan Organization (million Rials)

	Irrigation benefits							
	Preventing loss of rice crop	New rice land	New other crop land	Income of S.R.W. P.O.	Power benefit elec. sales	Total	Compounded at 12%	Compounded at 6%
1962	534	--	--	--	--	534	2,469	1,173
1963	534	--	--	40	--	574	2,370	1,189
1964	534	--	--	47	25	606	2,234	1,185
1965	534	--	--	54	28	616	2,028	1,136
1966	534	169	55	79	64	900	2,648	1,567
1967	534	338	111	104	430	1,517	3,981	2,490
1968	534	506	175	131	430	1,776	4,162	2,750
1969	534	675	221	149	430	2,009	4,202	2,935
1970	534	844	278	167	430	2,253	4,208	3,106
1971	534	1,013	332	185	430	2,494	4,159	3,243
1972	534	1,181	387	203	430	2,744	4,073	3,354
1973	534	1,350	442	221	430	2,977	3,959	3,446
1974	534	1,519	498	239	430	3,120	3,822	3,515
1975	534	1,688	553	257	430	3,464	3,670	3,560
Total	7,476[a]	9,283[a]	3,051[a]	1,876[a]	3,987[b]	25,673	47,985	34,649

[a]Appendix Table 27.
[b]Appendix Table 41.

Arithmetic corrections

An arithmetic error exists in Appendix Table 25, where column 2 carries a decimal one place too far to the left. This would lower the cost/benefit ratio presented by Plan Organization. No correction is made, however, since different labor costs will be used for both new rice lands and other irrigated crops. (These corrections have been made in Table 6.)

Another error in presentation occurs in Appendix Table 34. The returns per hectare are shown net of labor and water costs (Appendix Table 24). Yet all other evaluations carry gross costs and gross returns forward. To be consistent Plan Organization should have used 34,200 as the gross return per hectare in place of 27,800. Again, this particular correction has not been made because it will be argued below that the 34,200 value is itself suspect.

Another arithmetic mistake occurs in Appendix Table 26. Assuming annual water payments of 1,400 Rials per hectare, the income from the new irrigated lands will not quite reach the levels reported. The corrected values are shown in Table 4. Another arithmetic error occurred in the calculation of the increase in income from existing rice due to supplemental water. Column 1, Table 5 therefore uses an annual figure of 524 million Rials. (Refer to the mistake that was corrected on p. 54.)

Table 4. Corrected income of W.P.O.S.R. from sale of water

Year	Land presently under crop	New irrigated cropland	Total
1963	40	--	40.00
1964	47	--	47.00
1965	54	--	54.00
1966	61	17.36	78.36
1967	68	34.72	102.72
1968	77	52.08	129.80
1969	77	69.44	146.44
1970	77	86.80	163.80
1971	77	104.16	181.60
1972	77	121.52	198.52
1973	77	138.88	215.88
1974	77	156.24	233.24
1975	77	173.60	250.60
Total	886	954.80	1,840.80

Table 5. Income from irrigation portion of the project (million Rials[a])

Year	Preventing loss of rice crop	New rice	New other crop	Income of S.R. org. from sales of water	Total	Interest rate 12%	Interest rate 6%
1962	524	--	--	--	524.00	2556.0	1185.5
1963	524	--	--	40.00	564.00	2462.8	1202.5
1964	524	--	--	47.00	574.00	2233.4	1154.9
1965	524	--	--	54.00	578.00	2013.9	1096.7
1966	524	142.04	66.3	78.36	810.70	2517.7	1452.8
1967	524	284.08	132.7	102.72	1043.50	2890.5	1762.6
1968	524	426.12	199.0	129.80	1278.92	3165.6	2557.8
1969	524	568.16	265.4	146.44	1504.00	3327.4	2785.1
1970	524	710.21	331.8	163.80	1368.81	2699.8	2347.8
1971	524	852.25	398.0	181.60	1959.85	3456.5	2877.8
1972	524	994.29	464.5	198.52	2181.31	3429.7	2967.7
1973	524	1136.33	530.0	215.88	2406.21	3379.2	2864.5
1974	524	1278.38	597.7	233.24	2633.32	3304.0	2958.7
1975	524	1420.42	663.7	250.60	2858.72	3200.4	3031.5
Total	7336	7812.28	3649.1	1840.80	20285.30	40636.9	30245.9

[a]A Rial is equivalent to 1/80 of $1.00.

Disagreements in Conceptual Matters

Labor costs

Referring to Appendix Table 24 (cost and benefit for 1 hectare of rice paddy) an allowance of 1,000 Rials per day for labor has been made by Plan Organization. The reasoning is that since the marginal physical product of labor is equal to zero due to disguised unemployment, 10 percent of the money cost is considered an adequate allowance for the "social cost" of putting labor to work in new rice paddies. However, traditionally speaking, there is a set wage rate of 40 Rials per day. Laborers will not work for less than the traditional rate regardless of how badly they need jobs. Thus, while it may seem that the opportunity cost to society may only be 10 percent of the pecuniary cost of obtaining labor for the new lands, if the total wage bill isn't paid, the planned production will not materialize. This means that the utility of worker's leisure has a price that society must bear. Therefore, it seems more reasonable to assume that the whole of the daily wage rate is a real cost. Especially since it is borne directly by the landlords and is a real expense from their point of view.

The decision has therefore been made to leave the cost of labor at 10,000 Rials per hectare per year instead of 1,000 Rials. Total expense of production will therefore be 15,400 Rials per hectare for rice. The expense of 1 hectare for crops other than rice is estimated by Plan Organization at 5,400 Rials. This figure also allows only 10 percent of the money wage rate. To get to the original value of labor payment under our assumption, it is necessary to add 90 percent to 5,400. Thus, the labor expense of 1 hectare of land in production of other irrigated crops would therefore be 12,993.75 Rials per year.

Allowing for the new cost figures, Appendix Table 25 has been altered to allow for higher labor costs for new rice land and other irrigated crops. This correction is shown in columns 1 and 2 of Table 6. The totals from Table 6 are now added to public current expense (Appendix Table 23) to obtain column 2 in Table 7. The final total values are compounded using 12 and 6 percent rates to obtain the new values for irrigation costs as of the end of 1975. Actually, 1975 will no longer be the break-even year; it will occur further in the future. But it is convenient to carry out some of the compounding as of 1975 in order to save effort later on when the new break-even year is approximated.

Table 6. Corrected annual current expenses for private sector in irrigation

	Current expenses		Water right payment			
Year	New rice land	Other crop	Land under cultivation	New rice land	Land changing from dry farm to irrigated	Total
1963	--	--	40	--	--	40.0
1964	--	--	47	--	--	47.0
1965	--	--	54	--	--	54.0
1966	96.6	71.5	61	9.66	7.7	246.0
1967	193.2	143.0	68	19.32	15.4	439.0
1968	289.8	214.5	77	28.98	23.1	633.0
1969	386.4	286.0	77	38.64	30.8	819.0
1970	483.0	357.5	77	48.30	38.5	1,004.0
1971	579.6	429.0	77	57.96	46.2	1,190.0
1972	676.2	500.0	77	67.62	53.9	1,375.0
1973	772.8	572.0	77	77.28	61.8	1,561.0
1974	869.4	643.5	77	86.94	69.3	1,746.0
1975	966.0	715.0	77	96.60	77.0	1,932.0
Total	5,313.0	3,832.0	886	531.30	423.5	11,086.0

Table 7. Total public and private investment in irrigation (million Rial)

Year	Fixed	Current	Total	Interest rate 12%	Interest rate 6%
1955	61.5	--	61.5	629	203
1956	455.6	--	455.4	4,066	1,390
1957	707.6	--	707.6	5,768	2,079
1958	705.9	--	705.9	5,137	1,957
1959	740.8	--	740.7	4,813	1,937
1960	619.0	--	619.0	3,591	1,527
1961	710.6	--	710.6	3,681	1,654
1962	591.2	21	612.2	2,830	1,344
1963	603.6	77	680.6	2,811	1,410
1964	1,154.0	140	1,294.0	4,771	2,530
1965	896.6	156	1,052.6	3,465	1,940
1966	706.5	358	1,064.5	3,306	1,908
1967	444.7	563	1,010.7	2,800	1,707
1968	335.2	769	1,104.2	2,733	1,865
1969	335.2	967	1,302.2	2,881	1,958
1970	335.2	1,165	1,500.2	2,959	2,128
1971	225.5	1,363	1,588.5	2,801	2,126
1972	225.5	1,560	1,785.5	2,807	2,254
1973	225.5	1,756	1,981.5	2,783	2,358
1974	225.5	1,956	2,181.5	2,737	2,451
1975	225.5	2,154	2,379.5	2,665	2,523
Total	10,516.0	12,611	23,538.0	70,034	38,249

Yield and prices

Several important questions must be considered before the Plan Organization benefit or income figures can be finally accepted. Figures for crop yields and selling prices must be evaluated. In addition, some judgment is necessary regarding the extent of electricity markets.

The yield for rice per hectare is given as 3,800 kilograms (Appendix Table 24). Checking this figure against the Agricultural Statistics extracted from the 1960 World Agricultural Census reveals a significant difference. Representative 1960 figures for Gillan are shown in Table 8, along with yields obtained by a CENTO survey team in 1962. In addition, yields from certain earlier sources are shown in the same table. All of these estimates suggest that the Plan Organization yield figures for rice are much too high. Prices of different rice grades and for wheat were checked against figures from the World Agricultural Census and with the experience of persons owning lands in Gillan. These sources closely confirmed the prices used by Plan Organization and no adjustments for rice and wheat selling prices have been made.

Allowing for only yield corrections, income from 1 hectare of rice land is calculated to be as follows. Average yield for 1960 as listed above is 2,219 kilos. Allowing an increase of 20 percent in yield due to better water supplies the yield figure would be raised to 2,662 kilos per hectare. At a price of 9 Rials per kilo, income will be 23,967 Rials per hectare. This annual return per hectare is used in Table 9 after making an adjustment for gross income losses foregone if the land is converted to rice production. The lands generally going into rice production had former uses as shown in Table 10, and prices and returns as shown in Table 11. If these figures are used to construct a weighted average value of returns from former uses, the former average annual return is 574 Rials per hectare. Subtracting this gives a final adjusted gross value per hectare from new rice land of 23,393. This correction is carried over to Table 6, column 2.

Table 8. Selected example of recent crop yield and price experience in Iran

Kind of crop and citrus	Yield per hectare 1926	Yield per hectare 1960 1962	Rial per Kilo.	Return/ hectare for 1960 (Rials)
Wheat and barley irrigated (kg)	863.0	1,576.0	6.6[a]	10,401.6
Wheat and barley dry (kg)	--	380.0	6.6	2,508.0
Rice (kg)	2,242.0	2,219.0	10.0	22,190.0
Citrus (each)	--	37,544.0[b]	1.8[b]	69,080.9
Melon	--	6,435.1[b]	--	--
Lentils	--	1,090.4	17.8	19,409.1
Cotton	--	429.1[b]	--	--
Jute	822.4	1,175.4	12.0	14,104.8
Tobacco	801.4	703.4	54.4	38,264.9
Vegetable	--	--	9.0	--
Forage	--	--	--	--
Silk worm	225.5	665.8	31.0	20,639.8
Tea	--	2,282.0	21.0	47,922.0
Ground almond	--	1,000.0	20.0	20,000.0

[a]Not including barley.
[b]Value from CENTO survey team in Iran.
Source: CENTO (2); World Agricultural Census reported in (1); for 1926 Estates Appraisal Records, Ministry of Finance, for 1957 Ministry of Agriculture.

Table 9. Corrected returns from new rice land (million Rials)

Year	Net area 88 percent of gross	Gross return per hectare	Gross income
1966	6,072	23,393[a]	142.0
1967	12,144	23,393	284.1
1968	18,216	23,393	426.1
1969	24,288	23,393	568.1
1970	30,360	23,393	710.2
1971	36,432	23,393	852.2
1972	42,504	23,393	994.2
1973	48,576	23,393	1,136.3
1974	54,648	23,393	1,278.3
1975	60,720	23,393	1,420.4

[a]Corrected from 34,200 due to yield.

Similar steps are taken with respect to Appendix Table 35. The differences between 25,000 and 15,000 Rials per hectare explains the gross returns for all new lands going into irrigated crops (other than rice) except jungles. Similarly, the difference between former and predicted returns for jungles was taken by Plan Organization to be 20,000 Rials per year.

Actually, there is little reason to imagine that the former dry farm land yielded anything near 15,000 Rials (gross) per year. Even irrigated wheat land would return less than 11,000 and, in fact, dry land wheat returns (in Gillan) as of 1960 would be about 2,500 Rials per hectare per year (Table 8). It is true that some of the new land is to come from converted orchards, but they must be depleted, otherwise they would not be plowed under.

Table 10. Hectareages and former uses of new rice land in Gillan

Region	Meadow	Reservoir and marshes	Other crops	Orchard	Grazing	Total of lands minus reservoir
Upper Foomenat	12,740	5,900	4,560	--	--	--
Lower Foomenat	16,543	1,691	--	--	--	--
Left Bank	6,745	3,930	--	--	--	--
Right Bank	6,175	7,090	--	2,220	1,120	--
Total	42,204	13,611	4,560	2,220	1,120	50,124
Value per 1 hectare (Rials)	500[a]	--	3,000[b]	500[b]	500[b]	--
Gross return of all lands now going into rice paddies (mil. (Rials)	21.1	--	13.68	1.11	.56	36.45

[a]Plan Organization estimates.
[b]All prices from CENTO, 1963 (2), and personal contact and the Plan Organization.
Source: Appendix Tables 30, 31, 32, and 33.

Table 11. Former returns (opportunity cost) of jungle lands going into other irrigated farms

Region	Jungles in hectare
Upper Foomenat	--
Lower Foomenat	--
Left Bank	220
Right Bank	3,950
Total	4,170
Gross return from jungles per hectare (Rials)	5,000[a]

[a]Weighted average per hectare is equal to 5,000 Rials.
Source: Appendix Tables 30, 31, 32, and 33 and Table 9.

The same difficulty exists with the level of returns postulated by the Plan Organization once the land goes under irrigation (25,000 Rials per year). Even a hectare of good rice land is unlikely to earn more than 24,000 Rials per year and it is unlikely that, on the average, other irrigated crops could be better revenue producers than rice land unless a great percentage of new land goes into citrus production.

A weighted average of all annual returns from all former dry lands (not including converted ponds and reservoirs) has been computed using the data shown in Tables 11 and 12. This is 1,614 Rials per hectare for lands other than former jungles. Jungles are taken to return 5,000 Rials per hectare because they yield wood products in addition to grazing values (Plan Organization figure). The former jungles are assumed to be used for irrigated crops in the same proportion as assumed for other converted dry lands; namely, tea area, 6 percent; wheat and barley area, 45 percent; citrus, peanuts, jute, tobacco, lentils, vegetables, and potatoes, 49 percent. Except for tea lands, these are all estimates. Exact break-down of expected cropping patterns is never given in the Plan Organization review. This break-down is extracted from World Agricultural Census. A weighted index of the annual future returns per hectare based on the above percentages is 14,819 Rials. The net increase in gross returns per hectare is therefore taken to be 14,819 - 5,000 for former jungles and 14,819 - 1,614 for all other dry lands and former ponds. These corrected values are used along with net figures for new irrigated lands other than rice to make up Table 13.

Table 12. Former returns (opportunity cost) of dry lands (not jungles) going into other irrigated farms

Region	Other crop	Grazing	Orchard	Berry	Total
Upper Foomenat	10,500	--	--	--	--
Lower Foomenat	4,600	--	--	--	--
Left Bank	22,220	2,210	15,780	--	--
Right Bank	7,740	4,990	2,320	6,250	--
Total	25,060	7,200	18,100	6,250	56,610
Value/1 hectare (Rials)	3,000	500	500	500	--
Gross return from the lands (mil. Rials)	75.18	3.6	9.05	3.1	91.38

Source: Appendix Tables 30, 31, 32, and 33, and Table 9.

Table 13. Corrected gross return from converting dry farms and jungle to irrigated farms

Year	Net area in hectare	One hectare value in 1000 Rials	Increased income from present jungles	Net area in hectare	One hectare value in 1000 Rials	Increased income from present dry farm	Total
1966	345	10	3.45	4,840	13	62.9	66.3
1967	690	10	6.90	9,680	13	125.8	132.7
1968	1,035	10	10.35	14,520	13	188.7	199.0
1969	1,380	10	13.80	19,360	13	251.6	265.4
1970	1,725	10	17.20	24,200	13	314.6	331.8
1971	2,070	10	20.07	29,040	13	377.5	398.0
1972	2,415	10	24.15	33,880	13	440.4	464.5
1973	2,760	10	27.00	38,720	13	503.3	530.0
1974	3,105	10	31.05	43,560	13	566.2	597.5
1975	3,450	10	34.50	48,400	13	629.2	663.7

Receipts from power

Some account should be taken of estimates of future power sales. The earliest projections, those of the French consultants, were confined to growth in electricity consumption in Gillan. This was set at 30 million kilowatts annually by 1976. However, Plan Organization discovered, in their re-examination of the Sefeed Rood project, that the rate of increase of consumption in recent years will not substantiate the early estimates. According to Plan Organization, the population projections employed by the French engineers were too optimistic.

However, Plan Organization was able to accept lower sales in Gillan because by the time of their evaluation (1964) the transmission line to Ghazveen and Teheran had been added to the project. Since the Teheran area has been a power deficient area for years, the assumption by Plan Organization is that any amount of power not taken in Gillan can be sold in Teheran. There is little reason to disagree with this view, and it is assumed that the projected revenues from power sales will materialize.

Price levels

No allowance has been made for alterations in real prices received for crops due to an increase of some 50 to 60 percent in Gillan production. This convenient assumption, however, is not completely untenable. Gillan is already a surplus crop area and marketing channels are well developed, despite many primitive practices (10). Fortunately, the Teheran market is quite close and transport is readily available. This area constitutes a readily, rapidly growing market for citrus and better grades of rice, the very crops important to Gillan. In addition, Iran has been able to export rice in most years. The main price question thus concerns increased wheat production. Wheat prices fluctuate from year to year in response to harvest volumes and receipts of American "480" shipments. Any increases in Gillan production will have to share in such fluctuations (there is a minimum government support price) but is unlikely, of itself, to affect prices. This is because wheat is the main Iranian agricultural crop and any positive increment due to expanded Gillan production will be too small to have much national impact. Since there is a nationwide wheat market, it is difficult for local prices to get very far "out of line."

Water payments and receipts

Two questions regarding increased water supplies from the Sefeed Rood project must also be considered. The first is the possible confusion over the way water right payments are handled in the Plan Organization display of cost and benefit data. These payments are calculated on one hand as the income of S.R.W.P.O., and on the other hand as a current expense for the private sector. In other words, it looks like a double accounting mistake occurred. However, when the water right is accounted on both sides, they will net out leaving the benefit from additional crop value which is a rent to water and other factors of production. This is the benefit value that the feasibility analysis must and does capture.

Choice of water selling prices

The fixed selling prices of water are obviously crucial values. If the price of 1,400 Rials per hectare is too high for an adequate season's supply for new irrigated land, landowners will cut back purchases and the expected water revenues will not materialize. Historically, there has always been a tradition of set or established water prices just as is the case now with S.R.W.P.O. dictating them; in itself, this is not an innovation. According to private sources having agricultural experience in Gillan, prices of 1,400 Rials and 700 Rials (for supplemental water) per hectare are close to traditional levels. Thus it is assumed that the water can be sold at the prices listed.

American Water Resource Planning Documents and the Sefeed Rood Analysis

The most recent exposition of American planning criteria is set forth in Senate Document 97. This document is important with respect to the executive branch and legislative branch for it represents an attempt to arrive at common evaluation procedures for use in development of water and related land resources. In the Sefeed Rood case, Plan Organization had the sole responsibility of reviewing engineering cost estimates and had to make the decision of whether or not to contract the project out to the French. However, benefit/cost ratio was not officially calculated and published at the time of the dam. Plan Organization took for granted that the French consultants had established existence of an attractive benefit/cost ratio.

The philosophy of Senate Document 97 is that all viewpoints, national, regional, state and local, must be fully considered. The document goes on to list a series of purposes or services which might be provided by project construction and which would foster regional development. Although the geographical division of Ostans is similar to states in the United States, the political situation is quite different. All of the Ostans are under the constitutional monarchy in Teheran (capital city), therefore the priority of the projects are in the interest of the central government. Secondary benefits associated with a national as opposed to a regional viewpoint shall be combined with primary benefits when computing benefit/cost ratios. In the Sefeed Rood study, secondary benefits are not included in any direct way, and there is no mention of intangible benefits. For example, generation of new taxes are not considered nor is any allowance made for such items as recreational development. Since values of people in that region differ from those of the western world, recreational benefits are practically unknown.

All reimbursement comes from local sources; that is to say, sales of irrigation water and sales of power. Of course, such sales are unlikely to ever be able to cover all construction and operating costs of the project. The difference turns out to be a subsidy from the national exchecker just the same as nonreimburseable costs are absorbed on a national basis in American projects.

In short, there is no difference in the philosophical basis of establishing the overall feasibility of the project. Just as in American practice, the overall benefit/cost ratio of the Sefeed Rood project included in primary benefits all the net increases in return to agriculture even though in practice these are captured by the private sector. The only difference is that in the absence of specific allowances for secondary benefits, the Iranian estimates of benefits are somewhat conservative.

However, such benefits are not completely ignored. Even though formal values are not attached, there is a discussion about creation of new agricultural jobs in Gillan. The Plan Organization estimates total rice lands to reach 179,000 hectares once the project has been completed. Assuming that this provides 2 hectares of rice land per farm family, about 90,000 families can be accommodated. Since in 1961 there were approximately 70,000 rice growers in Gillan, the establishment of the project should provide lands for an additional 20,000 families.

A wide variety of opinion has been offered on the "correct" discount rates to be used in feasibility analysis of public projects. Senate Document 97 orders use of that current rate at which the American treasury can borrow money with maturities above 15 years. Others argue that rates in private markets for projects of similar riskiness would be more appropriate.

It has also been suggested that discount rates equivalent to the tax incidence of project costs be employed (7).

The question is whether these views (which refer to developed economies) is appropriate in the kind of situation Iran finds itself. In many developing countries, the returns to consumption as opposed to capital investment seem so high that utilization of a market rate of interest might imply discount rates such as to prevent acceptance of any but extremely productive projects. These points are emphatically mentioned in the recent CENTO publication on industrial development banking given to support these viewpoints as follows:

The money market in the middle east is very different from that in the west because the agencies supplying money and credit serve various sectors of the economy and are neither integrated nor linked. Thus, there is a wide disparity in interest rates, and changes in one area do not necessarily result in changes in another area.

Short-term rates of interest for private industrial borrowers in Iran may be quoted at 10 to 12 percent.

Industrial development bank rates are about 7.5 to 8.5 percent per annum to qualified borrowers. Are flexible interest rates the best means of rationing scarce funds? Those supporting the idea of a free market maintained that the system keeps rates linked to the productivity of capital. Thus, scarce funds would be used for purposes which society (acting through the market) values highest.

The opposing view is the industrial development bank rates must be lower than the going commercial bank rates for industrial borrowers. This viewpoint was justified on the grounds that a subsidy is necessary in some countries in order to secure the "proper" structure of investment.

Examples were given to support the latter viewpoint and included various industries in Iran where there is a reluctance on the part of private capital to venture into industrial investment because of higher rates of return in trade and commerce and also because of the businessman's desire for liquidity (3). Therefore, the relative merits of subsidies through interest rates and the extent to which the lending institution could determine whether or not it was subsidizing those borrowers whose potential contributions to economic development would contribute most to that goal. Another important aspect of utilizing high discount rates is that benefits associated with "distant" years have little present value.

RE-COMPUTED BENEFIT/COST RATIOS FOR SEFEED ROOD PROJECT

The first step in recomputation of a break-even point is to find the new ratios as of 1975, using all the corrections of the previous chapter. This step gives the following combined benefit/cost ratios at 6 and 12 percent rates of interest.

$$12 \text{ percent}: \frac{40636.9}{70034} + \frac{7105}{9240} = \frac{47741.9}{79234} = .6, \text{ and}$$

$$6 \text{ percent}: \frac{302459}{38249} + \frac{5301}{5004} = \frac{35546.9}{43253} = .821.$$

The above ratios refute the 1976 break-even point of the Plan Organization.

To search for a new break-even point, the data for benefits and costs are carried out to the year of 1980. Table 14 shows the compounding of benefits to 1980. Summations to 1975 are listed as the first row of Table 14. These column totals are compounded to 1980 as appropriate and additional yearly benefits are compounded and summed. Then the two compounded totals are added to give projected values for 1980. This is done for the last two columns of Table 14. The remaining columns are simply arithmetic totals. The same system is employed in Table 15 where irrigation costs are compounded until 1980.

Carrying values to 1980 has also been accomplished for power on the cost side in Table 16 and for power sales in Table 17.

Using the future values for 1980 supplies a combined cost and benefit ratio for irrigation and power at 12 and 6 percent interest rates as follows: at 6 percent the power benefit/cost ratio in 1980 is $\frac{95203}{73114.75} = 1.338$. Notice that the revenue from power is more than 1; this will compensate for a less than 1 return in irrigation and the combined ratio for irrigation and power will be:

Table 14. Return (benefit) from irrigation carried out to 1980 for Sefeed Rood project

Year	Preventing loss of rice crop	New rice crop	New other crop	Income of S.R. org. sale of water	Total	Interest at 12%	Interest at 6%
Total up to 1975	7,336.0	7,812.3	3,649.0	1,840.8	20,285.3	40,636.9	30,245.9
1976	524.0	1,420.4	663.7	250.6	2,858.7	5,041.7	3,637.3
1977	524.0	1,420.4	663.7	250.6	2,858.7	4,494.8	3,415.8
1978	524.0	1,420.4	663.7	250.6	2,858.7	4,015.0	3,211.5
1979	524.0	1,420.4	663.7	250.6	2,858.7	3,586.8	3,018.2
1980	524.0	1,420.4	663.7	250.6	2,858.7	3,201.2	2,837.0
Sub total	2,620.0	71,000.0	3,318.5	1,253.0	142,935.0	54,381.0	40,475.8
	7,336.0	7,812.3	3,649.0	1,840.8	20,285.3	20,339.5	16,114.8
Total	9,956.0	78,812.5	6,967.5	3,093.8	163,220.3	74,720.5	56,590.6

Table 15. Total public and private investment (cost) in irrigation carried out to 1980 for Sefeed Rood project

Year	Fixed	Current	Total	Interest at 12%	Interest at 6%
Total up to 1975	10,516.0	12,611.0	23,538.0	70,034.0	38,249.0
1976	--	2,154.0	2,154.0	3,799.0	2,762.7
1977	--	2,154.0	2,154.0	3,387.0	2,600.0
1978	--	2,154.0	2,154.0	3,025.0	2,446.1
1979	--	2,154.0	2,154.0	2,703.0	2,300.9
1980	--	2,154.0	2,154.0	2,412.0	2,034.6
Sub total	--	10,770.0	10,770.0	9,314.5	12,142.3
	10,516.0	12,611.0	23,538.0	123,516.0	51,185.8
Total	10,516.0	23,381.0	34,308.0	138,842.0	63,428.1

Table 16. Power costs for additional five years

Year	Fixed	Current	Total	Interest at 12%	Interest at 6%
Total up to 1975	2,076.0	641.0	2,717.0	9,240.0	5,004.0
1976	--	74.2	74.2	130.9	99.3
1977	--	74.2	74.2	116.7	93.7
1978	--	74.2	74.2	104.2	88.4
1979	--	74.2	74.2	93.1	70.3
1980	--	74.2	74.2	83.1	66.6
Sub total	--	371.0	371.0	527.9	418.3
	2,076.0	641.0	2,717.0	12,365.2	6,696.5
Total	2,076.0	1,012.0	3,088.0	12,893.1	7,114.7

Table 17. Power benefits for additional five years

Year	Total	Interest at 12%	Interest at 6%
Total up to 1975	3,987.0	7,105.0	5,301.0
1976	430.0	758.4	546.5
1977	430.0	676.1	513.7
1978	430.0	603.9	482.9
1979	430.0	539.5	453.9
1980	430.0	481.5	426.9
Sub total	2,150.0	3,059.4	2,423.9
	3,987.0	12,530.8	7,096.4
Total	6,137.0	15,590.2	9,520.3

$$6 \text{ percent} : \frac{95,203}{73,114.75} + \frac{56,590.6}{63,428} = 9.37, \text{ and}$$

$$12 \text{ percent} : \frac{74,720.5}{13,884.2} + \frac{15,590.2}{12,893.1} = \frac{903,107.0}{1,351,735} = .6.$$

This latter ratio shows that a 12 percent break-even is not attained. At 6 percent, break-even would occur in approximately 1982-1985. By experimenting with 12 percent interest rate, it was found that break-even occurs at about 1990; that is, about five years more than half-way through the project's estimated 60-year life (5).

Projected water and power sales, i.e., income of the S.R.W.P.O. would never be sufficient to amortize the dam during its physical life.

CONCLUSION

Shortcomings of planning have led to different completion dates for the dam, the irrigation system, and the power lines. It is apparent had the entire project been completed at the same time, the benefits would have increased considerably. Such negligence in planning continues to be repeated. For example, the S.R.W.P.O., the organization responsible for this project, lacks a definite plan for ensuring that land to go under irrigation is properly prepared in anticipation of the final stage of development of the project. It is likely that the necessary private investment would be encouraged and fostered if the W.P.O.S.R. would actively aid peasants in their preparations.

Another problem to be thought of is the market availability and finding an outlet for the increased commodities to be sold. This is particularly important in the economies of the developing and expanding regions. If consideration is not given to this important phase, the expansion program for development will collapse.

Some arithmetic errors were working against the Plan Organization at the very time they were building up the benefit side; if they had taken them into account, they would have break-even point before 1975. Therefore, the difference shown is more significant than might appear at first glance. Actually, re-evaluation shows there are benefits to be obtained and the dam ought to pay, for example, if they get to higher value crops. The most important conclusion is that you do not know what the real costs are, and whether the investment of the private investor really materializes. If these figures are right, the dam will pay for itself despite the suspicioned view before the study. It looks better than one might think.

APPENDIX

ENGLISH TRANSLATION OF PLAN ORGANIZATION
BENEFIT/COST CALCULATIONS

Sequence of Data Presentation

For purposes of estimating benefits and costs, the consulting engineers and the S.R.W.P.O. assume that the dam is intended for the purposes of irrigation and power generation. Therefore, all the expenses of the dam, cost of the power plant, buildings, the two generators, and power lines are changing to irrigation and power generation. A cost/benefit ratio is calculated separately for power and irrigation, then both are added to get a combined ratio.

Investment in irrigation is divided into public and private portions and is displayed according to the following outline.

I. Fixed investment in irrigation (Tables 18, 19, 20, and 21)

- A. Public
  1. Construction of dam
  2. Construction of irrigation system
- B. Private
  1. Investment for preparing the lands for cultivation
  2. Building ditches

II. Current expense (Tables 23, 24, 25)

- A. Public
  1. Personnel expenses of Sefeed Rood Water and Power Organization
- B. Private
  1. Expenses to prepare new cropland and payment for water on old and new lands

a. Plowing

b. Seed

c. Fertilizer

d. Labor

e. Water expenditure

Benefits listed from the irrigation portion of the project are:

I. Increased production of rice due to elimination of water shortages (Table 27)

II. Increased production of rice due to expansion of the rice land (Table 34)

III. Increase in the production of other crops (Table 35)

IV. Income of the Water and Power Organization from the sale of water and electricity (Table 26)

Costs of power generation are displayed in the following outline. All values are "public."

I. Fixed investment in power generation (Table 38)

A. Power plant buildings

B. Two generators

C. Power lines between Manjeel Pahlavey-Manjeel-Lowshawn-Rasht-Roodsar-Manjeel-Ghazveen-Teheran

D. Three additional generators

II. Current expense (personnel and administrative) (Table 39)

Benefits listed from power reduction are confined to the estimated revenues from electricity sales (Table 41).

The above listing is slightly different than what might be expected because private costs are not netted out. However, this is offset by introducing gross benefits of increased production and water revenues on the benefit side. This explains why water rentals can appear as both benefits and costs.

Two rates of interest are used in discounting or compounding operations, 6 percent and 12 percent. The latter rate is commonly used in Iranian business transactions, and therefore its effects upon benefit and cost streams are of interest. The assumption is that all the land will become productive by 1976, the year break-even is achieved according to Plan Organization calculations.

Any figure affected or associated with a discount rate must be interpreted carefully. In fact, individual derivations were a mystery until it was discovered that the "total" figure for any given year is compounded until 1975-76 at the rates shown. This scheme is followed in the Plan Organization's display of all cost and benefit categories. At the point in time where the sum of the compounded costs equals the sum of the compounded benefits, a break-even point has been reached and the benefit/ cost ratio is 1:1. In other words, cost and benefit comparisons are made by projecting values to a common future data rather than by discounting to compare present values. The procedure utilized probably simplifies determination of the break-even point.

Recognition that the usual comparison process has been reversed does not completely explain the values shown in Table 23 and others of similar nature to follow. After considerable experimentation it was discovered that the interest tables used for purposes of compounding have not been carried to six or seven decimal places. Apparently, the compounding was done on a log slide rule so that at best, accuracy to two decimal places was achieved. The effect on overall results are not too significant in terms of numerical values once the discrepancy is recognized. Thus, the compounded figures have not been changed except to correct a few obvious arithmetic mistakes.

Fixed Investment in the Dam and Irrigation Layout

Tables 18, 19, 20, and 21 contain the fixed cost estimates for irrigation structures and bringing new lands under cultivation. Private investment in irrigation does not commence until 1966. Allowance is made for interest on capital in Table 22.

Table 18. Fixed public investment in the dam and irrigation layout (million Rials)

No.	Year	Dam	Irrigation layout	Total
1	1955	61.5	--	61.5
2	1956	455.6	--	455.6
3	1957	707.6	--	707.6
4	1958	705.9	--	705.9
5	1959	740.8	--	740.8
6	1960	619.0	--	619.0
7	1961	710.6	--	710.6
8	1962	274.7	316.5	591.2
9	1963	134.0	419.6	613.6
10	1964	163.0	991.0	1,154.0
11	1965	--	896.6	896.6
12	1966	--	484.0	484.0
13	1967	--	222.2	222.2
14	1968	--	112.7	112.7
15	1969	--	112.7	112.7
16	1970	--	112.7	112.7
Total		4,573.0	3,718.0	8,291.0

The public cost estimates for the dam and irrigation canals are those submitted to the Plan Organization by the French engineers. The office of planning of Plan Organization investigated these estimates and confirmed their reasonableness. No attempt is made in the present study to adjust these estimates.

Table 19. Private investment for making cropland (over 10-year period)

Year	Million Rials
1966	160.0
1967	160.0
1968	160.0
1969	160.0
1970	160.0
1971	160.0
1972	160.0
1973	160.0
1974	160.0
1975	160.0
Total	1,600.0

Table 20. Expenses for making ditches (10-year investment period)

Year	Million Rials
1966	62.5
1967	62.5
1968	62.5
1969	62.5
1970	62.5
1971	62.5
1972	62.5
1973	62.5
1974	62.5
1975	62.5
Total	625.0

Table 21. Private and public fixed investment in irrigation (million Rials)

Year	Public		Private		Total
	Dam	Irrigation system	Making land ready for cultivation	Making ditches	
1955	61.5	--	--	--	61.5
1956	455.6	--	--	--	455.6
1957	707.6	--	--	--	707.6
1958	705.9	--	--	--	705.9
1959	740.8	--	--	--	740.8
1960	619.0	--	--	--	619.0
1961	710.6	--	--	--	710.6
1962	274.7	316.5	--	--	591.2
1963	134.0	469.6	--	--	653.6
1964	163.0	991.0	--	--	1,154.0
1965	--	896.6	--	--	896.6
1966	--	484.0	160.0	62.5	706.5
1967	--	222.2	160.0	62.5	444.7
1968	--	112.7	160.0	62.5	335.2
1969	--	112.7	160.0	62.5	335.2
1970	--	112.7	160.0	62.5	335.2
1971	--	--	160.0	62.5	222.5
1972	--	--	160.0	62.5	222.5
1973	--	--	160.0	62.5	222.5
1974	--	--	160.0	62.5	222.5
1975	--	--	160.0	62.5	222.5
Total	4,573.0	3,718.0	1,600.0	625.0	10,516.0

Table 22. Total public and private investment in irrigation (million Rials)

Year	Fixed	Current	Total	Interest rate 12 percent	Interest rate 6 percent
1955	61.5	--	61.5	629	203
1956	455.6	--	455.4	4,066	1,390
1957	707.6	--	707.6	5,768	2,079
1958	705.9	--	705.9	5,137	1,957
1959	740.8	--	740.7	4,813	1,937
1960	619.0	--	619.0	3,591	1,527
1961	710.6	--	710.6	3,681	1,654
1962	591.2	21	612.2	2,830	1,344
1963	603.6	77	680.6	2,811	1,410
1964	1,154.0	140	1,294.0	4,771	2,530
1965	896.6	156	1,052.6	3,465	1,940
1966	706.5	227	933.5	2,744	1,624
1967	444.7	300	744.7	1,954	1,222
1968	335.2	373	708.2	1,659	1,097
1969	335.2	440	775.2	1,580	1,103
1970	335.2	507	842.2	1,573	1,161
1971	225.5	573	798.5	1,332	1,038
1972	225.5	639	864.5	1,287	1,060
1973	225.5	706	931.5	1,239	1,078
1974	225.5	772	997.5	1,184	1,089
1975	225.5	838	1,063.5	1,127	1,095
Total	10,516.0	5,769	16,285.0	57,241	29,538

The land that was not previously cropped will now be used for the production of rice and other crops. This includes 41,000 hectares of meadows and 19,000 hectares now in reservoir ponds. In addition to this, 4,000 hectares of depleted forest will become irrigated cropland that is not rice. If investment for each hectare of land is assumed to be 25,000 Rials, the ultimate total investment of the private sector will be about 1,600 million. Since there is no specific program for bringing these lands into production, it is impossible to make an exact estimate of the annual cost of fixed investment by the private sector. However, Plan Organization hypothesizes that private investment starts in 1966 (when most of the irrigation network will be finished) and continues over the next 10 years as shown in Tables 19 and 20.

In the final stage of development, 64,000 hectares from the idle land will go under rice production and other irrigated crops. This will call for building ditches for irrigation. Other ditches will be required for about 61,000 hectares of land that has been dry farmed. If we assume the cost of making ditches is 5,000 Rials per hectare, the total investment for making ditches for private sectors would be 625 million Rials. This is under previous assumption that investment will take place in a 10-year period with equal amounts each year as shown in Table 20.

Current Investment in Dam and Irrigation Layout

Public sector

The public current expense is confined to personnel and administrative costs. A budget for S.R.W.P.O. for these purposes has been established since 1960.

Some of the programs this organization is to be engaged in are as follows:

1. Gillan agriculture development.

2. Utilizing resources to the fullest.

3. Raising the productivity of the farmers by training and extension work.

4. Developing more uses for electrical power.

5. Control of the rivers and canals that are in the W.P.O.S.R. jurisdiction.

6. Better utilization of the water by the farmers and changing the irrigation equipment.

7. Setting the price on water and electricity and organizing a collecting department.

Table 23 is the personnel budget for the organization and prediction of this budget for future years. Twenty-five percent of the total expense is in connection with electricity and the rest is assigned to agriculture.

Private sector

Current private expenses are for lands that will be put under crop during the development phase. Forty thousand hectares of meadows and 19,000 hectares of pond reservoirs will be converted to irrigated rice land. An additional 59,000 hectares of what are now dry farm lands will receive irrigation water. Current expenses will increase for these lands due to the water rental and more intensive agriculture. Some further current expense will be borne by the private sector to pay for supplemental water on existing rice lands.

Table 24 shows some of the cost and returns from 1 hectare of rice paddy. These figures and those in the accompanying footnote form the

Table 23. Personnel budget for W.P.O.S.R.

Year	Total of personnel expense	Personnel expense for agriculture
1962	27.6	21
1963	49.7	37
1964	123.8	93
1965	136.2	102
1966	149.8	112
1967	164.8	124
1968	181.1	136
1969	197.6	148
1970	214.1	161
1971	230.6	173
1972	247.1	185
1973	263.6	198
1974	280.1	210
1975	296.6	222
Total	2,563.0	1,922

Table 24. Cost and revenue on 1 hectare of new rice paddy[a]

	Income Rial	Expense Rial
Expenses		
Wages--25 days, 400 Rial per day, 10 labor hired		10,000
Seed--200 kilogram, average price - 10 Rial		2,000
Ploughing and fertilizer		2,000
Water		1,400
Income		
Average yield of crop--3,800 kilogram rice worth 9 Rial per kilogram	34,200	
Total	34,200	15,400

[a]For raising crops other than rice, 5,400 Rials expense of production is allowed per hectare.

[b]Of the annual 15,400 Rials total, the Plan Organization only considers 6,400 a "real" cost. They argue that the agricultural sector of Gillan Ostan suffers from concealed unemployment since the marginal value product about 90 percent of agriculture of labor is zero or less. Thus, only 10 percent of the listed labor cost represents alternative costs to society.

general basis from which the total private current costs (Table 25) was constructed. But it is very difficult to fully reconcile both tables. Later it will be shown that practically all the original irrigated land was in rice production and this totaled about 110,000 hectares. The S.R.W.P.O. expects to charge 14 and 7 Rials for new water and supplemental water, respectively (per hectare). Thus, in the final stages, the water payments for land already under cultivation will equal 77 million Rials per year (column 3, Table 25). The current expenses for new rice land shown seem to include water payments of 1,400 per hectare per year. The ultimate quantity of new rice land (68,000 hectares) times 1,400 is about 435 million Rials. This is close to the values shown for 1974-1975. All of the water payments shown in Table 25 for changing from dry farms to irrigated croplands seem to be connected with other than rice production. Dividing 75,000,000 by 1,400 gives 55,000 hectares, which is close to the expected new amount of irrigated land other than for rice (58,460). This reasoning is partially confirmed when the 55,000 hectare figure is used to generate the 1975 value shown under other crops. 55,000 x 4,000 (5,400 - 1,400) (from Table 24) equals 220--a number with the correct digital values (22) but larger by a multiple of 10. All the figures shown as expenses of other crops appear to have incorrectly recorded decimal points. A little experimentation reveals that the values in question are far too low. They can only be right if the amount of new cropland, other than rice, is on the order of 5,500 hectares instead of the actual 58,400 proposed.

The corrected figures <u>have not</u> been introduced into the original calculation which follows. However, if they were introduced, the result would be to increase costs and lengthen the time necessary to reach a break-even point.

Table 25. Annual current expenses for private sector in irrigation

Year	Current expenses		Water right payment			Total
	New rice land	Other crop	Land under culti-vation	New rice land	Land changing from dry farm to irrigated	
1963	--	--	40	--	--	40.00
1964	--	--	47	--	--	47.00
1965	--	--	54	--	--	54.00
1966	34.30	2.2	61	9.66	7.7	114.86
1967	68.60	4.4	68	19.32	15.4	175.72
1968	103.00	6.6	77	28.98	23.1	238.68
1969	137.36	8.8	77	38.64	30.8	292.60
1970	171.70	11.0	77	48.30	38.5	346.50
1971	206.00	13.2	77	57.96	46.2	400.36
1972	240.30	15.4	77	67.62	53.9	454.22
1973	274.70	17.8	77	77.28	61.6	508.38
1974	309.00	19.8	77	86.94	69.3	562.04
1975	343.40	22.0	77	96.60	77.0	615.00
Total	1,888.36	121.2	886	531.30	423.5	3,849.36

Water rights

According to the report of the W.P.O.S.R., 700 Rials per hectare are to be collected from the land under irrigation cultivation prior to construction of the Sefeed Rood Dam. Land that will receive supplemental water and lands that go from dry farm into irrigated land will pay 14,000 Rials per hectare. These payments are for an adequate quantity of water (acre-feet) to raise the crops in question.

Since the rent assessment of the rice land has not been completed, receipts from the water right payment in 1963 were about 40 million Rials. These calculations assumed that in the next four years assessment of the land will be completed and revenue will be collected from all the lands which are going under cultivation. Ultimately, this would amount to 77 million Rials.

Summary of Total Public and Private Investment in Irrigation--Compounded Values

In Table 22, the compounded totals of public and private irrigation costs are displayed.

Benefit From Irrigation Portion of Project

Irrigation benefits of the Sefeed Rood project flow from increased crop yields (due to better water management), increased amounts of irrigated cropland, and sales of electric power by S.R.W.P.O.

Yields and water management

On account of uncontrolled water of Sefeed Rood and shortage of water on the season of irrigation, before construction of Sefeed Rood Dam, 5 to 40 percent of the rice production of Gillan Ostan in the different regions used to be lost. This loss was the result of two factors:

1. Based on the assumption that in the irrigation season there is a shortage of water, in many areas planting did not take place.

2. In other farms, the yield of rice harvest was lessened during the growing season on account of water shortage.

For four years (1958 to 1962) the average percent of non-producing rice paddies to the total land area has been calculated. This figure for Gillan Ostan is 20 percent; in other words, 20 percent of Gillan production is lost. For Sefeed Rood area, 21.2 percent, and for Foomenat region, 19 percent. Also, estimation of the yields show that (this was done by taking 186 samples in 70 areas) the average production should increase 20 percent because of taking the increased water factor into consideration. In 1960, there was a bumper crop and the average yield was 3,300 kilograms per hectare where the average yield for 1958, 1959, 1960, and 1961 was 3,200 kilograms per hectare. A conservative estimate of yield is therefore 3,000 kilograms per hectare. If the average loss of 20 percent is eliminated, then production will increase by 0.6 tons per hectare.[4]

The increase in income from prevention of water shortages is as follows:

Gross area rice paddies (Table 26)	110,316 hectares
Net area rice paddies in hectares	110,316 x .88 = 97,078.08
Total increase in production in metric tons	97,078 x .6 = 59,246.84

If the average price of a ton of rice is 9,000 Rials, then total value of the increase of production is 533,214,000 million Rials. This result is utilized again in the income summary (Table 27). But a recalculation indicates an arithmetic error. The increase in tonnage should be 58,246.2. This would reduce revenue to about 524.2 million per year. For the present this correction is not made.

Yields and new lands

Tables 28, 29, 30, and 31 show the amount and kind of lands that will become new rice lands. They also show increases in areas of other irrigated crops. It is clear that if all the plans materialize, a significant up-grading of land use will occur. At the final stage of

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[4]The net area under cultivation is equal to gross x .88, the price of 1 ton of rice is 10,000 for sadry and 8,000 Rials for champa variety and production is 50 percent of each variety assumed.

Table 26. Income of W.P.O.S.R. from sale of water

Year	Land presently under crop	New irrigated cropland	Total
1963	40	--	40
1964	47	--	47
1965	54	--	54
1966	61	18	79
1967	68	36	104
1968	77	72	149
1969	77	72	149
1970	77	90	167
1971	77	108	185
1972	77	126	203
1973	77	144	221
1974	77	162	239
1975	77	180	257
Total	886	990	1,876

Table 27. Income from irrigation portion of the project (million Rials)

Year	Preventing loss of rice crop	Rice	Other crop	Income of S.R. org. from sales of water	Total	Interest rate 12%	Interest rate 6%
1962	534	--	--	--	534	2,469	1,173
1963	534	--	--	40	574	2,370	1,189
1964	534	--	--	47	581	2,142	1,136
1965	534	--	--	54	588	1,936	1,084
1966	534	169	55	79	836	2,460	1,456
1967	534	338	111	104	1,087	2,853	1,784
1968	534	506	175	131	1,346	3,154	2,084
1969	534	675	221	149	1,579	3,302	2,307
1970	534	844	278	167	1,823	3,405	2,513
1971	534	1,013	332	185	2,064	3,442	2,684
1972	534	1,181	387	203	2,314	3,433	2,827
1973	534	1,350	442	221	2,547	3,388	2,948
1974	534	1,519	498	239	2,790	3,312	3,046
1975	534	1,688	553	257	3,034	3,214	3,123
Total	7,476	9,283	3,051	1,876	21,686	40,880	29,445

Table 28. Foomenat upper area

Type of land used	Present stage Total area in hectare	Final development stage Rice paddy	Irrigated crop	Jungle	Areas not irrigated
Rice paddy	24,470	24,470	--	--	--
Meadows	15,210	12,740	--	--	2,470
Reservoir and shallow lakes	5,900	5,900	--	--	--
Other cropland	16,070	4,560	10,500	--	1,010
Jungles	1,730	--	--	1,730	--
Villages	360	--	--	--	360
Grazing land	3,620	--	--	--	3,620
Marshes	4,100	--	--	--	4,100
Total	71,460	47,670	10,500	1,730	11,560

Table 29. Lower Foomenat area

Type of land used	Prior stage of development Total area in hectare	Final development stage Rice paddy	Crops irrigated
Rice lands	5,671	5,671	--
Meadows	16,543	16,543	--
Reservoir	1,691	1,691	--
Others	4,600	--	4,600
Total	28,505	23,905	4,600

Table 30. The left bank area of Sefeed Rood River

Type of land used	Prior stage of development: Total area in hectare	Final stage in hectares: Rice paddy	Irrigated crop	Jungles	Areas not irrigated
Rice land	49,935	49,935	--	--	--
Meadows	6,745	6,745	--	--	--
Shallow reservoir	3,620	3,620	--	--	--
Other farming	2,220	--	2,220	--	--
Jungles	820	--	220	600	--
Villages	1,840	--	--	--	1,840
Grazing area	2,210	--	2,210	--	--
Marshes	1,470	310	--	--	1,160
Orchard	16,255	--	15,780	--	475
Beaches	1,050	--	--	--	1,050
Ponds	660	--	--	--	660
Total	86,825	60,610	20,430	600	5,185

Table 31. The right bank area of Sefeed Rood River

Type of land used	Prior stage of development: Total area in hectare	Final stage in hectares: Rice paddy	Irrigated crop	Jungles	Tea garden	Misc.
Rice land	30,240	29,595	--	--	--	--
Misc. croplands	8,360	--	7,740	--	--	620
Meadows & jungles	12,695	6,175	3,950	2,000	--	575
Reservoir	7,090	7,090	--	--	--	--
Orchard	2,720	400	--	--	2,320	--
Berry orchard land	8,140	1,820	6,250	--	--	70
Grazing land	6,110	1,120	4,990	--	--	--
Marshes & ponds	1,830	--	--	--	--	1,830
Beaches	2,790	--	--	--	--	2,790
Village	900	--	--	--	--	900
Total	80,880	46,200	22,930	2,000	2,320	6,785

development, 68,069 hectares will be added to the gross land area under rice cultivation. Other irrigated farm land will increase by 58,460 hectares due to conversion of low income dry farms, meadows, and jungles. These results are summarized in Tables 32 and 33.

Table 32. Amount and kind of lands that will go under rice lands (hectare)

Region	Meadow	Reservoir pools	Dry farm	Total
Upper Foomenat	12,740	5,900	4,560	23,200
Lower Foomenat	16,543	1,691	--	18,234
Left Bank	6,745	3,930	--	10,675
Right Bank	6,175	7,090	3,340	16,605
Total	42,203	18,611	7,900	68,714

Table 33. Amount and kind of lands that will go under production of other irrigated crops

Region	Dry farm	Jungles & marshes	Grazing	Orchards	Berry orchard	Total
Upper Foomenat	10,500	--	--	--	--	10,500
Lower Foomenat	4,600	--	--	--	--	4,600
Left Bank	2,220	220	2,210	15,780	--	20,430
Right Bank	7,740	3,950	4,990	--	6,250	22,930
Total	25,060	4,170	7,200	15,780	6,250	58,460

Estimates of income flows from private land conversion expenditures (beginning in 1966, Tables 19 and 20) are shown in Tables 34 and 35.

Table 34. Return from new rice land

Year	Net area[a]	Net return per hectare[b]	Gross income
	(hectare)	(Rials)	(mil. Rials)
1966	6,072	27,800	169
1967	12,144	27,800	238
1968	18,216	27,800	506
1969	24,288	27,800	675
1970	30,360	27,800	844
1971	36,432	27,800	1,013
1972	42,504	27,800	1,181
1973	48,576	27,800	1,350
1974	54,648	27,800	1,519
1975	60,720	27,800	1,688
Total			9,283

[a]Refer to footnote 4 on page 54.
[b]Refer to Table 24 on page 50.

Table 35. Gross return from converting dry farms and jungles to irrigated farms

Year	Net[a] area in hectare	One hectare value in Rial (1,000)	Increased income from present jungles	Net[a] area in hectare	One hectare value in Rial (1,000)	Increased income from present dry farm	Total
1966	3,450	20	6.9	4,840	10	48.4	55
1967	6,900	20	13.8	9,680	10	96.8	111
1968	10,350	20	20.7	14,520	10	145.2	166
1969	13,800	20	27.6	19,360	10	193.6	221
1970	17,250	20	34.5	24,200	10	242.0	277
1971	2,070	20	41.4	29,040	10	290.4	332
1972	24,150	20	48.3	33,880	10	338.8	387
1973	2,760	20	55.2	38,720	10	387.2	442
1974	31,050	20	62.1	43,560	10	435.6	498
1975	49,450	20	69.0	48,400	10	484.0	553
Total			380.0			2,671.0	3,043

[a]Refer to footnote 4 on page 54.

With respect to rice land, the Plan Organization assumed average production per hectare to be 3.8 tons. The cost assumption was 6,400 Rials (Table 24) and the selling price 9 Rials per Kilo. Since the per hectare costs have already been accounted for in Table 25, use of "net" returns from rice land (Table 34) when calculating benefits is clearly incorrect. For the present, however, no adjustment has been made. In Table 35, gross rather than "net" returns have been used for estimates of the return from new irrigated lands other than rice lands, so this is inconsistent.

About 3,500 hectares of the land that is occupied by depleted resource jungles and marshes will be converted to irrigated cropland, and about 48,400 hectares of lands that before development were dry farms will change to irrigated land. Both these figures allow for the loss in areas that will be taken up by new ditches and roads. Now, if the gross income from 1 hectare irrigated land (other crops) in Gillan is 25,000 Rials and the gross income from 1 hectare of dry farm is 15,000 Rials, the increase of gross income from other crops than rice is 10,000 Rials. Again, if the gross income from 1 lectare irrigated land in Gillan is 25,000 Rials and the gross income from jungle is 5,000, the increase of gross income is 20,000 per hectare of jungles now to be made irrigated croplands. (These are the returns assumptions utilized by Plan Organization.)

Income of W.P.S.R.O. from the sale of water

At present, the amount of water rents collected from Gillan lands come from 110,000 hectares of rice land. In the final stage of development, this will be increased to about 179,000 hectares of rice plus about 59,000 hectares of other irrigated crops. The charges will be 7,000 Rials per hectare for the original 110,000 figure and 14,000 Rials per hectare for all new irrigated lands.

For the new irrigated cropland the values shown in Table 26 are computed on the total or gross amount of new land, regardless of the quantity taken out for ditches and roads. The land presently under irrigation should earn 77 million Rials per year, but some of the survey and assessment work needed could not be completed before 1968.

Table 27 summarizes the expected amounts of income from the irrigation phases of the project.

Fixed Investment in Power Generation and Transmission

The initial costs for power production were confined to works at the dam site. During 1960 and 1961, two generators were installed at a total cost of 450 million Rials. Construction of power lines began in 1963. Table 36 shows the construction time table. The map in the back identifies locations.

Table 36. The starting and finishing time of the power network of the Sefeed Rood Dam

Construction	Starting date	Finishing date	Period
Pahlavey-Manjeel high power line	1962	1963	24 months
Manjeel-Lavashawn power line	Feb. 1962	Mar. 1963	14 months
Rasht-Roodsar power line	1964	1966	About 24 months
Manjeel-Teheran-Ghazveen power line	1964	1967	36 months

Manjeel-Pahlavey high voltage power line

The project for supplying electricity to Gillan was found to be necessary and the French engineers were given the contract to build these power lines. The purpose of this was to provide more reasonably priced electricity for Gillan areas for the houses as well as industry (refer to outline on page 41). During the first year of operation of the dam, electricity would be provided on a 24-hour basis. However, after the completion of irrigation systems and power lines to transfer power to Ghasveen and Teheran, additional electricity production will depend on whether the time of heavy irrigation coincides with high power demands.

The following is a technical description of the power line: the main power line is 100 kilometers in length with 132,000 volt pressure. The secondary power line is 17 kilometers with 11,000 volt pressure.

Manjeel-Rasht	68 kilometers
Rasht-Pahlavey	32 kilometers
Rasht-Lakan	8 kilometers
Expansion of Rasht-Lakan	9 kilometers

Along the length of this line there are nine transformer stations. The total investment is 280 million Rials--20 million Rials for the purchase of the land is deducted.

Manjeel-Lavashawn high voltage power line

At the present time, the maximum consumption in the towns along the line is 5,000 kilowatt hours at the peak and minimum consumption is 1,000 kilowatts per hour.

In order to have more power, a high voltage power line of 33 kilowatts is considered for Manjeel-Lavashawn. The advantages of this line would be: (a) when consumption of electricity is high, they can put the turbine into operation, and (b) the price of light becomes cheaper because of more consumption. The investment for putting the line in operation in 1963 was 39.2 million Rials.

Rasht-Roodsar power line

The market for light (electricity) from the Sefeed Rood Dam will be increased by the expansion of the high power line for Laheejan, Langerood and Roodsar. At present, the annual consumption of Rasht and Pahlavey Port is 10 to 15 million kilowatts, and the long-run estimate for consumption of electricity made by the consulting engineers is 30 million kilowatts up to 1976. Investment was 115.7 million during 1964-1965.

The region between Rasht and Roodsar is one of the most populated areas in the Gillan province. The consumption of light for industry is by far greater than any other area, and the possibility of increase in consumption is significant. In the vicinity of Langerood and Roodsar, there are more than fifty tea and rice processing factories. Therefore, the demand is high for electricity.

Moreover, peak activities of these factories is in April and May, which coincides with the time of irrigation. More power can be generated during irrigation periods.

Manjeel-Ghazveen-Teheran power line

The need for pumping quanat[5] water to the surface of the Ghazveen plain and for industrial and electrical needs of Teheran has been studied since 1958 by Plan Organization. The Plan Organization asked the French engineers to give their evaluation on the project. Following this, the Office of Plan Organization approved the project as being feasible.

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[5]Gravity flow system from bottom of well to surface by tunnel.

In 1961 and 1962, and engineers estimated that pumping in the Ghazveen area needed 40 million kilowatts per year. At the present time, two 17.5 thousand kilowatt generators are installed. In addition, there are places for three more generators that will add 429 million kilowatt hours annually. Since the consumption of electricity is not excessive for Gillan and the rate of increase in consumption is slow, 300 million kilowatt hours can easily be transferred to the Teheran and Ghazveen areas. After the installation of the Teheran-Manjeel power line, branch lines can be installed and all of the towns along this power line can benefit from a reasonable price.

The planned total investment for this power line is about 1,191[6] as follows divided over the three years 1964, 1965, and 1966. Tables 37 and 38 set out the relevant investment figures (all public).

Table 37. Cost of transmission lines in million Rials

Project	1963	1964	1965	1966
Manjeel-Pahlavey power line	280.0	--	--	--
Manjeel-Lavashawn power line	39.2	--	--	--
Rasht-Roodsar power line	--	44.9	80.8	--
Manjeel-Ghazveen-Teheran power line	--	123.8	533.7	533.6
Total	319.2	168.7	614.4	533.6

[6]Thirty million Rials is deducted for purchase of land.

Table 38. Public fixed investment in power line and power production in million Rials

Year	Dam	Power line	Total
1960	225	--	225
1961	225	--	225
1962	--	--	--
1963	--	319	319
1964	--	159	159
1965	--	614	614
1966	--	534	534
Total	450	1,626	2,076

Current Investment in Power Generation and Transmission

As previously stated, 25 percent of S.R.W.P.O. personnel and administrative costs (Table 39) are charged to electrical production. All current investments are public costs. Total investment in power is shown in Table 40.

Benefit from Electricity Sales

Income of the Organization from the sale of power following the construction of the power line network to transfer power from the center of the Sefeed Rood Dam for the consumption of light and industrial need and for Gillan Ghazveen and Teheran is shown in Table 41. The cost/benefit ratio should be considered both ways with rate of interest of both 12 and 6 percent.

Table 39. Personnel and administrative expenses for electricity

Year	Million Rials
1962	6.9
1963	12.4
1964	31.0
1965	34.1
1967	37.5
1968	41.2
1969	45.3
1970	49.4
1971	53.5
1972	57.7
1973	61.8
1974	65.9
1975	70.1
1976	74.2
Total	641.0

Table 40. Total investment in power (million Rials)

Year	Fixed	Current	Total	12 percent	6 percent
1960	225	--	225.0	1,305	555
1961	225	--	225.0	1,165	524
1962	--	6.9	6.9	22	15
1963	319	12.4	331.4	1,369	687
1964	159	31.0	190.0	700	371
1965	614	34.1	648.1	2,134	1,195
1966	534	37.5	571.5	1,680	994
1967	--	41.2	41.2	108	68
1968	--	45.3	45.3	106	70
1969	--	49.4	49.4	103	72
1970	--	53.5	53.5	100	74
1971	--	57.7	57.7	96	75
1972	--	61.8	61.8	92	76
1973	--	65.9	65.9	88	76
1974	--	70.1	70.1	82	76
1975	--	74.2	74.2	76	76
Total	2,076	641.0	2,717.0	9,240	5,004

Table 41. Income of the S.F.R.W.O. from the sale of power

Year	Power in million kilowatt per hour	Price of unit in Rial	Income	12 percent	6 percent
1964	25	1	25	92	49
1965	28	1	28	92	52
1966	64	1	64	188	111
1967	430	1	430	1,128	706
1968	430	1	430	1,008	666
1969	430	1	430	900	628
1970	430	1	430	803	593
1971	430	1	430	717	559
1972	430	1	430	640	527
1973	430	1	430	571	498
1974	430	1	430	510	469
1975	430	1	430	456	443
Total			3,987	7,105	5,301

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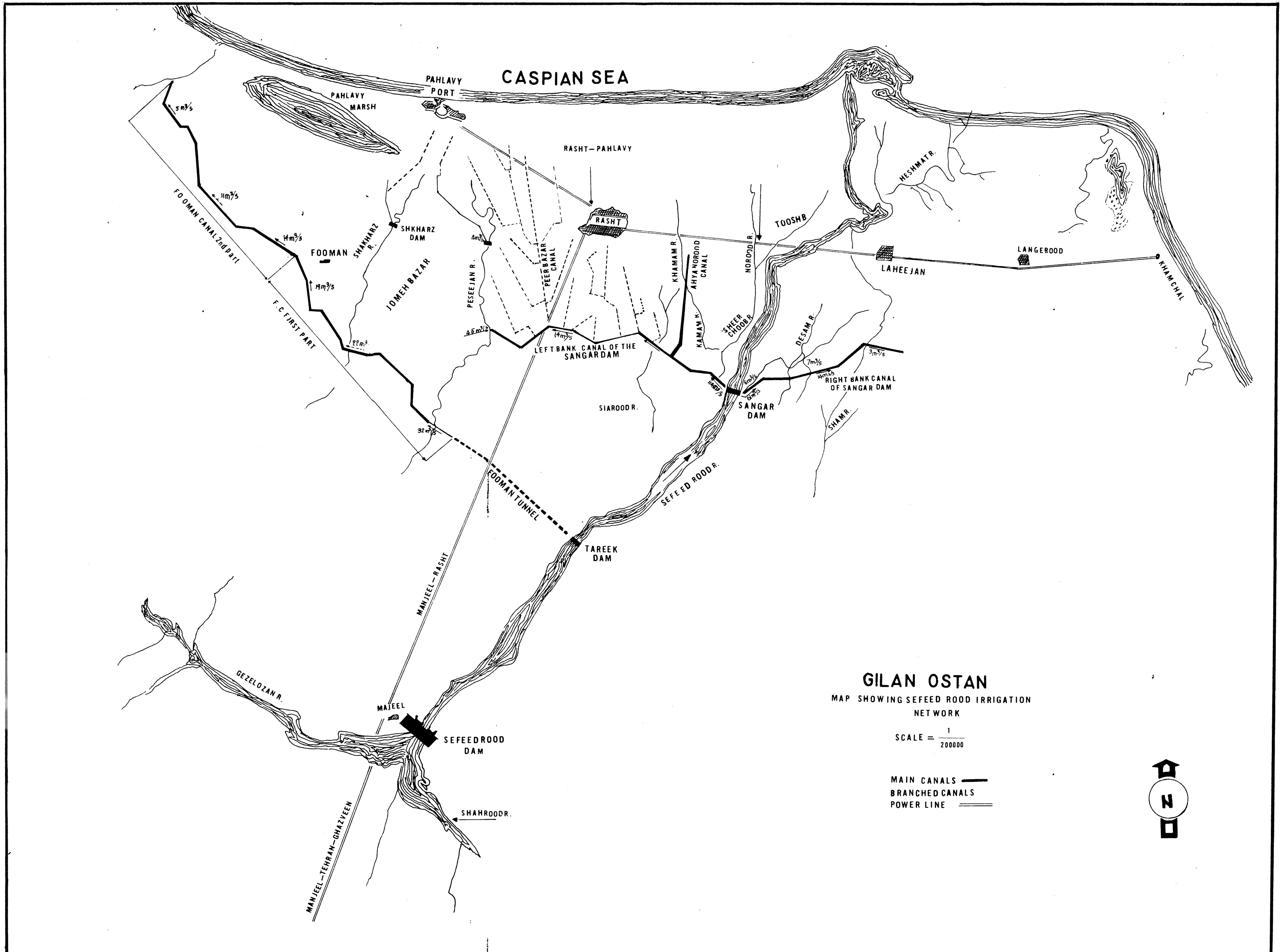

GILAN OSTAN

MAP SHOWING SEFEED ROOD IRRIGATION NETWORK

SCALE = $\frac{1}{200000}$

MAIN CANALS
BRANCHED CANALS
POWER LINE