landless and the rate of small-holders with less than 2 ha remains 59%, giving the average holding size of 2.13 ha per farm.

Besides, the average size of land holding per farm indicates 1.72 ha for Amol District, 1.55 ha for Babol and 1.55 ha for Babolsar, deriving the mean land holding size of the Project Area at 1.66 ha. The size by irrigation area gives a maximum level of 1.73 ha for HW and a minimum of 1.46 ha for HE, while those for AW and AE are averaged at the same 1.66 ha for each area separately.

3. 5. 2 Crops and Cropping Pattern

Rice paddy is by far the predominant crop currently found in the Project Area, while upland and orchard crops are minor ones accounting for only 2.3% of the total cropping acreage.

Rice varieties are roughly grouped into local and improved varieties, and the former is further classified into long grain and short grain varieties. Most of the local ones currently cropped are long grain, represented by Tarom. It is an early maturing variety that has kept a fairly stable yield performance. Besides, it's taste suits consumer's preference which makes its market price stabilize at higher price levels, leading it to the top share of the total cropping acreage in the Project Area.

Varietal improvement of rice in the Project Area has been initiated in early 1970s, and in the middle of seventies the activity marked a fast progress through a coordinating system of research cooperation with IRRI in the Philippines. In its initial stage the activity was focused on the exploration of high yielding varieties, but since the middle of the eighties it has given due attention also to taste, as a result of which improved varieties have been greatly diversified. Among representative improved varieties, strains of Amol-3 and Khazar are popular.

Upland cropping is scattered in the area where gravitational irrigation hardly covers crops or parts with higher elevation surrounded with paddy fields in the middle and the lower parts of the Project Area. Cucumber, melon, watermelon and other cucurbits constitute major crops among summer crops followed by tomato, eggplant and fresh consumed leafy vegetables. For winter crops lettuce, spinach, forcing radish and green broadbean (horse bean) are mainly cropped, while in some areas these winter crops are also introduced into rice fields. Wheat and barley are also cropped in part of the highland but their acreage as well as yield/ha remains at negligible levels.

Berseem clover has been recommended to be introduced as a secondary crop in rice fields as a strategy of promoting livestock sector since the middle of the eighties, but the acreage under berseem tends to level off due to various constraints such as limited supply of seed, poor drainage during winter on rice fields and customary trespassing of released bovines after harvesting rice crop.

Citrus has been mainly planted in orchards, consisting of mandarin orange which has replaced oranges since the early eighties. However, citrus production is now facing heated competition in the limited domestic markets among the producing areas along the Caspian Sea, with depressed price levels, discouraging orchard management.

The representative cropping pattern in the Project Area shows typical monoculture of rice crop, but in a part of the area double cropping has been introduced as combination of rice-berseem, rice-winter crops or rice-barley. In the case of the upland area, the patterns follow multi-cropping with winter and summer crops, where double cropping with wheat/barley-summer crops is partly observed.

Most of the orchards are mixed-cropped with various species of citrus, where mandarin predominates and some oranges, tangerines and lemons are mixed in. Orchards are partly intercropped with clover or vegetables, though these intercropped harvests are usually domestically consumed.

Current cropping pattern in rice fields is illustrated in Figure 3.5-1.

3.5.3 Agricultural Production

Agricultural production in the Project Area is estimated from the annual records by GDA of Mazendaran based on the data annually submitted from relevant district agricultural offices. However, the data is confined to major crops, and is not necessarily of satisfactory accuracy because of the different ways of estimation from one district to another. Moreover, the data mentioned above has been compiled by Shahrestan and hence it is not suitable to understand the true situation in the Project Area that encompasses parts of the three Shahrestan concerned. For this reason, production data by village in the 1988 agricultural census is adopted to obtain district-wise breakdown, which can be summarized as follows (For detailed figures refer to Appendix C. 1. 2).

Cropping Area of Main Crops by District

(Result of Agricultural Census 1988)

District	Crop	Cropping Area (ha)	Corrected Area (ha)	Production (t)	Yield (kg/ha)
Haraz West	Rice	7,482	(14,303)	27,496	3,675
Haraz East		13,274	(25,387)	49,691	4,007
Amol West		8,249	(17,532)	28,362	3,438
Amol East		12,940	(25,544)	40,948	3,164
Total		41,945	(82,788)	149,497	3,576
Haraz West	Barley	0	(0)	3	-
Haraz East		13	(25)	18	1,511
Amol West		3	(6)	7	2,400
Amol East		40	(80)	81	2,004
Total		56	(111)	109	1,963
Haraz West	Berseem	104	(200)	539	5,164
Haraz East		256	(499)	1,180	4,685
Amol West		13	(28)	9	651
Amol East		17	(33)	36	2,196
Total		390	(760)	1,764	4,525
Haraz West	Others	1	(2)	1	-
Haraz East		41	(90)	149	-
Amol West		7	(10)	13	-
Amol East		62	(121)	116	-
Total		111	(223)	279	-

Note: 1. The cropped areas given in the above table were underestimated as compared with actual acreage because the said census did not cover all the villages for data collection. Figures in brackets indicate corrected ones estimated from the number of uncovered villages and planimetric area measurement on maps etc..

2. As to berseem, census data is expressed on dry-matter basis. Berseem is seldom cut but livestock herds are pastured on it.

In this connection, trends in agricultural production as well as yields by serial year and by district of rice variety were given in Appendix C. 2. 1 and C. 2. 2.

3.5.4 Present Farming and Mechanization System

(1) Paddy

1) Variety

Acreage under improved rice varieties accounts for 56% of the total acreage, and their share in cropping tends to be higher in the higher elevations. With regard to maturity of cropped varieties, the following results have been obtained under the condition that aged seedlings are planted in mid-May.

Maturity Performance of Major Rice Varieties in the Project Area

Maturity	Name of Variety	Maturity Period (Month/Date)
Early-Maturing	Tarom	Aug./1~Aug./24
	Rashti	Aug./15~Aug./26
	* Taromasguari	Aug./25~Sept. /3
Medium-Maturing	* Khazar	Aug./25~Sept. /20
	* Haraz	Sept./25~Sept./9
Late-Maturing	* Amol - 3	Sept./1~Sept./25

Note: * improved varieties (Data from Amol Rice Research Station)

Tarom variety is susceptible to rice blast, belongs to panicles weight type, with longer plant height and hence liable to lodging. It has higher amylose content and so favorable cooking taste. While Amol-3 variety is resistant to rice blast, belonging to intermediate or panicle-number cum weight type, with shorter plant height, and one of high-yielding varieties.

2) Nursery Preparation and Nursing of Seedlings

Seed is usually selected by winnowing and also by salt water treatment, and part of the farmers follow the latter or gravity selection. As to manuring of seedbed, urea is generally applied to it at the rate of 10~20 g/m^2. Presprouting is made by putting seed in a gunny bag and soaking it for about 5 days at the seeding rate of 50~60 kg/ha. The soaked seeds are sown on upland-thermally protected, leveled nursery or on submerged nursery at the rate of 200~300 g/m^2. It takes 35~40 days to complete nursery operation.

3) Plowing and Puddling

Paddy plots are plowed with power tillers and tractors in late January in low-lying areas 20~30 cm deep. Harrowing and puddling is done with cage wheel a few days before transplanting, after submersion of paddy fields.

4) Application of Fertilizers

Basal dressing is applied just before puddling and the dose customarily applied by farmers tends to be higher than the standard or recommended one. In this connection, potash application is advised to rice plants at swampy areas by specifying the optimal dose, but it is not actually applied in the most cases.

Standard Dose of Fertilizers and Actually Applied in General

Dose	Improved Variety (Amol-3)			Local Variety (Tarom)			Remarks
	N	P	K	N	P	K	
Normal	100	50	50	65	50	23	Urea-N 46%
Actual	210	115	-	100	65	-	DAP-N18, P 46%

In general, half of the above listed total dose is top-dressed around 20 days after transplanting, but nearly the total dose is applied as the basal dose for local varieties.

5) Transplanting

Seedlings are randomly transplanted with a planting density of 12~15 hills/m^2, number of seedling per hill seems to be somewhat overpopulated counting 5~6.

6) Weeding

As to paddy weeds, eleusin and paddy eleusin particularly thrive. Lately, outbreaks of perennial weed species such as hairy tufted sedge, sagittaria paddy herb, sponogeton and cyperus-sedge are often observed.

Weedicide application is often practiced by spraying 4~5 ℓ/ha of Ronstar Emulsion a few days after transplanting, or Marshet instead of Ronstar, but Ronstar spraying during transreduction by the diluting process through overflow irrigation, leads to supplemental manual weeding, that is usually practiced twice, around 20 days and 35 days, after transplanting.

7) Plant Protection

Rice striped stemborer is controlled by dusting Padan powder once in early June at the rate of 10~15 kg/ha, followed by the second spraying of Padan Granule in late July at the rate of 20 kg/ha or Diazinon is often applied to late maturing varieties in early September. Hinozan powder is usually applied for controlling blast disease.

8) Water Management

Timely water control for irrigation and drainage is rarely practiced due to plot-to-plot irrigation system. Some farmers holding a continuous tract of field plots often provide water channels along a border of them, but they are seldom effective for controlling drainage.

9) Harvesting

Paddy is usually manually reaped with sickles, cut at the height of 20~30 cm above the foot of stubbles. Then reaped panicles are spread over the cut stubbles to expose them to sunlight for drying for a couple of days. In the case of farmers who hold more than two hectares, major part of harvesting labor is usually met by hiring from outside the paddy area. Threshing is practiced with threshers driven by the engines attached to power tillers, carrying harvested panicles to a convenient place where the thresher is installed, threshing by combines (for use of wheat harvesting)is also popular in field plots where they are readily tread in from access roads, and medium to large sized combines brought from Gorgan and other eastern regions are often seen threshing manually harvested paddy along village roads.

(2) Cultivation of Secondary Crops After Rice

1) Berseem

Sowing of berseem is generally practiced after the onset of the rainy season, i.e. mid-September to early October, at the rate of 40 kg/ha without prior plowing. Top-dressing of urea followed at the rate of 50~70 kg/ha, about 20~30 days after sowing. When seed begins to germinate, slug outbreaks often occur giving damage to germinated sprouts, for the control of which most cropping farmers spray Sevin molluscide on bunds of cropping fields at the rate of 20 kg/ha. Mowing is sometimes practiced with sickles by three cuttings per season, but most cropping farmers allow grazing over the crop. Uniform development of grass is hardly expected due to various causes like excessive dryness of soil during sowing or washing out by surface runoff of torrential rain, often leading to poorer yield. Growth inhibition by temporary water submersion during winter growing season seldom occurs.

2) Winter Vegetable

* Lettuce (leafy vegetable)

Nurseries for lettuce are ordinarily provided adjacent to growing lots, where seed is sown at the rate of 5 kg/1,000 m^2. 1,000 m^2 of nursery bed can cover 1 hectare of growing field. The cropping field is prepared by spreading 15 t/ha of poultry manure or compost after rice harvest, and seedlings at the age of 45 days after sowing are set in mid- or late November. Though shallow drains are provided around the cropped fields, ridging cultivation is not practiced. 1.5 t/ha of urea, 1.5 t/ha of DAP are applied by splitting the dose equally into basal and top-dressing broadcasted over the field. Fertilizer dosage is not uniform but varies with individual farmers.

As for plant protection, Sevin Granule is spread over field bunding 3~4 times at the rate of about 5 kg/ha as total from sowing to harvesting. Cut grass is conditioned on the field and packed in wooden boxes, then marketed commonly through middlemen.

* Forcing Radish (root vegetable)

Sowing of radish begins from early or middle of September with the growing period ranging 70~75 days, and sometimes it is intensively cultivated and harvested 2~3 times a year. Only basal dressing is applied to it by spreading urea and DAP at the rate of 150 kg/ha each, respectively. Seed is sown on flat rows at the rate of around 5 kg/ha. Thinning is never practiced, but plant protecting practices are applied to it in a similar way to those for leafy vegetables.

Manually harvested radish roots are washed with water without removing leaves and bundled with rice straw to market.

(3) Farm Mechanization

Current situations of machinery holding in the Project Area is shown in the Appendix C. 4. 1, indicating that farm mechanization is confined to plowing, plant protection and threshing, and hence remain part of a system of highly incomplete coverage.

According to a survey on rice production costs conducted by GDA Mazendaran, an outline of manual labor and hours of machinery operation are summarized in the following:

Per ha	Manual Labor (man-day)			Machinery Operation (hrs)			Machinery
BASIS	Amol	Babol	Average	Amol	Babol	Average	Utilized
Plowing	5.4	3.6	4.5	26.2	41.7	34.0	Power tiller
Puddling	1.2	0.8	1.0	7.5	10.5	9.0	ditto
Bunding	3.0	3.4	3.2	-	-	-	
Canal al.	1.9	2.9	2.4	-	-	-	
Nursery	8.0	2.6	5.3	-	-	-	
Planting	13.7	13.5	13.6	-	-	-	
Manuring	1.0	1.0	1.0	-	-	-	
Irrigation	7.1	7.7	7.4	-	-	-	
Spraying	1.3	1.3	1.3	4.4	7.4	5.9	
Weeding	10.3	11.9	11.1	-	-	-	Knapsack-
Reaping	13.7	13.0	13.4	-	-	-	sprayer
Threshing	4.9	5.1	5.0	6.4	11.7	9.1	Thresher
Carrying	4.4	5.6	5.0	6.4	9.6	8.0	Power tiller
Total	75.9	72.5	74.2	50.9	80.9	66.0	

Note: Threshing in Amol includes that with wheat-combines. puddling includes leveling, al ; alignment

3. 5. 5 Livestock

(1) Current Livestock Herd and Situation of Husbandry

Livestock herd presently kept by farmers in the Project Area is estimated at about 53 thousand heads of sheep/goats as well as 96 thousand heads of cattle, of which 10 % or above of cattle herd constitutes pure milch cows or hybrids.

Sheep and goats are chiefly fed in the villages located in highland, grazed within highland extended in piedmont area of the Alborz mountains during rice cropping season and then are migrated into plains after rice harvest and pastured in paddy fields or in coastal rangeland feeding rice straw, roughage/fodder or concentrates as supplemental.

Cattle are kept all over the rural area, the population of which is roughly proportional to numbers or density of farm households. Local species, accounted for over 90 % of the total cattle herd, are of smaller size and have less milching capacity than the improved, but are tolerant to rough feeding. Though increasing heads of cows which are fed in drylot as advised from extension side etc., however, a considerable percentage of farmers still keep them in released (not tethered) grazing, as too often observed at roadsides, canal-sides, in harvested rice fields etc.. Their supplemental feeds consist of hay/grass, rice bran, beet-pulp etc.

Specialized livestock farms are also found who keep several dozen herds of milch cow or meat cattle, though the number is quite limited, who raise barley, sorghum, berseem clover, etc. as feedcrops or prepare concentrates from ingredient component materials. Besides, some livestock farms feed herds of several hundreds of cattle by applying permission to forest management office in the southern border of the Project Area, but all of such large-scale feeders are faced with the task of how to procure feedstuff. Particularly, sharply boosted price levels of straw, rice bran etc. have led to higher feeding costs and resulted in eroded profitability.

Feeding resources currently available within the area is scarce other than rice by-products like straw and rice bran, and hence the size of current herds seem to be too much from the carrying capacity point of view, viz., the feeding rate at DCP(digestible crude protein) basis is about 27% and that of TDN(total digestible nutrient) basis is about 86% as explained in Appendix C.3, and it is assumed that the main reason of low productivity of livestock in the Project Area is due to such deficit of nutrient. However, despite feed deficiency situations, cropping area of berseem, that seems to be an extremely promising crop in terms of nutritional supply, has not so far been expanded upon. Several reasons therefore are suggested, but it is partly because labor reward is not as attractive as rice cropping, partly because a protecting fence would be needed against the invasion of released cattle due to customary grazing habit on rice field during winter, or berseem growing season.

Pests and diseases are still prevalent, whereas shortage of veterinary staff has not been solved. A major cause of infectious diseases must be the practice of released grazing as well as unsanitary drylot management, but also, resistance or tolerance to infection is limited by malnutrition which would contribute to this vulnerability. The Project Area is considered to have a high potential to develop a livestock sector, but so far as the vicious circle of the unfavorable custom of grazing on rice fields … giving damage to berseem crop by trespassing … disincentive to berseem growing … undernutrition of livestock … higher mortality and low level milching capacity … reluctance of improving drylot or feeding facility … returning to released grazing is kept on, immediate betterment in livestock productivity may hardly materialize.

With regard to poultry, more than ten poultry farms are found within the area in addition to an innumerable number of small scale feeding of hens, ducks/geese and turkeys in common farm households, likely meeting most of the demand in the area. However, even in the poultry sector, the most serious problem arises from the difficulty of feed procurement, actually all of their feed requirements are now dependent on external supply.

(2) Livestock Products

The objective of keeping sheep/goat herds in the Project Area is nothing but redmeat production, even though dairy products like butter, cheese and yogurt may also be obtained, these are almost all for domestic consumption. Most greasy wool is processed within the producing farms, but it is rarely marketed in local markets, in Amol etc.. Sheep/goats are sold live to individuals (for slaughtering in various sacrificial ceremony as offerings) or to butchers, in this occasion skins are given to those who slaughter animals, but when animals are slaughtered in slaughter-houses, they are sold to exclusive dealers.

The objective of keeping cattle mainly lies in milk production for home consumption, but for commercial purposes only a few large-scale livestock farms produce dairy products and beef for meeting consumer's demand within the area. In most cases male calves are sold before weaning to livestock farms etc. where they are fed as beef cattle. In the case of cattle steers they are bought by butchers and are slaughtered in municipal slaughtering houses. The disposal of skins is done in a similar way to that of sheep/goats.

As such, the livestock production in the Project Area has less value than apparently observed from the size of present herds, and this is why no livestock processing sector has developed in the urban area other than municipal slaughtering houses, and the major part of dairy products for urban demand has been met by supply from the outside, except for petty itinerant selling by farmers of their surplus in very limited areas.

3.5.6 Marketability of Agriculture & Livestock Products

The population of the urban area was about 151,000 in 1986 census year and it shared about 36% of total population in the Project Area. Large portions of fresh vegetables and other agricultural products are brought from different parts of the country to the urban area markets in the Project Area, and the Project Area is not self-sufficient in this concern. In other words, there is still considerable room to develop the market of agriculture products within the Project Area. Moreover, the coastal area of the Caspian Sea including the Project Area is a summer resort, and consumption of fresh vegetables increases sharply in June-September period, therefore it is worthwhile to consider the production of crops to meet such seasonal demand.

After all, the most important crop market for the Project Area is that of the metropolitan area where has some population nearly 10 million. Especially, since the outdoor cropping of vegetables in the suburbs of the metropolitan area is hardly possible during the winter period due to low temperatures. Although the Project Area is supplying some vegetables such as spinach, radish, chinese cabbage, lettuce, etc. even at present, the share is not sufficiently large because of lack of systematic marketing facilities such as collecting of crops, their transportion, etc..

There are about 1,400 ha of orchard which produce mainly citrus fruit, especially Onshu mandarin. Cultivation of this fruit became very popular in the Caspian Sea coastal area in the recent decades, therefore the competition in the market is rather hard for the product of the Project Area because the quality of this fruit in the Project Area is not as good due to poor management of orchard. Therefore most of the product is either for home consumption or selling at the local market, except a limited quantity which are marketed in the metropolitan area, etc. This trend will continue unless there is improvement of orchard management systems.

As explained in the above para 3. 5. 5, about 100,000 heads of cattle are raised in the Project Area, but neither meat nor milk is self sufficient therein. On the other hand, the country has been an importer of redmeat and dairy products since the 1970's, therefore it is deemed to have sufficient market capacity for those products. The Project Area is expected to produce more meat and milk to increase the country-wide self supply rate of those products.

In relation to rice, it may be said that the demand of Tarom is more than the production, but the high yield varieties such as Amol-3 are not so welcome in the market because their taste. However, those high yielding rice varieties are also sold in the market, with cheaper price than Tarom, due to absolute shortage of rice in the country, therefore the problem of marketing is not so serious at present . The recently developed high yield varieties such as Khazar have better taste than the previous ones, therefore, it is expected that the problem of marketability of high yield varieties will also be solved in future.

3. 5. 7 Farming Type and Farmer's Family Budget

(1) Farming Type

Farming types in the Project Area consist of; 1) land lord, 2) self-cultivating land owner, including resident land lord in the village, 3) crop sharing tenant and 4) farm worker, and mean ratio of above 4 types was 3.2 : 57.2 : 23.4 : 16.2 in the Project Area. This ratio is rather different even at the Shahrestan level, and those in Amol, Babol and Babolsar districts of the Project Area were 5.2 : 68.5 : 14.6 : 11.7, 0.0 : 38.1 : 41.2 : 20.7 and 0.2 : 41.6 : 30.6 : 27.6 respectively.

The farming types in the Project Area are assumed from the size of land holding and cropping pattern as below;

Farming Types	A		B		C		D	
Land Holding Size	0		~ 0.4	0.5 ~ 0.9	1.0 ~ 1.0		2.0 ~ 2.9	3.0 ~
Sharing Ratio *	17.9 %		11.7 %	19.3 %	24.7 %		15.2 %	11.2 %
Total Sharing Ratio *	17.9 %		31.0%		24.7 %		26.4%	
Income								
Rice - culture	1,063	39.5%	2,023	71.7%	3,493	73.8%	6,325	88.6%
Second Crop	762	28.3	35	1.2	370	7.8	337	4.7
Wage of Farm Works	345	12.8	264	9.4	130	2.8	51	0.7
Non Farm Works	520	19.4	498	17.7	738	15.6	425	6.0
Total	2,690	100.0%	2,820	100.0%	4,731	100.0%	7,138	100.0%
Expense								
Food	1,132	42.4	1,302	46.3%	1,725	33.4%	2,393	39.1%
Clothing / Housing	549		654	23.2	1,677**	32.4	1,362	22.3
Miscellaneous	242		317	11.3	533	10.3	577	9.4
Production Cost	746		542	19.2	1,235	23.9	1,789	29.2
Total	2,669		2,815	100.0%	5,170	100.0%	6,121	100.0%
Balance :	+ 21		+ 5		- 439 **		+ 1,017	

Note 1 : Unit = 1,000 rials
2 : * quoted from para 3. 5. 1 Land Ownership
3 : ** 656 in 1677 was cost of re - building of house, therefore actual balance is considered as plus side.

(2) Farmer's Family Budget

1) Production Cost

The GDA of Mazandaran has been undertaking a Shahrestan level sample survey of production cost of main agriculture products since 1989. The result of analysis of production cost of rice in 1989 - 1991 period in ex-Amol and ex-Babol Shahrestans were as shown below :

		Machine Cost		Labor Cost		Agri - input, etc		Total
		Amount	Ratio	Amount	Ratio	Amount	Ratio	Amount
			%		%		%	
1989	Ex-Amol	174	26.3	433	65.2	57	8.5	664
	Ex-Babol	222	25.8	534	61.9	107	12.3	863
1990	Ex-Amol	220	26.9	508	62.3	88	10.8	816
	Ex-Babol	185	24.7	478	63.8	86	11.5	749
1991	Ex-Amol	201	25.5	518	65.7	69	8.8	788
	Ex-Babol	173	20.1	596	69.3	91	10.6	860
Average in 3 years		195	24.8	511	64.7	83	10.5	790

The result shows that the share of machinery cost of the total production cost was 26.2% in ex-Amol Shahrestan, and that of ex-Babol Shahrestan gave 23.6%. On the other hand, the share of labor cost in ex-Amol was 64.4% which was almost equal to that of ex-Babol, 65.0%.

In relation to the agri-input such as water, seed, fertilizer, agri-chemicals, etc., water cost in ex-Babol which is mainly irrigated with well/pump was higher than that of ex-Amol which has water resources supplied from the Haraz river. Average input of seed was 66 kg/ha in both Shahrestans, but the price of seed/kg in ex-Amol was 590 rials despite the 350 rials/kg in ex-Babol. This difference of price is considered to be due to difference of varieties of rice, viz., Tarom in ex-Amol and Amol-3 and others in ex-Babol.

The unit price and quantity of input of fertilizer, insecticide, herbicide, etc. were considerably different by the samples. Such difference is assumed due to the difference of source, either rural cooperatives or free markets.

2) Market Price of Rice

The increase of price of rice in the recent decade at the rice market in Amol was very notable. Price of Tarom jumped as much as 5 times higher, and that of Amol-1 and 3 were also three times.

3) Farmer's Income

Above said sample survey of 3 years showed that the mean yield of paddy, unit price and mean income/ha were as below :

		Yield	Unit Price *	Gross Income/ha	Net Income/ha
		t/ha	rials/kg	1,000 rials	1,000 rials
1989	Ex-Amol	4.8	525	2,528	1,864
	Ex-Babol	5.1	373	1,901	1,038
1990	Ex-Amol	4.3	464	1,994	1,178
	Ex-Babol	4.3	345	1,484	735
1991	Ex-Amol	4.9	453	2,230	1,442
	Ex-Babol	5.1	395	2,012	1,152

* including straw

The average net income of farmer in the said three years showed a considerable areal difference, viz., net income in ex-Amol was 975,000 rials/ha, but that of ex-Babol was only 571,400 rials/ha.

3. 5. 8 Farmer's Organization

There are 2 kinds of farmer's organizations at present, Shora and Rural Cooperatives. The former is a village congress, but the members are appointed by the Ministry of Interior at present, however it is planned to apply an election system in future.

The rural cooperatives in the Project Area are formed with neighboring an average of 15 villages, and covering almost the whole area as shown in Figure 3. 5-2. There are 33 cooperatives, 23 of which are located in ex-Amol. The average number of members in the cooperative is 1,340 in ex-Amol and that of ex-Babol is about 2,100. The average capital of a cooperative is 58.5 million rials in ex-Amol and that of ex-Babol is 83.4 million, therefore the share of a member is about 40,000 rials in average in both Shahrestans.

Other than the rural cooperatives, there is also production unit cooperatives such as cattle breeder's, bee-keeper's, etc.. All of those cooperatives are under the superintendence of the MOA, and the main activities of the cooperatives are distribution of agri-inputs which are under the control of the government, mutual guarantee for the loan from the Agriculture Bank, etc..

Although it has not been formed in the Project Area, there is a system of rural production cooperative which enables procurement and operation of agri-machinery jointly or undertaking land consolidation works or, in general, to apply joint farming systems, and many regions have such kind of cooperative system.

It is worthwhile to consider application of such a cooperative system in the Project Area to promote land consolidation works, farm mechanization, etc.

3.5.9 Agriculture Supporting Institutes

The Shahrestan offices of the MOA and MOCJ are in charge of farming and rural affairs, respectively.

The main tasks of the MOA are improvement of seed, distribution of fertilizer/agri-chemicals and extension services for improvement of farming practice.

The seed improvement of paddy has been undertaken by the Amol Rice Experimental Station which is located in the Project Area and other stations in Sari, Tonekabon, Rasht, etc. They produced many varieties of paddy including high yield varieties such Amol-1 and 3, Haraz, Khazar, etc., and those varieties were distributed among the farmers of the Project Area after test cultivation and selection in the station and field trial by selected farmers. The high yields of paddy in the Project Area has been established through such joint effort of researchers, extension servicemen and farmers.

No research or experimentation for improvement of seed, farming practice, etc. has been done in the Project Area other than paddy, and the nearest experimental station for upland crops is located at Behshahr, at the east corner of Mazandaran province.

The Shahrestan office of MOA is in charge of extension services. In case of Babol, the Shahrestan office is Agricultural, Rural and Tribal Service Center (ARTSC), and the Shahrestan office of Amol was also reformed to ARTSC from the mid of 1370.

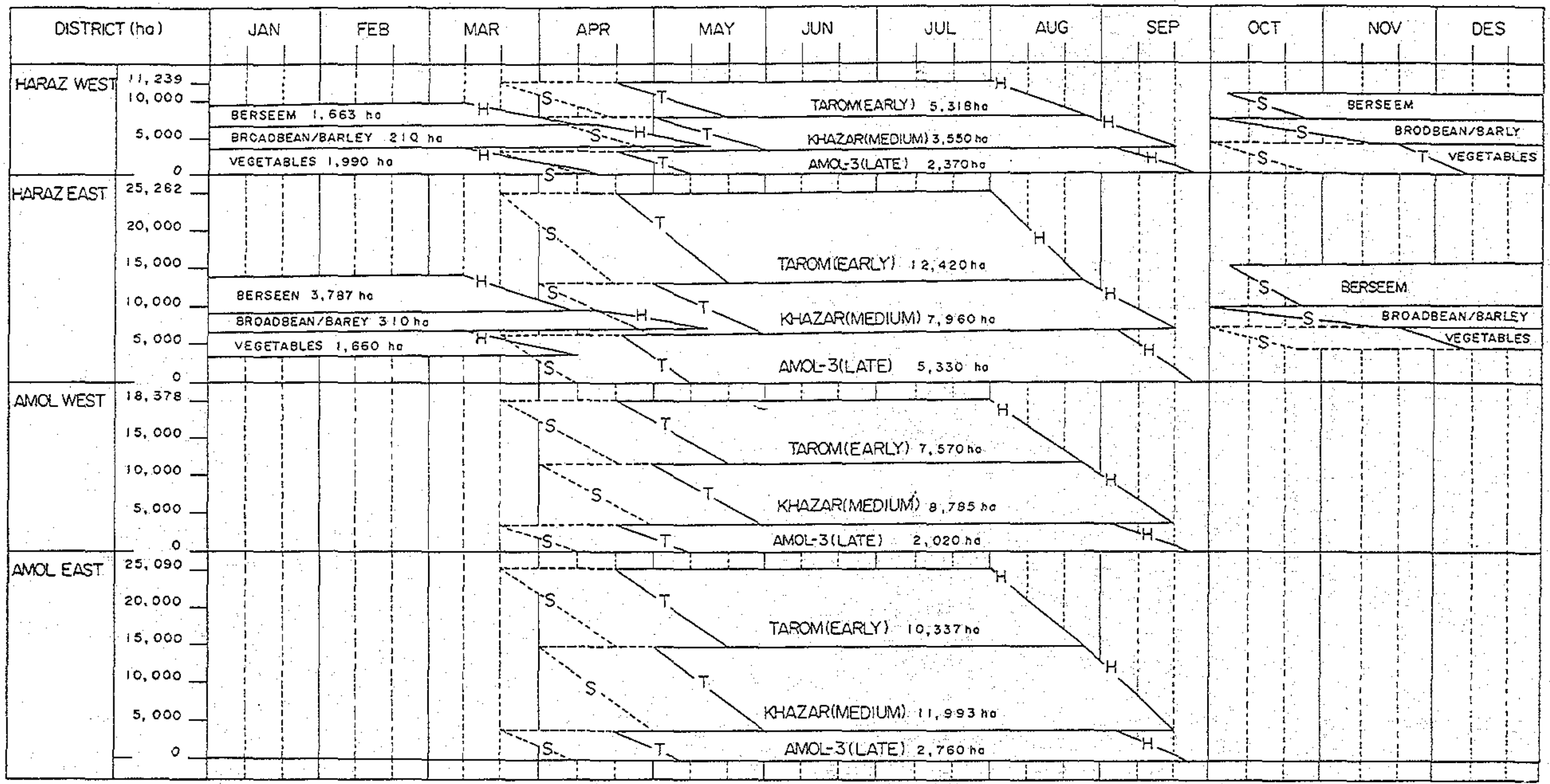
The ARTSC aims to keep close contact with the farmer providing a proper numbers of Rural Service Centers which have a group of technicians, extension servicemen, etc., to respond to the needs of farmers in the correspondent area. The service of RSC is not limited to the extension service or technical guidance, but they also can help farmers in land consolidation works, improvement of on-farm facilities, etc..

The MOCJ had been in charge of improvement of social infrastructure in the rural area, but the responsibility of forest management and livestock breeding were also transferred to the MOCJ since 1370.

The main points of improvement of social infrastructure in rural area are improvement of road, establishment of piped water supply system and public bath, etc.. To encourage the rural inhabitants to participate in the improvement of their living environment, the improvement works are executed using the contribution of beneficiary and subsidiary thereto.

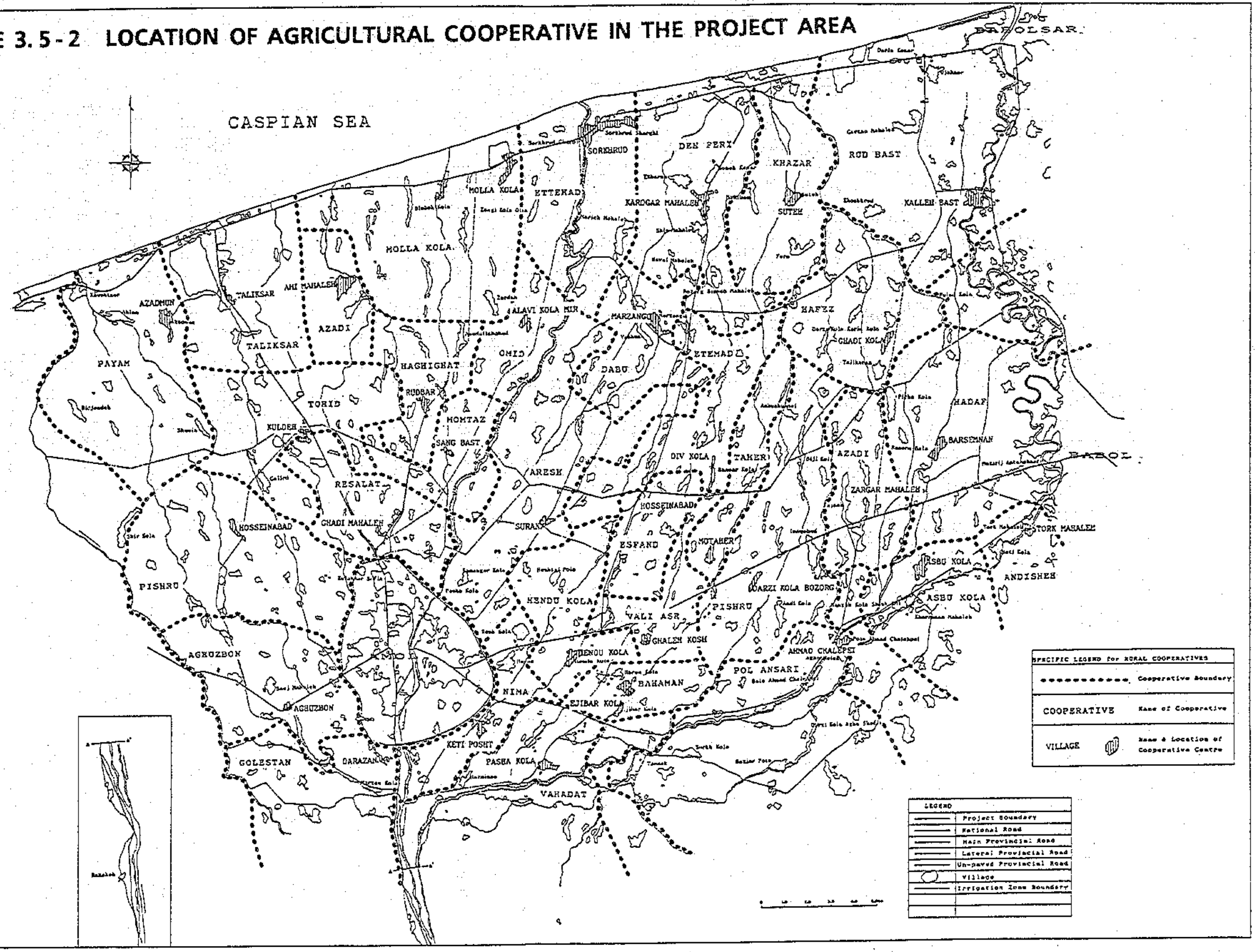
The Agriculture Bank is supplying credit to farmers through the rural cooperatives. Although there are some fluctuation by years, the total amount of credit extended is increasing in the whole Project Area in recent years. The average amount of credit in the recent 5 years in ex-Amol district was 65 million rials/cooperative and that of ex-Babol district was 124 million rials. However, credit supplied per member of cooperative was about 50,000 rials in ex-Amol and 60,000 rials in ex-Babol district. Most of the received credit was short-term farming credit, and medium or long term credit for farm facilities improvement was very rarely applied.

FIGURE 3.5-1 PRESENT CROPPING PATTERN



S: Seedling, T: Trasplanting, H: Harvesting

FIGURE 3. 5 - 2 LOCATION OF AGRICULTURAL COOPERATIVE IN THE PROJECT AREA



3.6 Existing Irrigation and Drainage Condition

3.6.1 Project Boundary and Existing Irrigation and Drainage

(1) Background

Since the topography, soil and climate are congenial to paddy growth and water for irrigation is available from the streams diverting from the Haraz river, paddy cultivation has been practiced since some hundreds of years ago.

Land under paddy has increased in the recent years as a result of recent exigency to increase food production to feed the expanded population and economic stability of rice growing farmers brought about by governmental price manipulation.

To expand and secure stable water supply, efforts have been put in to construct new farm ponds and to install shallow and deep wells. However, the perceived problems such as quantitative stability of water resources, increase in operation and maintenance cost of run-down facilities, and the need to retrace rice farming including labor problems remain to be solved. To formulate a solution, the Iranian government has requested the Japanese government to conduct a master plan on this Project Area. A big step towards this motive was made when MOE carried out a feasibility study on water resources development for the Haraz and Babol river basin.

(2) Project Boundary

The project boundary of this study was defined to include all the area irrigated by the Haraz river. It is bounded by the Alesh river to the west, the Babol river to the east, and the Caspian Sea to the north. The southern boundary of the west bank of the Haraz river is defined by the command area of the Haraz West Main Canal. For the east bank area it is defined by the command area of the Kari Rud. Note that the command area of Kari Rud unraveled by TIB survey in this study is different from that assumed in the Master Plan. The total area within the project boundary is 108,009 ha.

(3) Irrigation Condition

1) Area and Crop under Irrigation

About 77% or 83,000 ha is designated paddy, which is the main crop under irrigation.

2) Water Resources

The Alesh river, Haraz river, Babol river, Garma river and Kari Rud are the main rivers in the Project Area. The Kari Rud is an artificial channel constructed to divert irrigation water from the Haraz river.

The Haraz river, with 1,062 MCM (annual average runoff) discharge from a catchment area of 4,086 km^2, is the only river where surface runoff is utilized for irrigation. Utilization of water drafted from the thick aquifer for irrigation is common in the Project Area. Based on the data collected, about 143 MCM (135 MCM from wells, and 8 MCM from springs) is used annually to supplement irrigation water. When river water of the Haraz is adequate, groundwater is saved from utilization.

Return-flow is the other significant water resource. Over 100 secondary canals, varying from 20 to 30 km in length, divert water from the Haraz river and flow northward over an elevation difference of about 100 m. Excess water in this irrigation network of over 540 km is utilized for irrigation as return-flow in the middle and lowland region. Respective above water resources are utilized as below;

Available Water Resources

Water Resource	Haraz West		Haraz East		Total	
	Amount (MCM)	Area (ha)	Amount (MCM)	Area (ha)	Amount (MCM)	Area (ha)
Surface Water	238	18,867	404	32,126	642	50,993
Wells	47	4,086	88	7,588	135	11,674
Spring	3	266	5	454	8	720
Abbandan	10	904	26	2,323	36	3,227
Return Flow	19	1,692	32	2,880	51	4,572
Sub-Total	317	25,815	555	45,371	872	71,186
Shortage	63	4,591	108	7,057	171	11,648
Total	380	30,406	663	52,428	1,043	82,834

Note: Unit water requirement = (1,033 + 10) MCM ÷ 82,834 ha ≑ 12,600 m^3/ha

(4) Drainage Condition

1) Drainage and Crop

Paddy is cultivated in almost all of the arable land in summer. Except for some areas in the highland region, winter cropping is not a common practice, especially in the middle and low land region, due to poor drainage. Since less rain falls in summer, surface water diverted from the Haraz river and groundwater drafted from wells are used to irrigate the fields and drainage does not pose a problem. However, difficulty in mid-summer drainage (for plot-drying), delay in harvesting due to poor trafficability caused by rainfall during harvesting, limited mechanization due to low bearing capacity of soil affects to a great extent crop production.

Figure 3.6-1 gives the relation between cropping pattern, rainfall and groundwater level. As can be seen from the figure, drafting in summer and ponding water release for harvesting lower the groundwater level. It rises abruptly when rainfall increases after harvesting in October, causing poor drainage and inundation in many areas.

2) Distinguishable Drainage Characteristics

Drainage characteristics of the area can be summarized as follows.

- Well Drained Area

  Area in the highland region where drainage of rainfall and excess irrigation water is easy, and the groundwater level is low.

- Poorly Drained Area

  Area in the middle and lowland region where drainage of rainfall and excess irrigation water is difficult, and the groundwater level is high.

- Hardly Drained Area

  Exceptionally low-lying area, (-)24.0 m and below, in the lowland region, especially in the hinterland of Feridon Kenar, where drainage is obstructed by the rising of the Caspian Sea level and outfall (estuary) blockade due to bar formation. Groundwater level in this area is usually high and the area is inundated during irrigation period. Water drafted from shallow wells is sometimes saline.

- Coastal Sand Dune Area

  Highly percolative sand dunes are formed in the coastal region, which drain directly into the Caspian Sea. No drainage improvement is required.

  The geographical distribution of the respective areas is shown in Figure 3. 6-3 and the percentage is given in the following table.

Drainage Characteristics by District-Wise

(Unit: ha)

Characteristics	Haraz		Amol		Urban		Total	
	West	East	West	East	Amol	Bobal	(ha)	(%)
Well drained area	8,745	9,803	0	0	3,849	0	22,397	20.7
Poorly drained area	6,281	20,449	24,153	31,127	0	1,515	83,525	77.3
Hardly drained area	0	0	0	538	0	0	538	0.5
Coastal sand dune area	0	0	677	872	0	0	1,549	1.4
Total	15,026	30,252	24,830	32,537	3,849	30,252	108,009	100.0

Note: 1. Poorly drained area, where groundwater rises to 20 cm or more from the field surface.
2. Hardly drained area, where the land lies below (-)24.00 m in the Amol East District.

3. 6. 2 Existing Irrigation and Management

(1) Irrigation Facilities

1) Diversion Works

Diversion of water into the secondary canal is conducted through temporary intake structures or feeder canals constructed in the Haraz river and the Kari Rud. These temporary structures are easily destroyed by floods and re-constructed from time to time, consequently it is necessary to integrate them into a more organized system. To improve the system of water extraction, MOE has planned two diversion dams in the Haraz river, and one of them (Haraz Diversion Dam) is under construction.

2) Conveyance Facility

Predominant slopes of the high, middle and low land region are 1/50 ~ 1/200, 1/200 ~ 1/500 and 1/500 ~ 1/1,000, respectively. Invert gradient of the canals in the respective regions generally follow the topographical slope. In the highland the invert of the canals is heavily eroded and is protected by some ground sill or drop works. The major canals diverting from the Haraz river flow northward over a distance of 10 ~ 30 km and irrigate narrow strips of land, a few kilometers, on either or both side of the banks.

The total lengths of the secondary and tertiary canal are estimated at 540 km and 1,250 km, respectively. Also canal density is 6.3 m/ha and 15.2 m/ha, respectively. Due to the less canal density, plot-to-plot irrigation is commonly practiced, and subsequent puddling from upstream requires a long puddling period.

Since drainage is mostly necessary during off-season of paddy from September to February when most of the rainfall occurs, the irrigation canals also play the role of drainage canals.

(2) Water Resources

Total annual water requirement for paddy cultivation is estimated at 900 MCM ~ 1,000 MCM. About 640 MCM is supplied by surface runoff of the Haraz river and the Lar Dam. About 296 MCM comes from supplementary sources such as groundwater, farm ponds and return-flow. Out of the 296 MCM, 143 MCM is drafted from groundwater annually and this has reached its highest potential. Further increase in draft rate will decrease groundwater level and that will result in intrusion of salt wedge of the Caspian Sea.

Therefore, surface runoff development of the Haraz river is the only potential left to secure water for irrigation.

(3) Operation and Maintenance

There are main / secondary canals of 600 km long and tertiary canal with 1,250 km long, respectively. MOE is the main institution responsible for the operation and maintenance of the facilities and canals. The farmer pays a water fee for water management activity by MOE, and provides repair work of the facility on a volunteer basis.

Management of water distribution is performed by the chief mirab, one each assigned by MOE for Amol and Babol Shahrestan. The chief mirab enjoins the 116 zone mirabs who are responsible for management of secondary canals. In the terminal level, about 286 village mirabs operate water allocation in the tertiary and fourth canals.

Any water measurement facility is not equipped to the existing intakes and turnouts. Water distribution is practiced using a traditional measuring unit, namely "Abdang". Abdang means the distribution ratio of water, and it is given to and fixed at all intakes and turnouts. Depending on a given abdang, intakes and turnouts are operated empirically by mirabs to keep a fixed distribution ratio regardless of discharge.

3.6.3 Existing Drainage and Management

(1) Existing Condition

Drainage is characterized by a) drainage by irrigation-cum-drainage canals, and b) plot-to-plot drainage. Exclusive drainage canals are found only in the coastal area in the lowland region.

In the highland region, where hydraulic gradient is sufficient, no drainage difficulty exists. Excess irrigation water is easily drained into the canal. The secondary canal in this region also serves as a drainage canal.

In the middle land, drainage is difficult since the secondary canals are shallower and hydraulic head (elevation difference between paddy field and canal invert) is small. A major part of the middle land region comes into poor drainage conditions in the summer.

In the lowland region, drainage problems are more acute. Drainage is difficult in a large part of the area from autumn to winter with widespread inundation. Poor drainage is caused by excess irrigation water and free intrusion at the intake works, obstruction by village roads and irrigation canals, insufficient discharge capacity of irrigation-cum-drainage canals, sedimentation and weed growth in drainage canals and blockade by coastal sand dunes. River mouth closing is observed at the mouth of Feridon Kenar Drain, Mahmudabad Drain and Changar Drain. So far only Feridon Kenar Drain is influenced by estuary blockade.

The farmers remove sediment and weeds in the irrigation canals periodically but less frequently in drainage canals. Removal of sediment and drift sand in the larger estuaries and maintenance of drainage capacity of larger canals in the coastal dunes are performed by the respective local administrations using machines such as floating-type clam-shell and backhoe.

The up-coming of sea level of the Caspian Sea is becoming a serious problem, especially in those areas (-)24.0 m and below in the hinterland of Feridon Kenar.

(2) Existing Drainage Network

The existing drainage networks are shown in Figure 3.6-3. The table below gives the area of the respective network.

Drainage Area by Existing Drainage Network

Drainage Districts / Drainage Zone	Drainage Area (ha)	Ratio (%)
Haraz Left Bank Drainage District	42,880	39.7
1) Haraz Upper Drainage Zone	399	0.4
2) Alesh Drainage Zone	3,587	3.3
3) Changar Drainage Zone	6,634	6.1
4) Mahmudabad Drainage Zone	16,170	15.0
5) Siahrud Sar Drainage Zone	2,353	2.2
6) Tifangah Drainage Zone	6,119	5.6
7) Bisheh Kola Drainage Zone	291	0.3
8) Alamdeh Rud Drainage Zone	1,792	1.7
9) Shiah Kola Drainage Zone	761	0.7
10) Bir Rud Drainage Zone	3,793	3.5
11) Haraz Direct Drainage Zone	981	0.9
Haraz Right Bank Drainage District	65,129	60.3
1) Haraz Direct Drainage Zone	1,254	1.2
2) Shira Rud Drainage Zone	1,130	1.0
3) Feridon Kenar Drainage Zone	49,070	45.4
4) Babol Drainage Zone	8,195	7.6
5) Kari Right Bank Drainage Zone	5,480	5.1
Total	108,009	100

The west bank area of Haraz river, constituting 40% of the land, is drained by 11 drainage networks. The remaining 60%, that is the left bank area of the Haraz river, is drained by 5 networks. Feridon Kenar network alone drains about 49,070 ha or 45% of the total area, and is the largest network in the Project Area. The second largest network, the Mahmudabad Drain network drains about 16,170 ha or 15% of the land.

(3) Main Drainage Canal

As shown in Figure 3. 6-3, the main drains are found in the low-lying coastal area in the lowland region. The particulars of the drains are given in the table below.

Present Main Drains

Main Drains	Length	
Changar Drainage	14.4 km	
Mahmudabad Drainage	7.1	
Tifangah Drainage	15.0	
Ezbaran Drainage	6.1	Feridonkenar Drainage Zone
Mahlabon Drainage	18.2	
Suteh Keleh Drainage	16.4	
Hakkeh Dakal Drainage	6.2	
Total	83.4 km	

Notes:
- Length is estimated on a map scale of 1 : 20,000.
- Main drain is defined as a drain having a drainage area more than or around 5,000 ha.

(4) Secondary and Tertiary Drainage Canal

Exclusive drainage canals are not common in the Project Area. Most drainage is achieved through the irrigation-cum-drainage canal at the secondary and tertiary canal level.

(5) Elevation Distribution in the Low-lying Area

The difference in elevation between the low-lying area and Caspian Sea level is small, also it is mostly located in the Amol East District. The table below shows the elevation distribution in the low-lying area.

Ground Elevations in the Low Land Area

Elevation	Areas by Elevation		Total (ha)	Proportion to the Whole Project Area of 108,009 ha (%)
	Amol West District (Min. Elevation(-) 24.2 m)	Amol East District (Min. Elevation(-) 24.5 m)		
less than(-) 24 m	4 ha	538 ha	542	0.5
〃 (-) 23 m	29	1,681	1,710	1.6
〃 (-) 22 m	667	4,337	5,044	4.7
〃 (-) 20 m	3,968	8,098	12,066	11.2
〃 (-) 18 m	6,469	10,528	16,997	15.7
〃 (-) 16 m	8,442	13,021	21,463	19.9

3. 6. 4 Existing Irrigation and Drainage Facilities

(1) Existing Invert Gradient of Canals

According to the preliminary canal survey of about 530 km length consisting of a main canal of 83 km and a secondary canal of 448 km, invert gradient is closely related to topography. From the table below, it is clear that in the upstream reach of Haraz East District and Haraz West District the invert slope is steep, about 71% and 39% are steeper than 1/100, respectively. Invert gradient of over 50% of the secondary canals in the Project Area fall between 1/200 to 1/1,000 slope. Also over 60% of the drainage canals are gentler than 1/500 slope.

Longitudinal Slopes of Surveyed Canals

District	Survey Length (km)	Slope Distribution (%)				
		>1/100	1/100-1/200	1/200-1/500	1/500-1/1,000	< 1/1,000
Secondary Canals						
Haraz West						
Upper	40.6	45.4	32.4	18.5	3.7	0.0
		45.4	77.8	96.3	100.0	100.0
Lower	39.9	11.4	52.9	27.2	8.5	0.0
		11.4	64.3	91.5	100.0	100.0
Sub-total	80.5	28.5	42.6	22.8	6.1	0.0
		28.5	71.1	93.9	100.0	100.0
Haraz East						
Upper	66.1	41.4	38.0	12.4	8.2	0.0
		41.4	79.4	91.8	100.0	100.0
Lower	42.7	11.3	25.2	30.9	20.4	12.2
		11.3	36.5	67.4	87.8	100.0
Kari Left	68.3	0.0	1.5	3.9	44.5	50.1
		0.0	1.5	5.4	49.9	100.0
Sub-total	177.1	18.2	20.8	13.6	25.1	22.3
		18.2	39.0	52.6	77.7	100.0
Amol West	81.2	1.2	14.8	51.3	27.0	5.7
		1.2	16.0	67.3	94.3	100.0
Amol East	108.7	0.5	6.0	39.7	36.3	17.5
		0.5	6.5	46.2	82.5	100.0
Secondary Canals Total	447.5	12.7	20.0	28.4	24.8	14.1
		12.7	32.7	61.1	85.9	100.0
Major Drainage	83.4	0.0	3.2	33.8	28.4	34.6
		0.0	3.2	37.0	65.4	100.0
Total Surveyed Length	530.9	10.7	17.4	29.3	25.3	17.3
		10.7	28.1	57.4	82.7	100.0

Note) The figures in the upper row : Ratio of each slope class,
in the lower row : Accumulated ratio

(2) Main and Secondary Canal

1) Outline

The main facilities in the Project Area are those that divert and convey water from the Haraz river into the secondary canals. The three diversion works in the Alesh river are nonfunctioning in the latter half of the irrigation period due to decreased discharge. The Kari Rud, diverting from the Haraz river at the southern part of the Project Area, is utilized to irrigate the northeast region. Subjected to the influence of rural development, relocation and changes, about 100 secondary canals are now in use.

Since most of the rainfall occurs in autumn and winter and this does not greatly affect crop production, except for the seven drainage main canals in the low-lying area in the north, drainage facilities are less developed compared to irrigation canals. The role of most of the secondary canals are less trenchant and often function as irrigation cum drainage canals.

No clear distinction is made for canals smaller than the tertiary level. Water is supplied to the field from secondary canals through a network of still smaller canals. These canals also serve to catch excess water and convey it to be stored in the farm ponds or reused.

2) Kari Rud (Main Canal)

Kari Rud, about 50 km long, was constructed about 100 years ago to divert water from the Haraz river. It is "water-righted" and also functions as a river. The maximum discharge capacity is about 300 cms at the confluence of the Garma Rud and is much less, about 50 cms, at downstream.

The existing intake of the Kari Rud is located about 7 km upstream of the Haraz Diversion Dam. The water distribution ratio is 5 : 7 between the Kari Rud and the Haraz river. Since no integration of intake work is planned, the upper portion of the Kari Rud from the existing intake to the point where it will be joined to the Haraz East Main Canal will also be used in future.

The slope of the upper reach is about 1/400 and like those channels with direct intakes, this section is heavily eroded. The middle and downstream reach is less steep and used effectively for irrigation.

3) Secondary Canal

As mentioned earlier, the secondary canals are those channels which divert water from the Haraz river, the Alesh Rud and the Kari Rud. Most of these canals have evolved from smaller natural streams, while some are artificially excavated to provide water for irrigation. Those canals function as irrigation-cum-drainage.

Features of Secondary Canal

Primary Source	No. of Secondary Canal	Length (km)	Irrigation Area (ha)
Haraz River	24	310	44,000
Alesh River	5	20	600
Kari Rud Canal	75	210	26,000
Total	104	540	70,600

Except for limited locations where concrete and steel works are used, most of the intake works are simple temporary structures constructed with pebbles, stones, sandbags and wooden piles. The locations are changed and the structures are repaired or reconstructed after each flood.

The canals are basically open earthen canal type except a portion where the sidebank is protected by dry masonry. The slope of canals in the high and middle land region is about 1/100 to 1/200. Since the invert is heavily eroded due to steep gradient over the years, in some cases paddy field is about 5 - 6 m above the canal bed, causing water intake difficult. Therefore water is channeled into the field through a long approach canal.

In the lowland region, since drainage is obstructed by plugging due to deposition of sand transported from the high and middle land, intrusion of flood water from the surrounding fields and small hydraulic head between the water level in the canal and that of the Caspian Sea, these canals branch into smaller tributaries which drain into the farm ponds or directly into the Caspian Sea. Before each irrigation season the farmers repair the intake works and remove sediment from canal bed. The labor and cost for this work is becoming considerable.

4) Drainage Canal

As mentioned earlier, most of the secondary and tertiary canals in the high and middle land region are irrigation cum drainage canals. In the lowland region only a few canals, seven of them, are the major ones (see para. 3. 6. 3 (3)), and function as canal solely for drainage. They evolved naturally from smaller streams to collect excess irrigation water in the plot-to-plot irrigation system and flood runoff. Most of the other canals are irrigation-cum-drainage canals, and either drain into the seven major canals or directly into the Caspian Sea.

(3) Tertiary Canals

The total length of tertiary canal is about 1,250 km and the density is about 15 m/ha. Most of them are irrigation cum drainage canals, conveying water diverted from the secondary canals while collect drainage water and return-flow. The canal system, evolved over the years, is complex. The major tertiary canals are named. However, the command area is not known accurately: the command area ranges from 5 to 500 ha and the length from 0.1 to 10 km. These canals were unraveled in the TIB survey in this study.

(4) Existing Structures

1) Outline

Most existing structures are found in the Kari Rud, and the secondary and tertiary canals. As mentioned in previous sections, they are often temporary works constructed in earth canals. Only a limited number of semi-permanent works such as drop and regulating structure with stop-log are fortified with concrete wall and blocks. Over 300 permanent crossing structures such as concrete pipe and box culvert and bridge are constructed in locations where the Kari Rud and the secondary canals cross the main roads.

2) Sample Structure Survey

Zane-Mard Rud was surveyed as a sample of structure survey for secondary canal. The following table shows the existing facilities situation in the said canal.

Length of canal 30 km
Command area 3,500 ha

Existing Facilities and Canal Related Structures of the Zane-Mard Canal

Item	Description	Amount
- Intake	Right bank of the Haraz river (Stones, wooden logs etc.)	1
- Turnout for tertiary canal (Checks)	Irrigation area over 100 ha	10
	Irrigation area 50 - 100 ha	15
	Irrigation area less than 50 ha	17
	Total	42
- Drop	Height : 2 m	2
	Height : 4 m	1
	Total	3
- Bridge	National road (1st class)	2
	National road (2nd class)	1
	Trunk road	7
	Farm road	20
	Path road	25
	Total	55
- Culvert	Box type	10
	Pipe type	20
	Arch type	2
	Total	32

3) Farm Ponds (Abbandans)

Based on the data and field reconnaissance, existing farm ponds are summarized as below.

Total number 206
Total area 3,502 ha
Effective storage 36 MCM

List of Abbandans

District	Number of Abbandans	Area (ha)	Storage (10^3 m^3)
Haraz West	3	28	364
Haraz East	25	449	6,687
Amol West	81	1,106	10,200
Amol East	92	1,703	16,683
Sub-total	201	3,286	33,934
Amol Urban	0	0	0
Babol Urban	5	216	2,066
Total	206	3,502	36,000

Note) In the Amol East District, one abbandan (AE 88) is protected by the Ramsar Convention.

Besides being an effective source of water resources by storing excess irrigation water and return-flow, the farm ponds also regulate drainage by temporarily storing runoff.

3. 6. 5 Available Water Resources

The three main water resources in the Project Area are surface runoff, water stored in farm ponds and groundwater.

(1) Amount Available

1) Surface Runoff

Based on hydrological analysis, the surface runoff of Haraz river is given in the table below.

(Unit : MCM)

	Annual Average	Irrigation Period	
		Normal Year	Drought Year
Lar dam release	240	240	240
Residual basin	670	402	225
Total	910	642	465

2) Water Stored in Farm Ponds

As mentioned above, about 206 farm ponds are found in the middle and lowland region and the total surface area is 3,500 ha and effective storage is 36 MCM.

3) Groundwater

Groundwater survey in this study has revealed that about 143 MCM, 135 MCM from shallow well and 8 MCM from spring, is available for irrigation during summer.

4) Other Resources

Though subject to uncertainty, about 8% is estimated for excess irrigation water and return-flow which are reused for irrigation (see Appendix B. 2).

Developed water resources can be summarized as following table.

(Unit : MCM)

	Annual Average	Irrigation Period	
		Normal Year	Drought Year
Haraz river	910	642	465
Small pond	36	36	36
Groundwater	153	143	143
Return flow	73	51	37
Total	1,172	872	681

Note: Return flow rate is estimated at about 8% of intake discharge considering 50% of operation losses of water distribution.

3. 6. 6 Existing Irrigation Water Demand and Use

(1) Existing Demand

As mentioned in the existing canal network no measuring device is available at major intake points to measure water diverted from the Haraz river into the secondary canals, and quantitative assessment of the water flow in the major canal and demand of individual canal is not possible.

Therefore the existing water demand is estimated by assuming the following conditions.

1) Conditions

- Crop consumption is estimated from evapotranspiration
- Effective rainfall is 75% of monthly rainfall
- Deep percolation is 2 mm/day
- Total irrigation efficiency is 70%
- Puddling period is 30 days
- Nursery is 5% of total area under paddy (30 days)

2) Cropping Area

- Local variety	Early mature	36,529 (ha)	44%
	Medium mature	33,217 (ha)	40%
- Improved variety	Late mature	13,088 (ha)	16%
Total		82,834 (ha)	100%

3) Irrigation Requirement

Variety	Irrigation Requirement	Field Requirement	Irrigation Demand
	(mm)	(mm)	(mm)
Early Mature	872.8	782.8	1,118.3
Medium Mature	980.7	890.7	1,272.4
Late Mature	1,185.1	1,081.1	1,544.4

Irrigation requirement = Crop consumption + percolation
Field requirement = Irrigation requirement - effective rainfall
Irrigation demand = Field requirement/efficiency (0.70)

Irrigation requirement is converted to quantity of water demand as follow.

Early mature	1,118,3 mm × 36,529 (ha) =	408.5 MCM
Medium mature	1,272.4 mm × 33,217 (ha) =	422.7 MCM
Late mature	1,544.4 mm × 13,088 (ha) =	202.1 MCM
Total		1,033.3 MCM

Water demand for nursery is estimated at 10 MCM

Water demand for the whole Project Area becomes 1,043.3 MCM in drought year.

(2) Irrigation Practice

The two main irrigation water resources are surface runoff and groundwater. Irrigation practice is characterized by the respective water resources.

Surface water	:	The practices of water utilization are to divert surface water mainly from the Haraz river as well as small streams in and around the Project Area including return flow which is flowing down to the downstream as excess irrigation. Besides, in the middle and lower region, excess water is used effectively through farm ponds (abbandans) which are scattered in the area.
Groundwater	:	The groundwater is utilized in two methods such as pumping up from shallow wells and gravity method from spring.

High irrigation efficiency is achieved by plot-to-plot irrigation at on-farm level. As mentioned before, the secondary canal runs for many kilometers to the north and irrigates a narrow strip of land. This often results in delay and insufficient water in the lowland region. To mitigate this constraint, the farmers store water in the field to be used later for nursery and puddling as early as the latter part of the rainy season. This is one of the factors that hinder winter cropping.

3.6.7 Present Water Management and Water Rights

(1) Water Management

Except farm ponds, all water resource works, appurtenant structures for irrigation and drainage, and the coastal structures are operated and maintained by MOE. Irrigation water operation in the Project Area comes under ANDWO and BDWO, which are local offices of MOE.

The actual operation works are carried out by the chief, zone and village mirabs. The elected chief mirabs, besides leading and controlling the zone and village mirabs, sometimes appropriate water allocation for secondary and tertiary canals to which no zone or village mirab is assigned. Should the discharge in the Haraz river become exceptionally low, the mirabs, presided over by the chief mirab, manipulate and arbitrate water use to avoid water dispute. This is an efficient way of water operation because an impartial control is often possible by a third party.

(2) Water Rights

The Project Area has a complex traditional water right system. It came into being when the division ratio between the Haraz river and Kari Rud was decided at 7 : 5.

1) Water Right Registration

All beneficiaries (village unit) having water rights have been registered in the Registration Office. The registration is simple: Only village name and name of canal or spring, or return flow (water source). Quantitative specification is no where to be found.

2) Water Distribution

Water distribution is carried out by the traditional unit 'abdang'. It gives the allocation ratio and does not require quantitative measurement.

When water is abundant in a canal, all farmers use it for irrigation regardless of whether they have water rights or not. In dry years, water is allocated only to those with water rights.

3) Area with Water Rights

Based on 1985 survey, the paddy area with water rights is estimated to be 64,300 ha. The survey conducted by ANDWO and BDWO in 1990 shows that it has been increased to 66,500 ha.

3.6.8 Drought and Inundation

(1) Drought Damage

1) Paddy Yield, River Discharge and Rainfall

A relatively long statistical record on paddy yield, cultivated area, river discharge and rainfall are necessary in order to produce a reliable analysis on the effect of drought. Yield per ha, rainfall and discharge at Karehsang for 1982 to 1991 are tabulated as follows. It shows that in 1982, 1983 and 1988 there was a decrease in yield per ha.

Year	Yield	Rainfall (Apr. - Sept.)	Runoff (Karehsang) (Apr. - Sept.)
	(ton/ha)	(mm)	(MCM)
* 1982	4.1	203.3	251.8
* 1983	4.0	230.2	608.4
1984	5.1	164.7	479.1
1985	6.1	174.7	645.9
1986	5.9	221.2	630.5
1987	6.0	303.0	N.A
* 1988	4.1	359.7	637.4
1989	5.3	349.7	451.4
1990	5.4	167.8	399.1
1991	5.6	N.A	514.4

2) Evaluation of Drought

Damage to crops happens when there is a shortage of irrigation water or when rainfall is exceptionally low during the dry season. The table above shows that rainfall in the Project Area does not affect yield prominently. The decreases in yield in 1982 was probably caused by insufficient intake due to low discharge of Haraz river in that year. The decrease in other years, 1983 and 1988, was not caused by the shortage of irrigation water and could be attributed to pest and/or disease.

(2) Inundation Damage

Paddy cultivation is not affected seriously by inundation since only about 56 mm (10-year exceedance probability) of daily rainfall occurs from April to August. However, harvesting activity and mechanization are obstructed by autumn rainfall. About 82 mm (10-year exceedance probability) of daily rainfall falls in August to September.

On the other hand, winter cropping in about 78% or 64,480 ha of paddy field is difficult due to high groundwater table in autumn and winter by rainfall.

Moreover, some inter-village roads are inundated and interrupted due to rainfall in autumn and winter, and houses are sometimes flooded to the floor level nearby Feridon Kenar in this period.

FIGURE 3.6-1 PRESENT CROPPING PATTERN AND DRAINAGE FACTORS

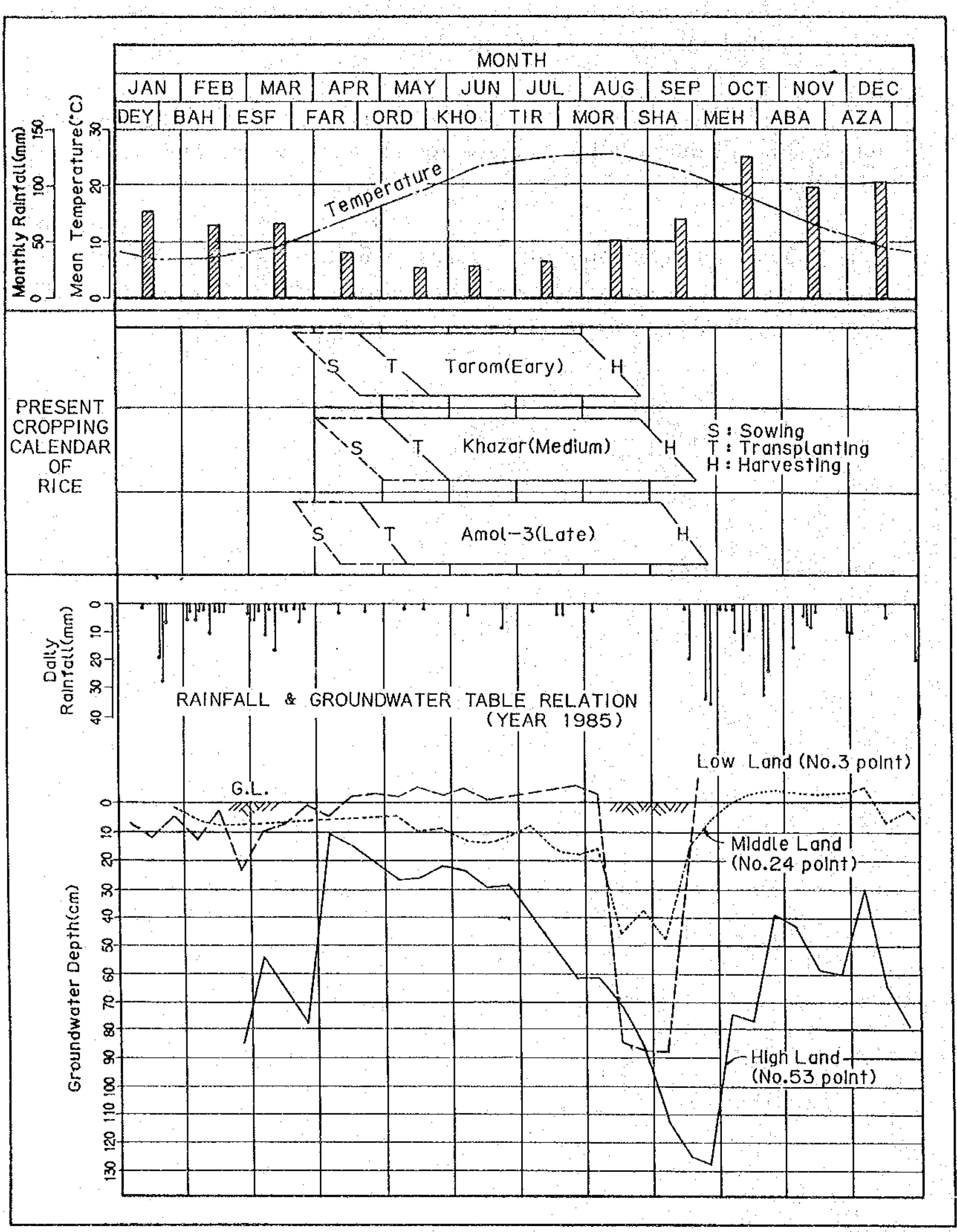


FIGURE 3.6-2 EXISTING IRRIGATION NETWORK

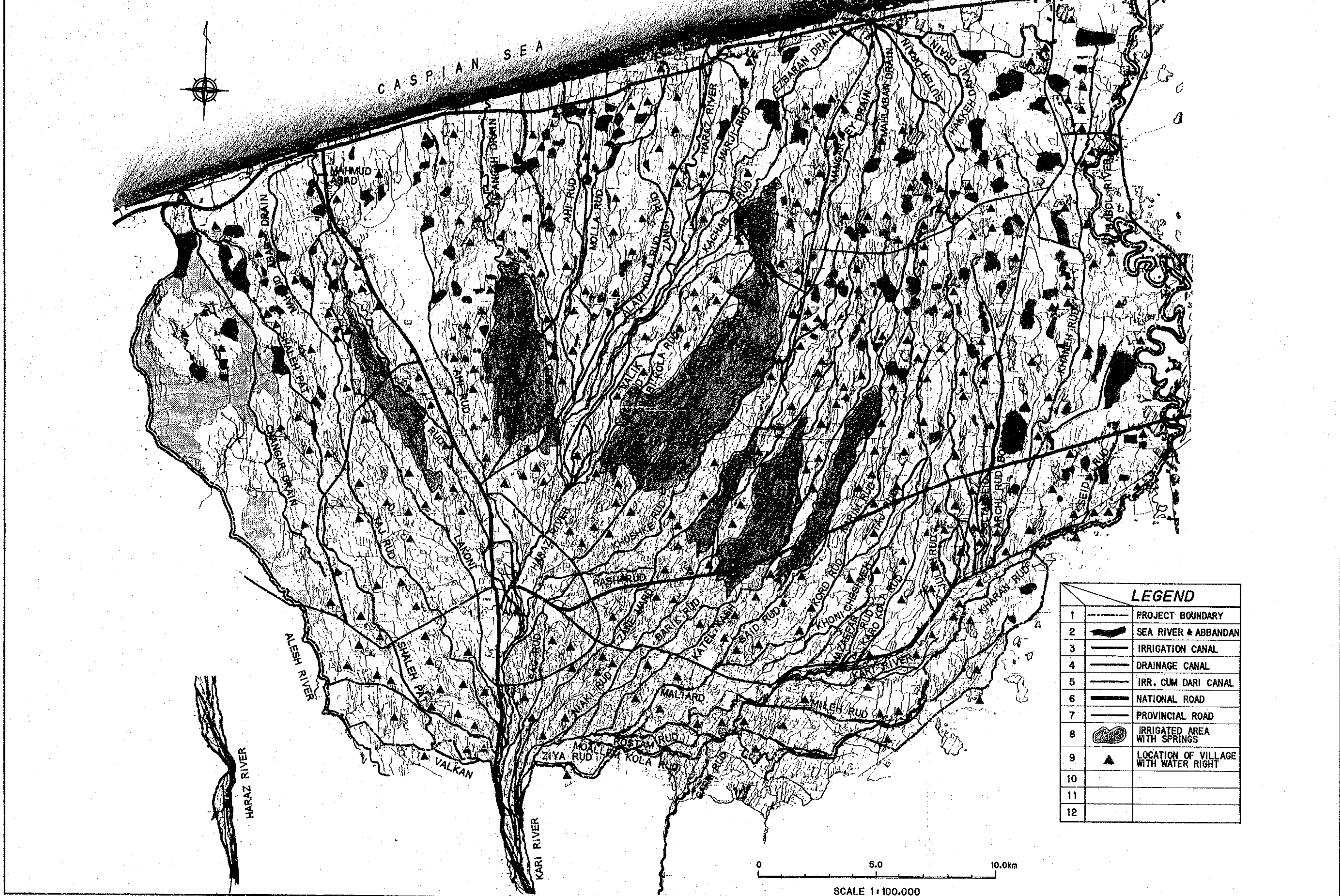
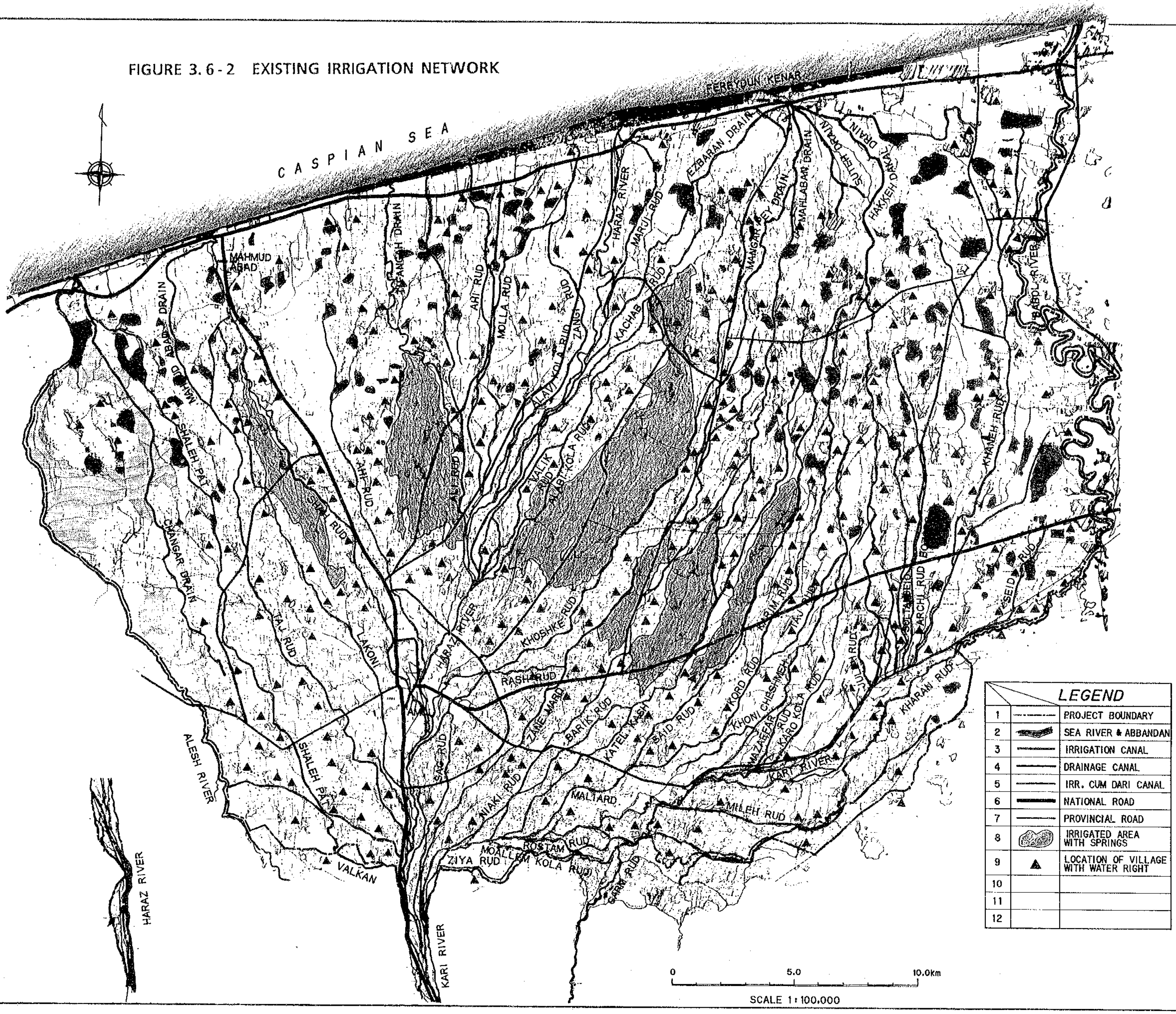


FIGURE 3.6-2 EXISTING IRRIGATION NETWORK



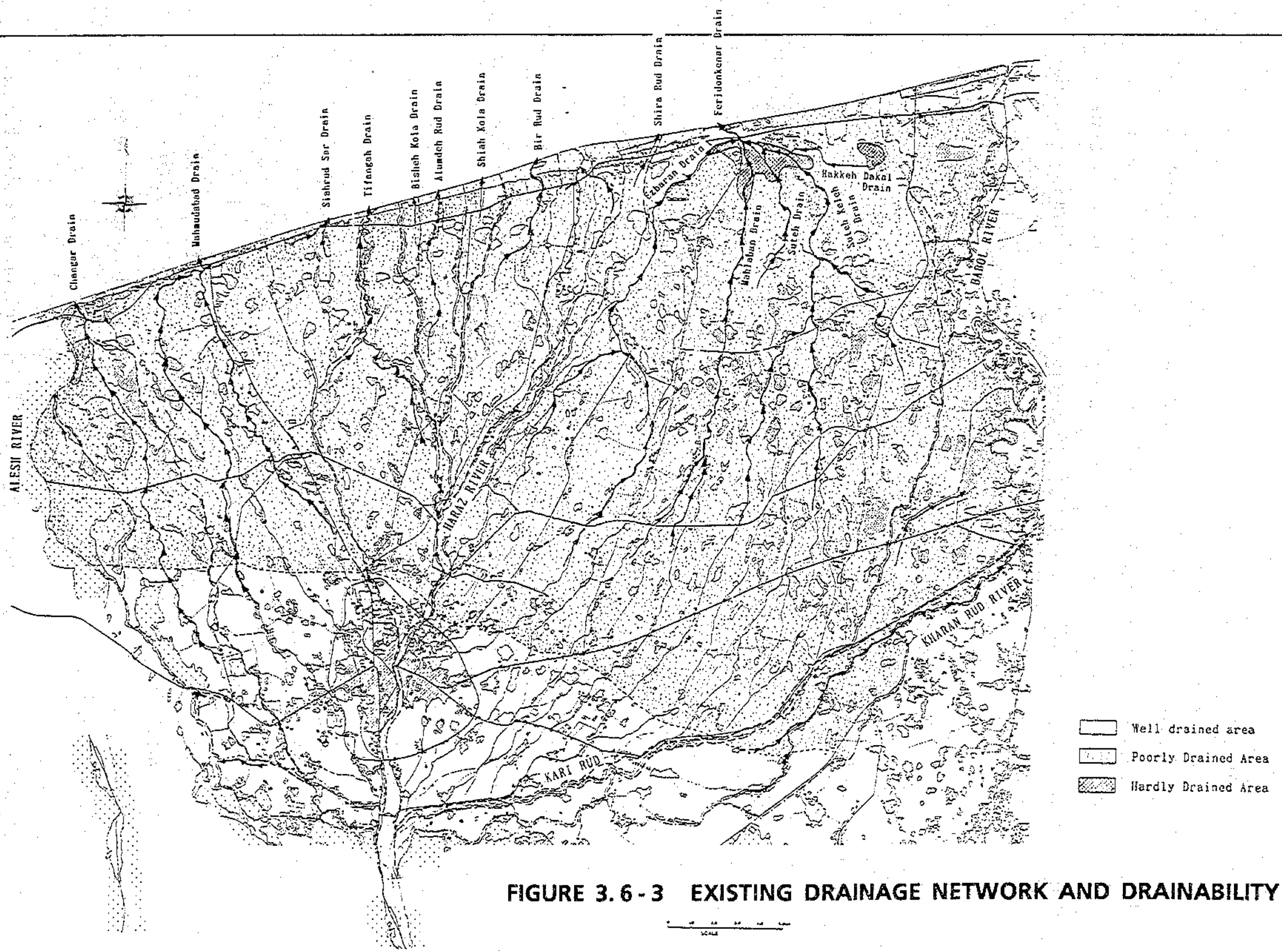


FIGURE 3.6-3 EXISTING DRAINAGE NETWORK AND DRAINABILITY

3.7 On-farm Systems

Present conditions of on-farm systems are studied based on the existing data such as the sampled farmer interview survey conducted by the CAPIC Office. The total sample size of this survey was 110 farmers from 11 villages, which seemed sufficient to grasp the conditions of on-farm system and farmers' intention of land consolidation.

3.7.1 Topography and Field Lot

(1) Field Lot Size and Shape

Based on the above survey, following understanding of field lot size can be obtained:

Average Size of Field Lot

Size of lot (ha)	No. of Farmers	Accumulation (%)
Less than 0.1	3	3
0.1 - 0.2	20	24
0.2 - 0.3	22	46
0.3 - 0.4	12	59
0.4 - 0.5	8	67
0.5 - 0.6	13	80
0.6 - 0.7	4	85
0.7 - 0.8	2	87
0.8 - 0.9	1	88
0.9 - 1.0	0	88
Over 1.0	12	100
Total	97	

- Majority of field lots is 0.1 - 0.3 ha, and the size of less than 0.3 ha accounts for about 50% of the sampled farmers,
- About 88% of farmers have the average lot size of less than 1.0 ha, and the rest of 12% have the average size of more than 1.0 ha,
- The lower the location is, the larger the lot size is, and vice versa, in general.

The farmers' views to their field lots from the points of size, shape, distribution and land leveling were also surveyed. The interview results are summarized as follows:

Size and Shape of Field Lot

Size of lot	No. of farmer
Too small	5 (5%)
Good	58 (53%)
Too large	45 (42%)
Shape of lot	No. of Farmer
Regular	80 (72%)
Irregular	31 (28%)

Distribution of Field Lot

Items	No. of farmer
Dispersive	19 (17%)
Rather Collective	35 (33%)
Collective	55 (50%)

Condition of Land Leveling

Items	No. of farmer
Good	45 (41%)
Fair	48 (44%)
Bad	17 (15%)

- Size: Only 5% of farmers consider their lot sizes are too small, on the contrary, about 42% (45 farmers) of farmers feel their lots are too large,
- Shape: About 72% (80 farmers) of farmers consider their lots are regular,
- Distribution: 17% of farmers consider their lots are dispersive, on the other hand, 83% of farmers accept their lots are collective or rather collective,
- Land leveling: About 15% (17 farmers) of farmers, whose locations are in the high or middle regions, consider their lots have bad land leveling condition.

(2) Topography

Based on the data of sample design areas, following features of topographical characteristics are summarized:

Areal Topography	Area Elevation (m)	Slope	Elev. Diff. of Field (cm)
Undulated	20 < E	1/200 - 1/100	10 - 200
Gentle	-10 < E < 20	1/500 - 1/250	10 - 50
Flat	E < -10	1/1,500 - 1/500	0 - 10

From the areal distribution of topographical features, undulated areas are prevailing in the high land, gentle areas in the middle land and flat areas in the low land, in general.

3.7.2 On-farm Irrigation and Drainage Systems

From the field survey, the conditions of on-farm irrigation and drainage systems are grasped as follows:

- Diversion works are made of earth bags, brushwood or concrete to raise the water level of canals, secondary or tertiary ones.
- Irrigation water is led to the upper point of a terminal irrigation block (TIB), which is about 110 ha in average, through an irrigation-cum-drainage ditch.
- In TIB, irrigation and drainage systems are plot-to-plot-mode.
- Drainage water is discharged into an irrigation-cum-drainage ditch finally.
- On the other hand, it can be said that the present irrigation method is effective from the viewpoint of re-use of return flow.

With the above systems, following problems are observed:

- Inundation results in the downstream fields during wet period, and second cropping becomes difficult.
- Ineffective and irrational water distribution during drought period.
- Washing away of applied fertilizers and chemicals due to plot-to-plot irrigation.
- Being impossible to control water depth in an individual lot.
- Being difficult to harvest the early matured rice when different varieties are planted together in a plot-to-plot irrigation unit.

In the above mentioned survey, irrigation and drainage conditions are interviewed from sampled farmers as following table;

Irrigation and Drainage Conditions

No.	Village Name	Location	Irrigation			Drainage		
			Good	Fair	Bad	Good	Fair	Bad
1	Katiposht	H.L	10			10		
2	Firuz Kola	H.L	10			10		
3	Ejibar Kola	H.L	10			10		
4	Ahmadchalepey	H.L	10			9	1	
5	Masumabad	M.L	9	1		3	7	
6	Eslamabad	M.L	11			6	4	1
7	Darzi Kola	M.L	10				8	2
8	Abdolabad	L.L	9	1		1	6	4
9	Vaskas	L.L	5	5		1	3	6
10	Ojakasar	L.L	7	2		5	3	6
11	Suteh	L.L	10		1		5	
	Total		101	9	1	55	37	19

Note: H.L : High land, M.L: Middle land, L.L : Low land

The results seem to reflect above problems, as follows:

- Bad irrigation condition, which means water shortage in every year, was the answer by only one farmer who cultivates in the low land. On the other hand, 17% (19 farmers) of farmers, whose lands are located in the middle and the low lands, reply drainage condition is bad.
- As for the upper land of the area, no farmer replied there are water shortage and inundation problems.

3. 7. 3 Farm Road Network

Following on-farm road conditions are prevailing in the Project Area:

- Main farm roads (linking farming areas and villages) exist with rough to gravel surface conditions. Their alignments are predominant north-to-south.
- Very few lateral farm roads (linking main farm roads and farming areas) and few field roads are observed.

Farmers' view for farm road construction is shown in the following table:

Farmers' View for Farm Road Construction

Location	No.	Village Name	Road Construction	
			Expecting	Not Expecting
H.L	1	Katiposht	10	0
H.L	2	Firuz Kola	5	5
H.L	3	Ejibar Kola	8	2
H.L	4	Ahmadchalepey	6	4
M.L	5	Masumabad	7	2
M.L	6	Eslamabad	10	1
M.L	7	Darzi Kola	6	2
L.L	8	Abdolabad	7	3
L.L	9	Vaskas	9	1
L.L	10	Ojakasar	8	1
L.L	11	Suteh	9	1
		Total	85	22

From the results, about 79% (85 farmers) of farmers want to have farm roads constructed.

3. 7. 4 Farmers' View to Land Consolidation

Farmers' views of land consolidation were investigated in the sampled farmer interview survey conducted by the CAPIC Office. In the survey, items of improvement priority, lot collection, land exchange and acreage reduction are interviewed with farmers. The results of the survey are shown in Table 3. 7-1 and are outlined as follows:

Collection of Lot		Land Exchange		Acreage Reduction	
Item	No of Farmers	Item	No of Farmers	Item	No of Farmers
Wanting	46 (85%)	Acceptable	43 (75%)	Acceptable	103 (93%)
Not wanting	8 (15%)	Not acceptable	14 (25%)	Not acceptable	8 (7%)

- Improvement priority: The first priority is land leveling in the high land, while it is drainage improvement in the low land. Farm road improvement holds second priority throughout the Project Area.
- Lot collection: About 15% (8 farmers) of farmers do not want to collect their field lots,

- Land exchange: About 25% (14 farmers) of farmers do not accept land exchange by land consolidation,
- Acreage reduction: About 7% (8 farmers) of farmers do not accept farm area reduction by land consolidation.

Generally speaking, the problems in promotion of land consolidation are primarily concerned with acreage reduction and exchange of their farm lands and farmers' share of the construction cost accompanied with its implementation. In this project, however, the greater part of farmers are interested in land consolidation, and these problems will be able to be settled from the survey results above mentioned. Another problem is that there is no criteria for land consolidation.

TABLE 3. 7- 1 FARMERS' VIEW TO IMPROVEMENT PRIORITY

(1) Scoring

		Scores *					
Village Name	Location	Drainage	Irrigation	Size & Shape	Collection	Farm road	Leveling
Katiposht	High Land	0	3	11	8	15	22
Firuz Kola	High Land	0	11	11	5	9	22
Ejibar Kola	High Land	3	2	2	5	14	15
Ahmadchalepey	High Land	0	26	6	5	12	5
Masumabad	Middle Land	11	3	7	5	13	15
Eslamabad	Middle Land	12	5	7	8	12	19
Darzi Kola	Middle Land	25	9	5	2	13	6
Abdolabad	Low Land	20	6	0	3	10	15
Vaskas	Low Land	26	3	0	12	17	2
Ojaksar	Low Land	24	9	2	5	18	1
Suteh	Low Land	5	18	3	6	22	4

*1: Sources are calculated based on the table "Farmers' view of Necessary Improvement". Scoring system is 3-point for 1st priority, 2-point for 2nd and 1-point for 3rd respectively.

(2) Priority

		Priority					
Village Name	Location	Drainage	Irrigation	Size & Shape	Collection	Farm road	Leveling
Katiposht	High Land	6	5	3	4	2	1
Firuz Kola	High Land	6	2	2	5	4	1
Ejibar Kola	High Land	6	4	4	3	2	1
Ahmadchalepey	High Land	6	1	3	4	2	4
Masumabad	Middle Land	3	6	4	5	2	1
Eslamabad	Middle Land	2	6	5	4	2	1
Darzi Kola	Middle Land	1	3	5	6	2	4
Abdolabad	Low Land	1	4	6	5	3	2
Vaskas	Low Land	1	4	5	3	2	5
Ojaksar	Low Land	1	3	5	4	2	6
Suteh	Low Land	4	2	6	3	1	5

3.8 Review and Comments on the Previous Studies

3.8.1 Land Use

(1) Project Area and Cropping Area

The Project Area and cropping area of the previous studies as well as this study can be summarized as below;

(Unit : ha)

Land Use	This Study	Master Plan Study	HWDP-I Study
Paddy	82,834	72,610	77,000
Upland	265	3,750	9,935
Orchard	1,399	2,010	6,540
Sub-total	84,498	78,370	93,475
Others	23,511	26,850	37,705
Total	108,009	105,220	131,180

The gross area has increased to 108,009 ha by 2,789 ha from the Master Plan Study. This increase results from involving the upper lands of the Haraz West and East Districts. However, increase of the paddy area is mainly due to reclamation or shift from the areas of upland, orchard and forest.

In comparison with the HWDP-I Study, the gross area has decreased by 23,171 ha. Because the HWDP-I Study covers an area extending in the southern region of the Kari Rud, that is beyond the boundary of this Study.

(2) Land Use Plan

The Master Plan topographically divides the project area by watersheds, into three sub-areas as based on altitude, i.e., high, middle and low lands, and employed cropping intensity indicators of 160% (paddy 100%, berseem 50%, vegetables 10%) for the high land and 150% (paddy 100%, berseem 50%) for the middle and the low lands. Regarding mechanization and its facility, the study proposed introduction of the agricultural machinery, improvement of the existing rice mills and installation of the paddy seedling supply centers.

The area referred to by HWDP-I covers southern areas where upland acreage is comparatively larger, and mainly "paddy with upland crops" type patterns are proposed. Two types,. i.e., 80%, and 70% of the total cultivated area are to be cropped with paddy (and the remaining 20% and 30% with upland crops) were proposed, while targets are set for second crops after paddy to cover 28-32% of the land with berseem and 2.6 - 4.6% with winter vegetables, in this report. It has formulated a combined cropping system of upland type (barley-tomato/cucumber or barley-soyabean/corn) with paddy type (paddy followed by berseem/lettuce), on unit rotation blocks with acreage size of 1,000 ha.

3. 8. 2 Irrigation System Improvement

Concerning the investigation for the project area in past years, the Master Plan Study was carried out by JICA, in 1985.

After that, the MOE has implemented the feasibility study on the development of water resources and the irrigation and drainage improvement in the Haraz River Plain in 1988. The draft final report has been submitted to the MOE in October, 1990.

In both studies above mentioned, the results concerned with irrigation are as follows;

(1) Water Requirement

The estimation of water requirement, which is the most basic element in irrigation planning, has been carried out according to "Irrigation and Drainage Paper (No. 24)" by FAO, and the procedure is acceptable.

The irrigation efficiencies applied in both studies are as follows;

Name of Crops	Water Resources	Ea	Ed	EP
Rice	Surface Water	0.90	0.78	0.70
		(0.90)	(0.75)	(0.675)
	Groundwater	0.90	0.95	0.86
		(0.95)	(0.95)	(0.90)

Note; Ea ; Field Application Efficiency
Ed ; Distribution Efficiency
Ep ; Overall Efficiency (Ep = Ea × Ed)
( ) ; Master Plan Study

According to the MOE report, the water requirement has been calculated as shown below, based on proposed cropping pattern;

- Surface water requirement; 11,588 m^3/ha
- Groundwater requirement; 9,433 m^3/ha

(2) Irrigation Method

According to the HWDP-I Study, the dominant irrigation methods are continuous irrigation and intermittent irrigation in the Project Area. For the selection of methods, an experiment was carried out in Amol Rice Research Station. However, a conclusion has not yet been reached.

This study principally follows continuous irrigation, but intermittent irrigation can be also achieved within some extent of canal capacity which is designed to meet the requirements for puddling.

3.8.3 Drainage System Improvement

Drainage has been studied by the Master Plan and the HWDP-I studies. The HWDP-I Study carried out a detailed survey for sub-surface drainage to the depth of the impermeable layers and the hydraulic conductivity of sub-surface layers. This F/S study follows the results of the HWDP-I study. For the surface drainage, the Cypress-Creek Formula has been applied after reviewing its applicability and experience in Iran.

Drainage factors of each study are as shown in Table below.

Summary on Drainage Factors by the Studies

Drainage Factors	M/P Study	HWDP-I Study	This F/S Study
Design Year			
Agricultural Drainage	1/10 yr	1/5 yr	1/10 yr
Maximum Capacity	1/10 yr	1/25 yr	1/25 yr
River Improvement			1/25 yr
Drainage Equation or Method			
Surface Drainage	Sequential Reservoir Model	Cypress-Creek Formula	Cypress-Creek Formula
1/5 yr	Analyzed on 1/10 yr only	$Q5=0.01196\ M^{5/6}(m^3/s)$	-
1/10 yr	Terminal Level 15 lit/sec/ha Canal Level 6.4-10 lit/sec/ha		$Q10=0.01542\ M^{5/6}(m^3/s)$
1/25 yr	-	$Q25=0.01636\ M^{5/6}(m^3/s)$	$Q25=0.01917\ M^{5/6}(m^3/s)$
Sub-surface Drainage	1) Hooghoudt 2) Don kirkham	1) Hooghoudt 2) Ernst 3) Ellipse	1) Modified Ellipse
Drainage Rate	2.9 mm/day	5.45 mm/day	2.2 mm/day (0.8 mm/day in the case with Farming Drainage)
Drainage Criteria			
Surface Drainage	24 hours	2 days	2 days
Sub-surface Drainage	one month	2 days	5 days
Rain Gauge Station	Babolsor	Larim	Babolsar
Depth of Drainage Canal			
Terminal Ditches (4th, 5th)	1.2 m	1.2 m	0.6 m(Well drained area) 1.0 m(Poorly drained area)
Tertiary Drainage Canal	-	2.4 m~	1.5 m~
Secondary Drainage Canal	-	2.4 m~	1.5 m~
Depth of Tile Drains	1.0 m	1.7 m	0.9 m~

Note M: Drainage Area (ha)

3.8.4 Surface Water Development

In relation to surface water resources development plan, the following existing studies have been reviewed in this study:

- HWDP-I study
  1) Low flow runoff analysis (A-2)
  2) Water resources development plan (B-9)

- M/P study
  1) Low flow runoff analysis (Appendix A-2)
  2) Water resources development plan (Appendix B-1)

(1) Low Flow Runoff Analysis

M/P and HWDP-I studies have used monthly discharge data in related rivers as shown in Table 3. 8 - 1.

1) Low Flow Runoff Analysis of the Haraz River

Both studies have used the same data on monthly basis which have same accuracy. However, revision of data was not given in M/P study for adjusting the effects on river flow by the Lar dam, therefore data used by M/P study were slightly lower than adjusted flow data. Correlation coefficients of interpolation by HWDP-I study are more or less 0.8 so that accuracy of interpolation is justified to be high.

Therefore, it is suggested to use the monthly runoff data by HWDP-I study for the Haraz river.

2) Low Flow Runoff Analysis of the Babol River

Since this study does not aim to study water resources of the Babol River and interpolation accuracy by HWDP-I study is sufficiently high, this study will use the monthly runoff data of HWDP-I as general hydrological information about the Babol river.

3) Low Flow Runoff Analysis of the Tributaries of the Babol River

M/P study has not used any data of the tributaries such as the Kela Rud and the Sajjad Rud rivers, because no recorded data has been given by M/P study. This data is very important for studying water resources and floods of the new expansion area and the Garma Rud river.

HWDP-I study interpolated and extended that data by appropriate data of adjacent stations. However, its accuracy is not sufficiently high. Furthermore, extended data length is less than 10 years, such length is not sufficiently long for the study. Consequently, this F/S study conducted a study on the relationship between runoff and rainfall for the Kela Rud and Sajjad Rud river.

(2) Water Resources Development Plan

Table 3. 8 - 2 shows the result of a comparison between M/P study, HWDP-I study and this study on water resources development plan. HWDP-I study can be summarized as below:

- Possible quantity of groundwater is quite high.
- Including new expansion area (DII (1)) into irrigable area.
- Irrigation area is large, because irrigation is given to other crops than rice.

As a distinctive peculiarity of this study, return-flow is considered as one water resource in the Project Area.

3. 8. 5 Groundwater Development

A number of investigations and evaluation studies of groundwater resources has been conducted for treating the future water demand in this region. As the representative suggestion for these, three articles, which are reported in the (a) M/P report prepared by JICA (in Master Plan of Caspian Sea Coastal Area Agriculture Development Project), (b) HWDP-I report and (c) Quantitative and qualitative mathematical investigation report prepared by the Mahab Godss Consulting Engineers (in Hydrogeological Study on Babol-Talar-Haraz River Plains) are taken up. Table 3. 8 - 3 shows the results of groundwater balance by above studies.

A considerable difference apparent between the two studies as shown in Table 3. 8 - 3, especially in the estimation of the feasible amount from groundwater resource. For instance, a feasible amount shows to be about 345 MCM in the report of HWDP-I, while only 137 MCM (112.2 MCM + 24.6 MCM in an irrigation period) is in the M/P Report.

The feasible amount of 137 MCM/year by M/P report was based upon the actual groundwater utilization when the hydrological balance already reached a critical condition. On the other hand, the amount of 345 MCM/year was assumed on a condition that its hydrological balance has a room to exploit groundwater more. Its practical application was done by the Weighed Ground Water Mathematical Model and the results of the respective items were as follows;

- Groundwater draft from wells at present	239.62MCM/y
- Development amount due to groundwater management	105.40MCM/y
- 60% of evaporation from aquifer	17.30MCM/y
- 60% of drainage to the out of area	23.60MCM/y
- 60% of spring discharge	41.50MCM/y
- Extra groundwater draft	23.00MCM/y
- Total exploitable amount	345.02MCM/y

Nowadays, these differences have arisen as a large obstacle for considering or planning the agricultural development program as well as that of other purposes in this region. In this F/S Study, the groundwater development of shallow aquifers is considered to reach already to the feasible amount in 1991, because the dynamic groundwater table was positioned below the sea level in the coastal area in said year.

3.8.6 Irrigation and Drainage Facilities Development

(1) Irrigation and Drainage Facilities Development Plan by MOE

The MOE formulated the development plan, in which the Project Area is covered, aiming at the stable supply of irrigation water and the elimination of the inundation damages during the rainy season. The salient features of the major facilities planned by the MOE in the Project Area are as follows (refer to Table 3.8 - 4):

- The Haraz and the Amol diversion dams are constructed on the Haraz river which runs in the center of the Project Area.
- Main canals are planned on both sides of these diversion dams.

- As for the secondary canals, the existing canals are planned to be utilized in most cases by linking them to the main canals. In some areas, however, new secondary canals are proposed as required.
- The Kari Rud, whose diversion site is located in the upper reach of the Haraz diversion dam, is planned to be connected to the above facilities for its effective utilization.
- The canals, which divert directly from the Haraz and the Alesh rivers, are utilized effectively in the planning.
- The main drains are to be constructed parallel to the Amol East and West Main Canals. In addition to this, the improvement of the main drainage canals in the low land is also proposed in order to eliminate the inundation damages.

1) Diversion Dam

- The Haraz diversion dam (HDD) is planned to command the irrigation area of about 44,000 ha, and its site is located in the upper reach of the Haraz river. On the other hand, the Amol diversion dam (ADD) has the irrigation area of about 36,000 ha, and its location is in the middle reach of the Haraz river.
- The Haraz diversion dam is almost completed.
- The construction site of the Amol diversion dam is planned in the downstream of the Haraz diversion dam with the distance of about 12 km, however, the implementation plan of this dam is not yet decided. The construction of this dam is judged to begin after the irrigation and drainage development plan of the area is completed.

2) Main Canal

- The Haraz East Main Canal (HEMC) is almost completed on the right bank of the Haraz diversion dam, while the Haraz West Main Canal (HWMC) on the left bank.
- The Amol East Main Canal (AEMC) is planed on the right bank of the Amol diversion dam, while the Amol West Main Canal (AWMC) on the left bank.
- As for the canal structures of the main irrigation canal, a thin concrete lining is adopted for the gentle longitudinal slope portions, on the other hand, a reinforced concrete flume for the steep slope