CHAPTER 4 : THE PROJECT

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4.1 OBJECTIVES OF THE PROJECT

This Project is recognized as the model agricultural development project for other future development projects in Romania under its new social and economic systems. The Project Area has high potentials for agricultural production owing to the favorable natural conditions such as climate, topography and soil. However, the yield of crops has been largely fluctuated by the meteorological conditions especially rainfall because of no irrigation systems. The farmers in the area have strong expectation for the introduction of the irrigation system in order to achieve the stable agricultural production. On the other hand, the anxiety of the farmers to the new social and economic systems might be one of the causes of stagnation of the agricultural production in the area.

With the improvement of the constraints to agriculture mentioned above, the Project aims to increase the crop production in compliance with the Government policy objectives, to show the farmers the direction of farming by stabilizing the farming conditions and increasing the agricultural productivity and to promote the stable life of the people by activating the regional economy through improvement of living standard of the farmers.

In order to attain the objectives of the Project, the following plans are proposed:

- Sustainable farm production through the year by introducing the irrigation system;
- Improvement of land productivity by the effective use of land and water resources;
- Production of high value-added crops, establishment of marketing system and improvement of agro-industries suitable for the free-marketing system;
- Organization for the operation of the irrigation facilities to be introduced and farming; and
- Consideration of intention of the individual farmers in planning the above.

4.2 PROJECT FORMULATION

4.2.1 Basic Concepts in Project Formulation

(1) Water Resources

The water resources development plan for the Siret-Ialomita Agricultural Development Project by MoE seems to be reasonable in general. Therefore, the irrigation plan in the Project is prepared on condition that the irrigation water necessary for the Project is available without any shortage from the completed Calimanesti Dam.

(2) Planning of Project Facilities

The Irrigation Facilities to be covered by the Project are planned on the following conditions:

a) Some of the irrigation facilities of the Project including canals, pipelines, pump stations, etc. are now under construction by MAF. Therefore, the facility planning of the Project are made for the remaining works as of December 1994.

b) The Main Canal has been completed up to the intake of the Distribution Pump Station (SRP V) located at the 5.3 km point from the intake by MoE with the Romanian own fund. It is recommended that the remaining construction works of the Main Canal which is still under progress be completed up to 32 km from the intake, the end of the Main Canal for the

Project, as soon as possible by MoE. However, the remaining portion of the construction works in connection with the Main Canal are included in the facility planning of the Project due to uncertainty of the construction schedule of the Main Canal by MoE.

(3) Design Conditions of the Project Works

The design conditions for the Project Works adopted by MAF are also generally applied in the formulation of the Project in consideration of the past ample experiences on the irrigation farming for a long time in Romania and the economy of the Project. The modifications and/or changes of the existing design of the Project Works are made in consideration of maximum utilization of the facilities already completed at the site, if any.

(4) Irrigation in Vineyard

The irrigation system is introduced to a part of the objective vineyards, excluding the ones where the troublesome soil erosion may occur due to the comparatively steep slope of land and the height of land from the Main Canal is higher than the economical water-lift tentatively adopted, in consideration of the results of research and investigation made by the Government organizations concerned, the existing data and information available and the probable big damages for the grapevine in the severely drought year.

(5) Change of Vineyard to Arable Land

The present vineyards scattered in the irrigation development area with small blocks are to be chaged to the ordinary arable land in consideration of efficiency of land use and profitability of farming, which corresponds with the actual trend of the land use at the site.

(6) Existing Putna Canal System

The area within the Irrigation Study Area which are benefited by the existing Putna Canal System at present are converted to the beneficial area of the proposed new irrigation system. However, the Putna Canal System is kept as it is in consideration of the existence of the beneficial area of the System outside of the Project Area and the emergency supplemental use of the water of the System for the Project beneficial area.

(7) Future Farming System

The proposed agricultural development plan is prepared on condition that most of the individual small-scale farmers in the Project Area organize some associations, which meets the policy of the Government of Romania, even though some of them still continue their farming individually (about 10% of the present individual farmers have intention to continue their farming individually according to the interview made by the Study Team).

(8) Soil Conservation Works

The countermeasures for soil conservation in the Project are planned only in the case that the probable soil erosion may directly damage the Irrigation Area to be developed through the Project implementation in consideration of the main objective of the Project. Other soil conservation works which are necessary for the stability of the area but do not have direct connection with the stability of the Irrigation Study Area will be considered as the future project to be executed with other financial sources.

(9) Cropping Pattern

The proposed crops and cropping patterns will be prepared in general based on the crops and cropping pattern presently adopted by the farmers in the Project Area and those proposed in the existing plan prepared by MAF, in consideration of the farmers' self-sufficiency of foods, food

demand in the area, technical level of the farmers in farming practices, sustainability of farming, environmental preservation through farming, present conditions of marketing and financial supporting systems, expansion of livestock in the near future, etc.. Furthermore, mechanization of farming shall be further expanded in consideration of the present farming practices, climatic conditions in the area, the size of the farm fields, etc..

(10) Marketing System

The establishment and/or improvement of the marketing system will be included in the Project as much as possible in addition to the establishment of the irrigation system, because of an efficient marketing system being very important for the success of an agricultural development project.

(11) Agro-industries

In general, the improvement of the existing factories only will be considered in the Project in consideration of the present sufficient capacities of these factories even after the implementation of the Project.

(12) Agricultural Credit

The financial supporting is one of the most important factors for the improvement of the farming conditions of the small and medium-scale farmers. And the improvement of the agricultural credit system is considered as one of the main themes in the Project formulation.

4.2.2 Presently Proposed Irrigation Plan

(1) Irrigation Plan

1) Natural Conditions of the Project Area

The Project Area about 23,900 ha is located in the northern end of the Siret Plain with the elevation at approx. EL. 70 m in the east and EL. 180 m in the west.

Climate of the Study Area can be summarized as follows:
- the annual average temperature in Focsani is 10.4 °C:
- the mean annual precipitation in Focsani is 540 mm and the total rainfall during irrigation period, between April and September, occupies 61 % of the annual precipitation;
- the maximum deficiency between precipitation and evapotranspiration appears in July and August
- north-west winds are dominant through the year, the average wind speed ranges between 4.6 m/s and 6.2 m/s, but the calm days during the irrigation period is 40.3 % at Adjud Station;
- the first and last frost day are the middle of October and early April, respectively, and
- annual average number of days of snowfall and snow coverage are 15 to 25, and the maximum thickness of snowfall is 30 to 40 cm in Focsani.

Most of the Project Area covered by chernozems, gray soils and brown soils, and the land is classified as Class I or II. the groundwater level is mostly low with 10 to 20 m depth from the ground having no influence on the irrigation.

2) Irrigation Plan

Most of the irrigation water is supplied by pumping from the main canal led from the Calimanesti Dam, which is located at the northeastern border of the Project Area in the Siret River. Two main pumping stations (SRP-V and SRP-IX) and seven (7) booster pump stations

(SPP-11, -20, -20A, -21, -26, --27 and -28A) pump up water from the main canal. While SRP-1A and SPP-10 are directly taking out the water from the Calimansti Dam.

As shown in **Fig 4.2.2-A3**, the irrigation water lifted by pumps with three steps; the first is pumping water from the main canals to the first terrace distribution canals (CD-1, -4, -7 and -11) running along contour line of EL.110 to 120 m, the second is pumping up from the first terrace distribution canals to the second terrace distribution canals (CD-2, -5, -8A and -8) running along the contour line at EL.130 to 140 m by re-pumping stations, and the third is pumping water from the second terrace distribution canals to the third terrace distribution canals (CD-3, -6, -6A, -9 and -10).

Water level control gates are installed in distribution canals so that the distribution canals can function the water storrage (farm ponds) for booster pumps operation.

(2) Water Requirement

1) Evapotranspiration (ETo)

According to the design standard of Romania, the evapotranspiration is estimated by the Thornwaite Method. According to the 30 years meteorological data at Adjud or Focsani stations, the evapotranspiration during irrigation period are estimated as follows:

(Unit : mm/day)

	Apr.	May	Jun.	Jul.	Aug.	Sep.
Penman Method	3.61	5.00	6.22	6.62	5.82	3.73
Blaney-Criddle Method	3.14	4.85	5.76	6.95	6.28	4.46
Thornwaite Method	1.72	3.22	4.31	4.63	4.18	2.79

2) Crop Water Requirement

Based on the estimated evapotranspiration, crop coefficients, precipitation and soil water holding characteristics, the monthly crop water requirement were estimated at the assuarance 80% and 50%. The result of 80% asurance at 1,200 m^3/month/ha was applied as a net water requirment at the field.

3) Irrigation Water Requirement

According to the existing plan of the Project and pump operation conditions described below, the peak field water requirement under 20 hr/day booster pump operation was estimated at 0.579 lit./s, and intake pump capacity under 24 hr/day. operation was 0.612 lit./s.

(3) Irrigation Efficiency

The existing irrigation plan, the field irrigation efficiency conveyance efficiency for booster pumps and distribution pipes are estimated at 90% and 95%, respectively. And the conveyance efficiency for canals and intakes is estimated at 92%.

(4) Irrigation Time

In the farm field where the sprinkler irrigation is adopted, the following system has been practiced for many years in Romania as a result of the technical and economic studies, field trial operations, etc.:

A. Operation (an example):

a. Sprinkling in an unit	:	10 hr. (7:00 -17:00)
b. Break for transferring lateral lines etc.	:	2 hr (17:00 -19:00)
c. Sprinkling in the next unit	:	10 hr. (19:00 - 5:00 of the next day)
d. Break for transferring lateral lines etc.	:	2 hr. (5:00 - 7:00)
e. Continuing to the third unit	:	10 hr. (7:00 -17:00)

Note: Two units are irrigated in a day

B. Operator's assignment with three shifts of working:

a. 1st shift	:	7:00 -15:00
b. 2nd shift	:	15:00 -23:00
c. 3rd shift	:	23:00 - 7:00 of the next day

In consideration of the experience for the operation and maintenance of the irrigation facilities for a long time, the same operation system may also be adopted in the Project. In this case, the control, operation and maintenance of a booster pump station (SPP) covering an irrigation block and the field operation works (like valve operation) shall be managed by a control unit to be newly organized for the respective irrigation blocks in the Project Area or by the existing control organization which may have to be reorganized according to the respective requirements. On the other hand, disconnecting, shifting and reconnecting of the lateral lines shall be done by the farmers themselves. The similar procedures have already been practiced for many years in Romania.

Furthermore, in the proposed operation system, the Distribution Canals (Branch and Tertiary Canals) will work as a kind of farm ponds and cope with the minor change or modification of pump operation at the end of the system. On the other hand, the change of the lateral lines from the portable ones to the fixed ones shall be considered in the future in line with the improvement of the living standards of the farmers in the Project Area.

(5) Interval of Irrigation

The interval of irrigation proposed in the Project is 12 days in consideration of such natural conditions as climate (temperature, humidity, wind, rainfall, sunshine and cloudiness, evaporation, etc.), soil (depth of top soil, texture, EC, moisture, etc.), topography and the size of an irrigation block to be controlled by a booster pump station. In due consideration of the site conditions, it is judged that the irrigation interval of 12 days is reasonable and that it shall be adopted in the Project.

(6) Size of One Rotation Block

The sprinkler planned for the Project, also it is normally adopted in irrigation project in Romania, is under the following specifications:

- nozzle size	: diameter 7 mm
- operation pressure	: 2.5 kgf/cm^2
- unit discharge	: 2.61 m^3/hr.
- effective diameter	: 33 m

Based on the above specification, the space of lateral lines of 24 m is widely adopted in Romania at present. On the other hand, the length of lateral lines varies from 250 m to 400 m in accordance with the topographical and administrative conditions in the respective project areas. If there are no negative conditions, the standard maximum length of 400 m is adopted in consideration of economy of the facilities. The length of lateral lines adopted in the Project is from 300 to 400 m. The lateral pipes applied in the Project is pre-stressed pipes, asbestos pipes and PVC piles depending on the water pressures.

(7) Size of One Irrigation Block

The Project Area is divided into the 49 irrigation blocks as shown in **Table 4.2.1-A1, Figs 4.2.2-A1** and **A2** considering the following conditions. The size of one rotation block of the sprinkler irrigation system is set based on the size of one sprinkler unit and the interval of irrigation as follows:

S x L x I x T

where; S : Space of Lateral line (standard : 24 m)
L : Length of Lateral line (standard max. : 400 m)
I : Interval of Irrigation (standard : 10-15 days , 12 days in the Project)
T : Number of Times of Irrigation (standard : 2 times / day)

The size of one irrigation block is set based on the size of the rotation block mentioned above, the topography of the area and administration boundary of the area in consideration of the past O & M experiences in similar projects. In Romania, the size of approx. 300 - 3,000 ha has been selected as that of one irrigation block. And in the Project proposed by the MAF, the size of the irrigation blocks is in the range between 69 ha in the minimum to 1,255 ha in the maximum (average : 488 ha). Therefore, the size of the irrigation blocks set in the Project is judged to be reasonable.

(8) Control System

In the Project, the water-level control systems are planned to be introduced to the distribution (lift) pump stations (SRP) and the booster pump stations (SPP) independently.

(9) Rearrangement of Farm Land

The land ownership within the Irrigation Area is both private and state, with a total number of more than 3,000 of land owners being divided into 3 groups (which are sub-divided into 6 categories of land tenure), and scattered in the Area at random. A grouping and rearrangement of these farm lands in accordance with the irrigation pipeline network to be constructed in the Irrigation Area is definitely necessary for an efficient operation of sprinkler irrigation and the success of the Project accordingly. This matter is now under consideration by MAF (**Fig 4.2.2-A4**).

(10) Facility Planning

According to the existing plan of the Project, the following facilities have been planned and their design has also been completed:

- Pumping stations			59 units
Main pumping stations (SRP)		10 units	
Main canal	2 units		
Calimanesti Dam (the Siret River)	1 unit		
Distribution canals	7 units		
Booster pumping stations (SPP)		49 units	
Main canal	7 units		
Calimanesti Dam (the Siret River)	1 unit		
Distribution canals	41 units		
- Distribution canals			11 lines (74.9 km)
For the first terrace	4 lines (30.7 km)		
For the second terrace	3 lines (26.7 km)		
For the third terrace	4 lines (17.4km)		

- Pen stock ---------- 10 lines
  - For the first terrace 3 lines
  - For the second terrace 3 lines
  - For the third terrace 4 lines

4.2.3 Present Condition of the Constructed Project Works

The general plan of the existing design of the Project is as shown in **Fig 4.2.2-A1**. The construction works of the Project facilities have been executed by two Ministries in parallel, namely; a) Calimanesti dam, Intake and Main Canal by MoE and b) the irrigation facilities such as SRP, CD, SPP, CP, A and hydrants for the sprinkler units by MAF. The detailed design of the irrigation facilities has already been completed and the construction works are now on-going. Administrative flowchart of the Project implementation is as follows:

a) Planning: MAF
b) Design: ISPIF-SA
c) Construction works: SC ZBOINA-SA, etc.
d) Operation and Maintenance: RAIF-Vrancea

The progress of the construction works of the Project facilities as of August 15, 1994 is shown in **Fig 4.2.3-A1**.

(1) Calimanesti Dam, Intake and Main Canal

The overall works of the Dam and Intake have already been completed remaining some finishing works. On the other hand, 5.5 km section of the Main Canal from the Intake out of total length of the Main Canal for Phase I of the Siret-Ialomita Agricultural Development Project of about 32 km (up to 0.3 km downstream SRP V) have already been completed. Moreover, about 80 % of excavation of the remaining sections of the Main Canal and several crossing works have also already been completed. The construction works are still on-going.

1) Calimanesti Dam

The Calimanesti dam is a part of the series of dams constructed on the Siret River to maximum utilize the water resources of the Siret River. The purposes of the dam is to store the water for the hydro-power, irrigation of 500,000 ha of the Siret Ialomita Agricultural Development Area and flood control. The Project pumps-up the water from the reservoir at 2 pumping stations (SRP-IA, SPP10) and irrigates 1,709 ha at maximum discharge 1.193 m^3/s.

Major dimensions of the Dam are shown as follows:

- Dam
  - type of dam : Gate controlled earth dam
  - dam height : 22.5 m
  - crest elevation : 32.36 amswl
  - length of embankment : 10.475 km
  - type of embankment material : (refer **Fig 4.2.3-A2**)
  - slope of the embankment : 1 : 2.5
  - volume of embankment : 2.5 X 10^6 m^3
- Spillway
  - type of control : gate controlled
  - catchment area : 145,000 km^2
  - design discharge : 7,008 m^3/s (1/1,000 probability)
- Reservoir (refer to H-Q and H-A curves in **Fig 4.2.3-A3**)
  - highest water level : 77.0 m (with storage 60 X 10^6 m^3)
  - full water level : 75.0 m (with storage 44.27 X 10^6 m^3)

water surface area : 18 km2
- Hydro-power Plant
maximum generation capacity : 6 MWH (planned)

2) Siret-Baragan Canal

The Project pumps up the water from the Canal at 2 main pumping stations (SRP-V and IX) and 7 booster pumping stations (SPP-11, 20A, 20, 21, 26, 28A and 27) covering 20,651 ha which is almost 92% of total Project Area at the maximum discharge of 12.544 m^3/s. The design of the canal has been almost completed by AQUA PROIECT under the MoE. As the first stage construction, the construction of the intake structure, canal and related structures was commenced in 1990. 5.5 km of the canal with intake structure has been completed and the test operation of the intake gate was made in September 1994. The remaining part of Phase 1 construction of the Canal are under construction part by part, such as the Putna siphon and road/railway crossing structures, but the definite date of the completion is not clear.

The canal has the maximum flow capacity of 200 m^3/s, and it is planned to connect with the Danube River on the way collecting water from Prisaca Dam in the Putna basin (30 m^3/s) and Surduc and Siriu dams in the Buzau basin (110 m^3/s). Longitudinal Profile and the standard cross section of the Canal are shown in **Figs 4.2.3-A4** and **A5**.

(2) Pump Stations

1) Distribution Pump Stations (SRP)

Ten (10) SRP are planned as shown in **Fig 4.2.2-A1**. SRP V and SRP IX are located at the Main Canal and SRP IA are located at the Siret River, while others are located inside the service areas along CD.

The planned pump type are of horizontal single stage, double suction, volute pump (NDS/RDN), horizontal single stage, mixed flow pump (BRATES) and vertical multi stage, mixed flow pump (MV/MA), depending upon their design discharge and total head as shown in **Table 4.2.2-A2**. SRP V and IX only have both pump house and control house, but others have only control house and pumps/motors are installed in the open air. The construction works of five (5) of the total number of SRP have been almost completed. The progress of the construction works of these pump stations are shown in **Table 4.2.3-A1**.

The following recommendations/advice will be made on already built SRP based upon the site investigation by the Study Team:

a) Check on roller bearing, rubber rings, etc. for both pumps and motors shall be carried out before test operation, because almost five (5) years have passed without operation since the completion of them;
b) Anti-corrosive measures such as painting shall be carried out for the exposed steel pipes as soon as possible; and
c) Repairing works and some final touches are required for the damaged portions of structures and buildings.

2) Booster Pump Stations (SPP)

Forty nine (49) SPP are planned as shown in **Fig 4.2.2-A1**. SPP 10 is located at the upstream the Calimanesti dam and SPP 11 / SPP 20 / SPP 20A / SPP 21 / SPP 26 / SPP 27 are located at the Main Canal. Others are located inside the service areas along CD.

Pumps are designed with type of horizontal single stage, double suction volute pump (RDN), horizontal single stage, single suction volute pump (NC and AN), vertical multistage mixed flow pump (MV and MA), depending upon their design discharge and total head as shown in

Table 4.2.2-A2. All SPP have only control house, and pumps/motors are installed in the open air.

The construction works of ten (10) of the total number of SPP have been almost completed and the progress of the construction works of these pump stations are shown in **Table 4.2.3-A1**. Same recommendations/advice will be made on already built SPP.

3) Drainage Pump Stations (SPE)

Two(2) SPE are planned at the plot 3A in the north eastern part of the service area due to the construction of river dike for the Calimanesti dam. However, no design work has been carried out.

(3) Distribution Canals (CD)

Thirteen (13) CD are planned as shown in **Fig 4.2.2-A1**. The total design length of CD is about 74.9 km. The construction works of eight (8) of the total number of CD have been executing except for CD11 which has been already completed. The progress of the construction works of these canals are as shown in **Table 4.2.3-A2**.

(4) Distribution and Sub-Distribution Pipelines (CP and A)

The general layout of CP and A for forty three (43) irrigation sectors prepared by MAF is as shown in **Fig 4.2.2-A1**. The total length of CP and A is approx. 485 km. The construction works of CP and A for sixteen (16) out of forty three (43) irrigation sectors have been already started. Five (5) irrigation sectors out of 16 irrigation sectors No 10, 11, 25, 25A and 28, have been mostly completed. The progress of the construction works is shown in **Table 4.2.3-A3.**

4.3 PROPOSED AGRICULTURAL DEVELOPMENT PLAN

4.3.1 Land Use Plan

The land use plan for ISA has been prepared in accordance with the results of the Land Classification based on the analysis of soil characteristics, trend of the land use and in consideration of the present land use. The following are the main features in the land use planning:

(a) Use as arable land but without irrigation is planned for some areas of the present arable land due to the topographical and pedological constraints of the land and in consideration of the proposed reservoir bank of the Calimanesti Dam.

(b) Continuous use as pasture without irrigation is planned for the present pasture.

(c) Use as vineyard without irrigation is planned for some areas of the present vineyard in consideration of the height of land from the Main Canal and probable troublesome soil erosion due to comparatively steep slope of land.

(d) Use as arable land with irrigation is planned for some areas of the present vineyard by changing their land use in consideration of effective land use of the areas and profitability of farming in respective areas.

On the other hand, any development plans for SCSA are not considered in compliance with the objectives of the Study. Therefore, the present land use of SCSA is fixed in the Project.
The hectareage of the planned areas of respective land uses in ISA is summarized below and the distribution of the respective areas are shown in **Fig 4.3.1-A1**.

Present			Plan		
Land Use		Area (ha)	Land Use		Area (ha)
Agricultural Land	Arable Land *	20,850	*Arable w/ Irrigation*		*18,780*
			Arable w/o Irrigation	(a)	2,070
	Pasture	500	Pasture w/o Irrigation	(b)	500
	Vineyard	5,830	*Vineyard w/ Irrigation*		*2,600*
			Vineyard w/o Irrigation	(c)	1,790
			Arable w/ Irrigation	*(d)*	*1,440*
	Sub-total	27,180	Sub-total		27,180
Non-agricultural Land **		1,720	Non-agricultural Land		1,720
Total		28,900	Total		28,900

Note: w/: with , w/o: without

* The arable land includes the meadow of 20 ha.

** This area includes the urban areas, river courses, etc..

Based on the above results, the area of 24,150 ha consisting of the arable land and vineyard to be irrigated with the Project (22,820 ha), pasture (500 ha) and non-agricultural land such as urban areas and small streams (830 ha) has been selected as the Project Area which is divided into 5 zones by the rivers flowing through the area east to west direction as shown in **Fig 4.3.1-A1**.

Land Use	Present (ha)			Plan (ha)		
	Gross	Net *		Gross	Net *	
Arable	18,780	18,590	w/o irri.	20,220	19,810	w/ irri.
Vineyard	4,040	4,000	w/o irri.	2,600	2,550	w/ irri.
Sub-total	22,820	22,590		22,820	22,360	
Pasture	500	500	w/o irri.	500	500	w/o irri.
Non-agricultural	830	1,060		830	1,290	
Total	24,150	24,150		24,150	24,150	

* The net cultivated area of the present agricultural land is set as 99% of its gross area in consideration of existing small streams/gullies, public and farm roads, etc. in the area. On the other hand, that of the planned irrigation development area is set as 98% of the gross area considering the planned Branch Canals with maintenance roads, farm roads, catch drains against soil erosion, etc. in addition to the present conditions.

4.3.2 Farming Plan

(1) Basic Strategy

To show the direction of farming to a large number of small-scale private farmers who have appeared after the revolution is not only an urgent subject for the Romanian agriculture but also a social problem in this country. From such a point of view, the proposed farming plan focuses on a financial independence of the small-scale farmers in the Project Area and aims at a sustainable and profitable agriculture with careful consideration on environment by the introduction of vegetables, which is the most profitable cash crops for a small-scale irrigation farming, into the proposed basic combination farming of "cereal crops, leguminous crop and livestock".

That is;

(a) Cereal crops (maize, wheat and barley) are the staple food and are also used as feedstuff for livestock. As these crops produce a lot of organic matter which returns to soil, it is possible to raise healthy and illnessless crops with the fertile and physically improved soil by application of the organic matter. Furthermore, a rapid and large change of the present production amounts of main crops in the Project Area should be avoided in order to secure the amounts of staple food, feedstuff and industrial materials presently required.

(b) Leguminous crop (bushbean or soybean) is introduced in order to provide feedstuff (seeds and whole crop at ripening stage for silo) as well as food and industrial materials. They contribute to the maintenance of soil fertility through their nitrogen fixation of about 150 kg/ha/year. Moreover, they control the growth of weed by covering the soil surface with their broad leaves. Consequently, less use of chemical fertilizer and herbicide can be realized.

(c) Livestock production is expected to increase in the near future as a main protein resource for the Romanian nation. The barnyard manure produced from the excretions of livestock increases soil fertility and improves the physical condition of soil, which makes possible to perform a sustainable agriculture.

(d) Vegetable cultivation is the most profitable irrigation farming. Though it requires intensive farming, it is suitable for the small-scale farmers because of the high profit per unit area. Although the vegetable cultivation requires also fertile soil with high moisture holding ability and well drainage ability, it is possible to supply such soil and maintein it by performing the combined farming of "cereal crops, leguminous crop and livestock".

As mentioned above, the farming with introducing vegetables into the combined cultivation of "cereal crops, leguminous crop and livestock" can realize a sustainable and profitable agriculture with careful consideration on environment by the application of less amounts of fertilizer and agricultural chemicals, because of such farming maintains fertile soil and raises healthy crops.

Regarding the market for vegetables, there are 3 main markets around the Project Area; Focsani with 100,000 in population, Buzau with 150,000 located 100 km south of the Project Area and Bacau with 200,000 150 km north. In Bacau, cabbage, tomato, egg plant, green pepper, water melon and melon are promising (SCPL, Bacau). In connection with the market in Bucharest, it is considered that there will be competition with the advanced vegetable production areas on the outskirts of Bucharest and also in the Danube basin located at the southern part of the country in addition to the disadvantage that the market is located at 270 km far from the Project Area. However, the quality of vegetables presently sold at the markets in Bucharest is not good. Furthermore, it is reported that the considerable pollution of groundwater is severely progressing in the Danube basin.

In such situations, it is considered that the production of high quality vegetables with organic fertilizer, non or less application of chemical fertilizers and agricultural chemicals will be able to compete with the vegetables in those areas. The proposed combined farming of "cereal crops, leguminous crop and livestock" makes it possible to produce such high-quality vegetables.

Besides, there exists a food processing factory, SC CONTEC SA, in Tecuci, Galati District, where 45,000 ton of tomato, 10,000 to 15,000 ton of other vegetables and 2,500 to 3,000 ton of fruits are processed per year. At present, only 40% of the processing capacity are utilized. So that, it is also possible to supply the vegetables produced in the Project Area to this factory.

There are 5 commercial companies (SCM) in 100 samples for the hearing survey carried out by the Study Team. The average farming scale is 727 ha. In such large-scale farms, the cultivation of such crops as wheat, sunflower and sugar beet which require less labour force per unit area is suitable. It is, therefore, considered that the individual farmers and the associated farmers who have much agricultural labour force in their farming units compared with SCM can coexist with SCM by performing such intensive agriculture.

It is proposed that this Project Area becomes a model area of the financially independent farming by small-scaled farmers with production of high-quality vegetables. To achieve this objective, necessary supporting systems such as producer's organization, facilities for collection and shipping of products, processing facilities, development of marketing, transportation system, equipment of agricultural machinery, maintenance and using system of

agricultural machinery, extension services of technology, collection system of information and propaganda activity are to be established. Furthermore, an establishment of a mass-production center for virus-free vegetable seedlings with bio-technology can be considered for the production of high-quality vegetables with mechanization as a future plan.

(2) Cropping Plan

Based on the above basic strategy, the cropping plan in the Project has been prepared in consideration of the following;

(a) To ensure the present production amounts of the main crops in the Project Area;
(b) Introduction of leguminous crop (bushbean or soybean) in order to maintain soil fertility and to produce feedstuff and cash crops;
(c) Introduction of vegetables as cash crops;
(d) Effective use of arable land; and
(e) Change of some of the present vineyard into the arable land in consideration of profitability of farming.

1) Area Required for Main Crops

a) Present Production Amount of Main Crops

The present production amount of main crops in the Project Area is estimated by multiplying the areas actually cultivated in 1992 with the average yields in the areas for 8 years from 1986 to 1993 as shown below (detailed breakdown is shown in **Table 4.3.2-A1**):

Crop	Wheat	Barley	Maize	Bean Seeds	Sun-flower	Sugar Beet
Production (ton)	6,656	1,886	34,825	26	1,011	1,911
Yield (ton/ha)	2.3	2.4	2.7	1.4	1.6	17.1

Crop	Potato	Vegetable	Annual Pasture	Grape	Perennial Pasture
Production (ton)	3,087	12,715	257	26,120	11,877
Yield (ton/ha)	12.8	16.7	13.5	6.5	23.8

b) Yield of Main Crops under Irrigation

The yields of main crops under irrigation in the Project Area and their increase rates compared with the present production have been determined based on the data obtained through 2 sources, that is, the data of the Romanian irrigation experiments carried out under different agroclimatic zones and the data obtained as the maximum yields in the Project Area for the past 8 years as shown below (detailed breakdown is shown in **Table 4.3.2-A5**):

Crop	Wheat	Barley	Maize	Sunflower	Sugar Beet	Potato	Grape
Yield (ton/ha)	3.4	3.6	4.5	2.3	30.5	21.3	8.9
Increase (%)	50	50	70	45	78	67	37

It should be noted that there is much difference on yields between the actual farmers' fields and the experimental fields, as a sample in Constanta District, as shown in **Table 4.3.2-A6**.

Increase of Yield Estimated based on Data of Experiment

Th increase ratios of crop yields under irrigation estimated based on the data collected from the Romanian irrigation experiments located at the different agro-climatic zones are as follows (the details are shown in **Tables 4.3.2-A2** and **-A3** also **Fig 4.3.2-A1**):

Crop	Wheat	Maize	Sunflower	Sugar Beet	Soybean	Potato	Maize-for-Silo
Increase(%)	53.8	75.8	54.9	87.6	78.3	67.1	125.1

In the above esimation, the average of data representing those of the agroclimatic zones I and II are used due to the Project Area being located around the boundery of zones I and II. Furthermore, the increase ratio of yields between the yield under unirrigated condition and the one under irrigated condition at the same farm, not the yield itself, is adopted, because the yields at the experimental farms are too much higher than those of the Project Area even under the same condition. On the other hand, the increase ratio of yield of grape differs largely depending on viriety, location of farm, irrigation method, etc. In the estimation, 15.0 to 43.0% (for wine grape) are used.

Increase of Yield Estimated based on Data in the Project Area

The result of analysis of the crop production data in the Project Area for 8 years from 1986 to 1993 shows that the crop yields have high correlation with the rainfall during the growing period for respective crops (**Table 4.3.2-A4**). As the yield of each crop under irrigation, the average of the maximum yield at 19 towns/villages for 8 years is adopted as shown below:

Crop	Wheat	Barley	Maize	Sunflower	Sugar Beet	Grape
Increase(%)	45.9	45.9	65.6	34.6	69.1	36.6

c) Area Required for Producing the Present Production Amounts

From the above results, the area required for producing the present production amounts under irrigation and the percentage to the total irrigated arable land are calculated as shown below (the details are shown in **Table 4.3.2-A5**):

Crop	Wheat	Barley	Maize	Beans	Sun-flower	Sugar Beet	Potato	Vege-tables	Annual Pasture	Total
Area (ha)	1,958	520	7,698	11	436	63	145	305	11	11,145
Ratio (%)	9.9	2.6	38.9	0.1	2.2	0.3	0.7	1.5	0.1	56.3

Based on the above, the ratio to the total arable land of the proposed cropped areas under irrigation with the Project have been determined below. On the other hand, the areas for the vegetables have been determined in consideration of the newly developed areas for vegetables (the detailes are shown in **Table 4.3.2-A7**).

Crop	Wheat	Barley	Maize	Sunflower	Sugar Beet	Potato	Annual Pasture
Area (%)	12.0	3.0	45.0	2.5	0.5	1.0	0.1

2) Introduction of Leguminous Crop

It is planned in the Project to introduce leguminous crop in order to maintain soil fertility and produce feedstuff and cash crops for the area of 25% of the total irrigated arable land with the condition of 4-year crop rotation and shifting every year to the remaining new area. The leguminous crop to be introduced is bushbean or soybean. Assuming that the amount of nitrogen fixed by the beans is 150 kg/ha/year, around 40 kg/ha of nitrogen are fixed in soil per year.

3) Introduction of Vegetables

At present, sunflower, sugar beet, potato, cabbage, onion and tomato have been cultivated as cash crops. In the Project, cauliflower, cucumber, garlic, green pepper, egg plant and carrot, which have high marketability, storability and transportability are newly introduced in addition to the above presently cultivated cash crops. The total cropped area of vegetables including the

area of 2nd cropped area after wheat amounts to 22.9% of the total arable land. The cropped areas of cash crops by crop are as shown below (also refer to **Table 4.3.2-A7**):

Crop	Sun-flower	Sugar Beet	Potato	Cabbage and Cauliflower	Cucum-ber	Tomato	Carrot	Onion, Garlic, Green Pepper and Egg Plant	Total
Area (%)	2.5	0.5	1.0	5.5 each *	5.0 *	1.5	1.4	1.0 each	26.9

* including 4.0% for the succeeding crop of wheat

4) Effective Use of Arable Land

For the effective use of arable land, it is planned in the Project to introduce maize-for-silo as a succeeding crop of barley. As an ideal harvesting stage of maize-for-silo is yellow-ripe stage, maize is required to crop after barley which can be harvested at the middle of June. As the succeeding crop of wheat which is harvested at the middle of July, it is planned to introduce late-cabbage, late-cauliflower and late-cucumber, which can be harvested at the time from October to November when higher market price of them can be expected. It is also considered that in the case of introduction of bushbean in stead of soybean, late-cabbage, late-cauliflower and late-cucumber are introduced as a succeeding crop of bushbean. By utilizing the land as planned above, the use rate of land becomes 148%.

5) Change of the Existing Vineyard to Arable Land

For the reason that the grapevine tolerates to water stress, the grapevine has been widely planted in the Project Area. However, under the planned irrigation condition, it is considered that many of the existing vineyards in the Project Area will be changed to arable land from the view point of the profitability of farming for the arable land in consideration of the soil conditions, topography and present plantation scale. Therefore, all the vineyards in the proposed irrigated area except for the big plantation in Odobesti are planned in the Project to change to the arable land.

(3) Cropped Area and Cropping Time

The planned cropped area and cropping time in the arable land in the Project Area are shown in **Table 4.3.2-A7** and **Fig 4.3.2-A2**. The areas for respective crops are expressed in the rate to the total irrigated arable land. In the case of vegetables, the proposed plan shall be sifted to more profitable plans with the progress of grower's technology, the development of market and the improvement of transportation of the products.

(4) Crop Rotation System

The planned crop rotation system is shown in **Table 4.3.2-A8** and **Fig 4.3.2-A3**. In the plan, leguminous crop is always planted once 4 years in the same field, which contributes to the maintenance of soil fertility and also the control the growth of weed. The crop rotation system has 6 different cropping patterns. In these patterns, maize is cultivated continuously for 2 years in the same field but other crops are cultivated in the different fields every year except for a part of vegetable fields where the vegetables are cultivated continuously for 2 years as a succeeding crop of wheat.

(5) Agronomic Countermeasures against Soil Erosion

According to the soil conservation survey, there exist in the Project Area about 6,800 ha of slightly eroded arable land and 1,800 ha of moderately eroded area (**Table 4.5.2-A1**). As agronomic countermeasures against the soil erosion in such areas, it is recommended that for the slightly eroded areas, the field of maize where the erosion is raised easily and the field of other crops such as wheat, barley and soybean where erosion is comparatively suppressed be

alternately with a right angle to contourline by adopting contour strip-cropping method in each field.

Furthermore, for the moderately eroded areas, it is recommended that wheat, barley or legminous crop be introduced in the field in place of maize, or that alley cropping of maize and other crops along contourline be introduced in each field with a convenient planting width for the mechanical cultivation.

(6) Labour and Machinery Requirements

The labour force required for the performance of the proposed crop production plan has been estimated as shown in **Fig 4.3.2-A4**. The maximum labour requirement through a year appears at the middle of September with 174,042 men-days for 10 days. However, the necessary labour force can be supplied only from the labour source within the Project Area due to the available labour force within the Project Area being estimated at 19,000 men.

On the other hand, number of machines required for the practice of the above plan has been estimated to be 235 tractors (65 Hp), 125 disk plows, 72 disk harrows, 16 wheat/barley seeders, 59 maize/sunflower seeders, 8 bean seeders, 18 wheat/barley combine-harvesters (**Table 4.3.2-A9**), 89 maize combine-harvesters, 12 bean combine-harvesters and 5 sunflower combine-harvesters. These required numbers of machinery can be provided from the presently available numbers of machinery occupied by AGROMEC, ROMCEREAL and private suppliers in the Project Area except for the maize combine-harvesters. However, the maize combine-harvesters are not necessarily required, because the harvesting of maize is commonly being done by manual force.

4.3.3 Crop Production Plan

The production amounts of crops to be produced under irrigation with the Project and their increase ratios compared with those of the present condition are estimated based on the above cropping plan as shown below (**Table 4.3.3-A1**):

Crop	Production (ton)	Increase (%)	Crop	Production (ton)	Increase (%)
Wheat	8,080	21	Onion	4,358	68
Barley	2,154	14	Garlic	1,387	new crop
Maize	40,329	16	Green Pepper	4,358	new crop
Sunflower	1,148	14	Egg Plant	6,537	new crop
Sugar Beet	3,021	58	Carrot	10,526	new crop
Beans	10,897	new crop	Tomato	17,829	679
Potato	4,225	37	Annual Pasture	454	77
Maize for Silo	23,166	new crop	Perennial Pasture	11,877	0
Cabbage	64,257	2,489	Grape	22,812	-13 *
Cauliflower	23,268	new crop			
Cucumber	32,081	new crop	Total	292,764	

Note : * Due to the decrease of the cropped area because of change of vineyard to arable land

The total production amount of crops with the Project (292,764 ton) becomes nearly 3 times the present production amount (100,311 ton, see **Table 4.3.3-A2** and **A3**). The vegetables as cash crop occupy nearly 60% of the total production amount followed by cereal crop (17%), forage crop (12%), grape, leguminous crop and industrial crop. With the implementation of the Project, it is possible to shift from the present agriculture in which cereal crop (43%) and grape (26%) are the main crops to the profitable and sustainable agriculture in which the remarkable increase of income and maintenance of soil fertility can be expected (**Table 4.3.3-A4**).

(Unit : 10^6 Lei)

Crop	with Project				without Project			
	Gross Income	Cost	Net Income	Net Income (%)	Gross Income	Cost	Net Income	Net Income (%)
Cereals	7,790	4,660	3,130	3.8	6,660	2,781	3,879	28.4
Cash Crops w/o Vegetables	11,008	2,959	8,049	9.8	1,579	555	1,024	7.5
Vegetables	89,787	21,105	68,682	83.5	7,916	1,759	6,157	45.2
Forsge	810	337	473	0.6	106	52	54	0.4
Grapes	3,878	1,928	1,950	2.4	4,441	1,919	2,522	18.5
Total	113,273	30,989	82,284	100.0	20,702	7,066	13,636	100.0
Ratio (w : w/o)	547	439	603	-	100.0	100.0	100.0	-

4.3.4 Livestock Production Plan

The number of cattle breedable has been estimated based on the amount of feedstuff produced with the Project in accordance with the follows:

Crop	Produced Feedstuff (ton)	Required Feedstuff (kg/day/head)	No of Breedable Cattle (head/year)
Wheat	1,424	-	-
Barley	268	-	-
Maize	5,504	-	-
Total	7,196	3	6,572
Maize for Silo	23,166	-	-
Annual Pasture	197	-	-
Total	23,363	40	1,600

The amount of feedstuff is estimated by adding the amount of maize-for-silo which is newly introduced in the Project to the difference between the production amounts "with Project" and "at present" for wheat, barley, maize and annual pasture. The amounts of feedstuff required for an adult cattle per day are set as 3kg of cereal grain and 40kg of maize-for-silo (or annual pasture as green forage). As a result of the analysis, 1,600 of adult cattle can be bred per year with the implementation of the Project in addition to the presently bred one.

4.3.5 Farm Household Economy Plan

(1) General

Two types of farm management are predictable in future in the light of current Government policy orientation recommending individual farmers to organize associations or agricultural companies to strengthen their economic viability. They are the associations with handy acreage consisting of member farmers who are mostly small-holders and the remaining individual farmers who prefer independent farming because of their confidence or technical superiority/specialty in farming management. Accordingly, individual farmers often fulfill higher crop yields than those harvested by group farming, whereas they can hardly enjoy scale merit derived from large-scale mechanization, failing to have better yields for crops like wheat that require tractor operation or higher degree of farm mechanization. Forming associations can provide member farmers with better access to agricultural inputs, agricultural loans/subsidies and modern technologies both at present and in future. They can more easily follow crop rotation practices that promises them to bring desirable results in their farming activities.

Agricultual income for these two patterns of farming units is projected to increase with the Project not only through increased yields but also through reasonable rotation practices and crop diversification that enables the farmers to stabilize/expand their livestock sector. Livestock

production that currently contributes a high share to farm economy within the Project Area will sustain its importance also in future either by providing both individual farmers and associations with value-added dairy/meat products or by supplying them manures to conserve soil fertility, as well as draught power to cultivate their fields, means to carry inputs/outputs.

Required amounts of agricultural inputs at the project stage are also augmented according to the estimated rates per hectare for sustaining the projected yields, including especially water fee, rental cost of sets of sprinkler, transportation cost for increased harvests etc. In addition, marketing cost is incurred for new or increment part of cash crop production at the said stage. In this connection, the price level adopted here would not be any more sustained even in future with increased or glut supply in markets. Alternatively, the adopted prices should be applied to the quantity that is estimated to be sold at the terminal retail spots, while the portion of home consumption be evaluated at the value equivalent to production cost and the rest loss derived from marketing and harvest failure be evaluated at null value. Here, price erosion brought about by supply expansion may well be neglected, because there is no adequate way of forecasting it.

Land-holding size of a standard individual farm household and that of an association are projected based on the present average and desirable size for the convenience of mechanization. Annual farm budget is estimated based on the proposed production plan for the project stage and annual average within the Project Area for current base. But as regards the unit prices, those prevailed in August-October 1994 are employed for both stages, according to the main producing period of each crop concerned.

The particular limiting factors to be taken into account are available family labor force, projected capacity in marketing outlet and profit increment against additionally required cost. In respect of vineyards, current economic status seems gloomy due to higher labor/input costs and lower wine-grape/wine prices. But so far as they are inherited assets with a heavy investment, it seems unlikely that they are completely pulled out for crop conversion but for those with poorly yielding, small parcel of yards. Therefore, over half of existing vineyards are projected to remain as they are despite of their relatively or temporarily lower net profit currently prevailing. This could be justified when one duly evaluates down-stream industy related to winery activities, actually creating value-addedness and job creating effect on local population in and around the Project Area. In any case, winery/fruit juice industry can absorb local labor surplus in lingering slack in and around the Project Area.

The above-mentioned preconditions imply the following farming types that will shift from current status to predicted form as given below:

Farming Type		Land Size	Number of Units	Area Coverage	Labor Force
Individual Farmers	Present	1.10ha/ household	19,562	21,518ha	2.3/family
	with Project	4.00ha/ household	1,422	5,690ha	2.5/family
Association	Present	208ha/association	26-by 4,195	5,402ha	169/association
	with Project	500ha/association	42-by 22,335	21,000ha	500/association

In the table given above, number of individual farm units is estimated from the rate(%) of households whose land-holding size ranges more than 3ha/household, and the rest is expected to organize associations with appropriate sizes, the average of which will be 500ha or minimum tract to extend an efficient farm-machinery operation.

For each type, all the projected production including farm by-products is either consumed at home for self-consumption as food and livestock feed or sold through marketing network newly provided. There might be a future possibility of undergoing differentiation into units specialized in livestock production and those only engaged in crop farming Its possibility is more plausible for associations than for individuals since the former have more organisable labor force and investing capabilities. Both individuals and associated farming units follow the planned rotation system, though current cropping patterns adopted by them are different.

1) Individual Farmers

The cropping patterns currently adopted by the individual farmers are:
5-serial year pattern with Wheat (W), Maize (M) and Forage Crops (F)
MMMMM: 48%, WMMMM: 37%, WMMWM: 10%, MMFFF: 5%

From the above cropping behavior, the average annual crop composition is estimated as 86% (0.9ha) of maize, 11% (0.1ha) of wheat and 3% (0.0ha) of forage crops. In addition, in the case he holds a small vineyard with 0.1ha, his cropping pattern/rotation is planned with 4-year rotation as MMCZ, MMWZ, MMZS, MMZC, CWSZ, ZWSC, where each rotation type in 4 serial years has the same share or 16.7% (C: Cash Crops, Z: Beans and S: Sugar Beet). It follows that the remaining individual farmers with much larger size of their holding (4ha) grow 1.2ha of maize, 0.5ha of wheat, 0.5ha of silage-maize, 1.0ha of beans and 0.6ha of cash crops. Besides, he keeps 0.1ha (ranging 0.0 to 0.2 ha) of his vineyard.

2) Associations

The cropping patterns currently adopted by the assiciations are:
5-serial year pattern with Wheat (W), Maize (M), Sugar Beet (S), Barley (B), Cash Crops (C) and Pasture (P)
WMMWM: 15%, BWZWM: 10%, WSWWW: 12%, WBWCW: 35%, WWBWM: 26% and PPPPP: 2%

From the above cropping behavior, its average annual crop composition is estimated as 55.2% (34ha) of wheat, 17.2% (10.5ha) of maize, 14.2% (9ha) of barley, 2.0% (1ha) of sugar beet, 2.4% (1.5ha) of sunflower, 7.0% (4ha) of cash crops and 2.0% (1ha) of perennial pasture. Vineyard has the largest share in associations (actually only a few of them are specified as winery and many have quite limited acreage of vineyard), acounting for 146ha or 70% of the total acreage. Its cropping at with Project stage is planned as the same as shown for individual farmers, where the break-down of cash-crops is exemplified as: 2.0% for sunflower, 0.2% for sugar beet, 4.3% each for cabbage and cauliflower, 4.0% for cucumber and 6.3% for other vegetables etc. totaling 21.1% as the total share of cash crops.

(2) Economy of Individual Farmers' Household and of Associations

The agricultural annual income is estimated for the above listed two types of production units expected to exist in the project stage. The estimation is also made for the currently existing small individual farmers that would fail to get organized into members of an association and small associations that will still remain without any expansion at the project stage. The result of farm budget can be briefed as below, assuming the profitability of reffered crop per hectare as in the following.

(Unit: 10^3 Lei, * 10^6 Lei)

Crop	U.P.	Yield/ha (ton)			Sale Value			Cost/ha			Net Profit		
Stage		w/	w/o	Dif.	w/	w/o	Dif.	w/	w/o	Dif.	w/	w/o	Dif.
Maize	140	4.5	2.7	1.8	633	373	260	420	145	275	213	228	-15
Wheat	220	3.4	2.3	1.1	748	499	249	389	217	172	359	281	78
Barley	170	3.6	2.4	1.2	616	411	205	363	209	154	253	202	51
F.Maize	10	39.0	-	-	390	-	-	468	-	-	78	-	-
Alfalfa	10	22.7	13.5	9.2	227	135	92	429	93	336	-202	42	-244
Beans	820	2.2	1.4	0.8	1,804	1,141	663	410	192	218	1,394	949	445
S.Beet	55	30.5	17.1	13.4	1,678	943	735	528	280	248	1,150	662	488
Sunflo.	170	2.3	1.6	0.7	812	560	252	374	169	205	438	391	47
M.Cabb.	225	43.0	26.7	16.3	7,837	4,866	2,971	3,914	2,744	1,170	3,923	2,122	1,801
Onion	1,000	22.0	19.9	2.1	17.8*	16.1*	1,696	7,053	8,340	-1,287	10.3*	7.8*	2,983
E.Cucu.	500	50.0	-	-	16.0*	-	-	6,416	-	-	9,584	-	-
Potato	356	21.3	12.8	8.5	6,492	3,888	2,604	3,503	2,291	1,212	2,989	1,597	1,392
W.Grap.	170	8.9	6.5	2.4	1,520	1,110	410	443	410	33	1,077	700	377

Notes: w/ (with Project), w/o (without Project), U.P. (unit price, Lei/kg), F.Maize (Forage Maize), S.beet (Sugar Beet), M.Cabb. (Middle Cabbage), E.Cucu. (Early Cucumber)

Other important crops not reffered for economic calculation are :

(Unit: 10^3 Lei, * 10^6 Lei)

Crop	U.P.	Yield/ha (ton)			Sale Value			Cost/ha			Net Profit		
Stage		w/	w/o	Dif.	w/	w/o	Dif.	w/	w/o	Dif.	w/	w/o	Dif.
Soybean	450	3.0	-	-	1350	-	-	533	-	-	817	-	-
E.Tom.	420	60.0	15.4	44.6	16.1*	4140	12.0	6,605	2,963	3,642	9,523	1,177	8,346
E.Cauli.	500	17.0	-	-	6,503	-	-	3,428	-	-	3,075	-	-
Carrot	650	38.0	-	-	20.0*	-	-	7,506	-	-	12.5*	-	-
O.C.**	711	28.5	-	-	6,555	-	-	3,533	-	-	3,022	-	-

Note: E.Tom. (Early Tomato), E.Cauli. (Early Caulifiower), O.C. (Other Crops)
**: Average of early/late cauliflower, bell-pepper and egg plant.

The estimated economy of the proposed Farm structure is as follows:

(Unit: 10^6 Lei/year/farm)

Type	Sector	with Project			without Project			Incre. Net
		Gross In.	Cost	Net In.	Gross In.	Cost	Net In.	
I.Large	Crop	13.1	5.3	7.8	1.3	0.5	0.8	7.0
	Grapevine	0	0	0	0.2	0.1	0.1	- 0.1
	Animal	1.7	0.8	0.9	1.9	0.4	1.5	- 0.6
	Winery	0	0	0	0.4	0.3	0.1	- 0.1
	Total	14.8	6.1	8.7	3.8	1.3	2.5	6.2
I.Small	Crop	1.5	0.4	1.1	0.4	0.2	0.2	0.9
	Grapevine	0	0	0	0.1	0.0	0.1	-0.1
	Animal	0.6	0.3	0.3	0.3	0.1	0.2	0.1
	Winery	0	0	0	0.2	0.1	0.1	-0.1
	Total	2.1	0.7	1.4	1.0	0.4	0.6	0.8
A.Large	Crop	1145.9	499.8	646.1	177.0	92.4	84.6	561.5
	Grapevine	0	0	0	78.9	35.0	43.9	- 43.9
	Animal	143.6	81.8	61.8	146.5	108.1	38.4	23.4
	Winery	0	0	0	116.2	94.4	21.8	- 21.8
	Total	1289.5	581.6	707.9	518.6	329.9	188.7	519.2
A.Small	Crop	464.5	219.2	245.3	29.2	17.6	11.6	233.7
	Grapevine	0	0	0	205.7	91.2	114.5	- 114.5
	Animal	82.8	49.3	33.5	10.7	5.6	5.1	28.4
	Winery	0	0	0	303.0	246.1	56.9	- 56.9
	Total	547.3	268.5	278.8	548.6	360.5	188.1	90.7

Notes: In.: income, Incre.: increment,
I.Large: Large-scale Individual Farm (total arable land 4.0ha incl. 0.2ha vineyard)
I.Small: Small-scale Individual Farm (total arable land 1.1ha incl. 0.1ha vineyard)
A.Large: Large-scale Association Farm (total arable land 500ha inc. 56ha vineyard)
A.Small: Small-scale Association Farm (total arable land 208ha incl.146ha vineyard)
* Vineyard in w/o Project condition is changed to arable land in w/ Project condition

Besides, all the remaining vineyard area is projected as exclusively managed by private winery enterprises, the economy of which is estimated as follows:

(Unit: 10^6 Lei/year/farm)

Type	Sector	with Project			without Project			Increase
		Gross In.	Cost	Net In.	Gross In.	Cost	Net In.	in Net In
Winery Enterprise	Crop	0	0	0	0	0	0	0
	Grapevine	909.8	405.2	504.6	704.5	312.2	392.3	112.3
	Animal	0	0	0	0	0	0	0
	Winery	1,701.2	1302.0	399.2	1,317.2	1,036.2	281.0	118.2
	Total	2,611.0	1707.2	903.8	2,021.7	1,348.4	673.3	230.5

Also, livestock economy is estimated based on residue of cereals/beans and newly introduced feed-maize, to which purchased seed cake of sunflower is added, relying on available farm labor within the farm. Income is estimated from marketable heads and cost from feed materials, labor for husbandry etc..

Agricultural net benefit as farm budget is estimated in the following taking into full account the salable portion of perishable products and salable livestock heads based on available ration including fodder crop, cereal residues/straw and other conventional forage resources.

4.3.6 Marketing Plan

(1) General

1) Cereals

In the Project stage, cereals are projected to flow through ROMCEREAL network. As to cash crop, processing materials such as sugar beet and sunflower are marketed through hither-to established routes, the transportation of which is provided by the processors from the collecting points to their processing units located out of the project area. Usually trucks are provided by ROMCEREAL and transportation cost and others including costs for input supply through ROMCEREAL are collected in kind, for example 1 ton of cereal out of 5 tons of it from 1 hectare. Farmers and associations make contract with ROMCEREAL before spring to secure input supply.

2) Vegetables

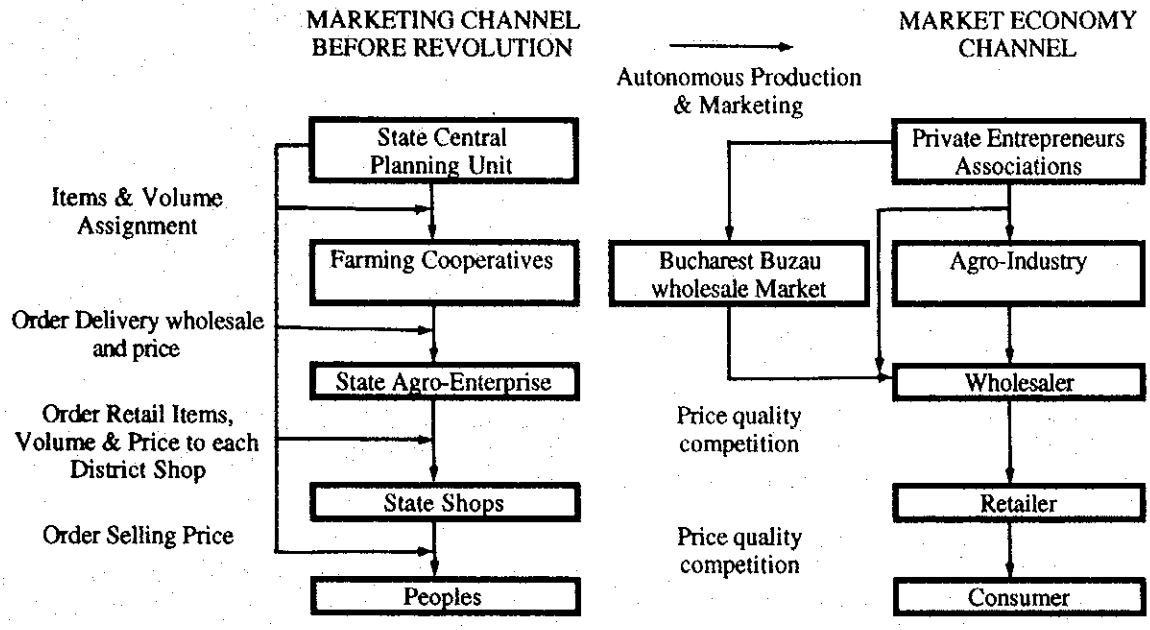
In case of vegetables, the increment quantity of which is projected as the largest of all crops, an appropriate marketing organization should be established among farmers, in order to deal the products most efficiently and timely. In future, modernized vegetable sorting/packaging centers with air-conditioned storage system will be established and refrigerator vans will carry the packed vegetables to suitable markets. However, such costs can only be covered with unit prices in which real values are reflected or with remunerative taxation system that won't gives farmers heavy burden. Therefore, a conventional and cost-saving selection system is projected to meet the purpose of handling perishable produce effectively. Practically, velt-conveyers can be applied to the process of selection with suitable devices to prevent slipping off from velts, and appropriate feeders to feed fruit/root on them.

(2) Promotion Program for Small and Medium Scale Farmers' Organization

Marketing of the agricultural products is the most important sector for the rural development and also the most difficult subject. Marketing development cannot be completed only inside the Project Area without consumers' market. With the market economy penetrates into the rural, marketing channel, facilities required can be certainly expected to be developed. It is, however, difficult to forecast the speed of its progress. It will surely require long time and rather big capital to improve and develop the marketing system.

Also, in the sector of agricultural marketing, it is indispensable to move from the left channel to the right one as drawn in the following figure. Organization of small- and medium-scale farmers is required with top priority by declaring the commercial activity in the articles of the association. In order to secure the success of multipurpose organization of associations, manpower or powerful leadership, produce or most marketable produce with competitive price and quality, and capital or introduction of soft-interest credit for production, marketing and livelihood are required.

Pre-enlightenment and training seminar shall be planned and executed for promoting the advanced farmers and the farming leaders including the transfer of market economy concept and the enterprise management know-how.



(3) Packing House Development Program

Agricultural marketing of the products in the Project Area is summarized as follows:

1) Cereals

Three (3) grain centers with total storing capacity of 94,000 tons are at Adjud, Padureni and Focsani around the Project Area belonging to the state enterprise ROMCEREAL. Expected volume of 51 tons of cereals to be produced in the Project Area can be marketed without any problem.

2) Oil Seed

Private oil extraction and refinery factories exist in the marketable area with enough capacity to process 16,000 tons oil seed to be produced in the Project Area.

3) Sugar Beet

3,000 tons of sugar beet to be produced in the Project Area to be delivered continuously to the existing seven (7) private sugar refinery factories having exceeding capacity.

4) Feeds

Marketable volume excluding stockpile for self-supply is delivered to any one of the seventeen (17) existing feed mills around the Project Area.

5) Vegetables

Marketing facilities are indispensably required for packing and handling 169,000 tons of vegetables (**Table 4.3.6-A1**) ; the biggest crop in the Project Area. As shown in **Table 4.3.6-A2**, the prospected market to sell about 106,000 tons net marketable volume excluding volume of post-harvest and marketing loss and stockpile for self-supply is targeted as follows:

Market	Population (Person)	Annual Consumption (ton)	Target Volume (ton)	Market Share (%)
Vrancea District.	393,408	113,410	30,259	41.2
Buzau	849,867	158,585	18,000	11.4
Bacau	205,029	38,258	5,000	13.0
Braila	234,110	43,685	5,000	11.4
Tecuci Onesti	115,635	21,577	2,000	9.3
Bucharest	2,086,294	389,302	45,000	11.6
Total	3,884,343	724,817	105,259	14.5

It is required to establish the following packing houses in order to market the volume of vegetables to be produced in the Project Area:

a. Function
Packing houses provided with functions and facilities capable for collecting, grading, washing, packing, pre-cooling, storing and delivering all kinds and volume of vegetables to be produced in the Project Area without quality depreciation.

b. Types of Packing Houses
Three (3) types of packing houses are required; a) for potato and carrot, b) for onion and garlic and c) for other green vegetables, due to collecting and grading methods, harvest period and physical characteristics of each vegetable.

c. Number of Packing Houses
It is required to establish a total of fourteen (14) packing houses consisting of two (2) potato and carrot houses, two (2) onion and garlic houses and ten (10) green vegetable houses inside the Project area to market the volume produced (**Fig 4.3.6-A1**).

d. Collection Capacity
Maximum collection volume per day amounts to 4,405 tons in early October based on the volume produced, harvesting time and types of vegetables.

e. Collection, Grading and Storing Method
In order to save the initial investment cost, protect quality depreciation and secure higher profit, the vegetable processing method for each type of vegetable is proposed as shown in **Fig 4.3.6-A2**.

f. Scale of Packing House
The type and capacity of packing house and required facilities/equipment are shown in **Table 4.3.6-A3** and **A4**. They are summarized as follows:

Packing House	Space Required/House (m^2)	Storage Capacity/House (ton)
Potato	4,960	Nominal 5,875
Carrot		Nominal 1,104
Onion	4,200	Nominal 2,780
Garlic		Nominal 975
Green Vegetable	4,880	Nominal 3,350

The cooling house layout of each type of vegetable is shown **Fig 4.3.6-A3**.

g. Installation of Packing House and Management System
The packing houses shall be invested and installed by the farmers themselves because of the marketing channel being organized and controlled under the private sector. As shown in **Table 4.3.6-A5**, the total cost of packing houses construction is estimated about $16X10^6$ US$. In the Project, the installation cost of them is included in the production cost of crops as an depreciation cost.

The annual operating cost of $3X10^9$ Lei consisting of hired labour, electricity and maintenance requires in addition to this fixed cost (**Table 4.3.6-A6**).The packing houses shall be managed democratically by private production associations to be organized under the proposed Promotion Program for Small and Medium Scale Farmers' Organization. Daily results of collection, sizing and delivery of products shall be clearly recorded by means of computer system linked with car-operation plan and market information; what is called marketing system.

Furthermore, growers' associations shall have the transportation vehicles to support growers whenever they need. Assuming more than 2 round-trip transport a day, required fleet of trucks is estimated at around 120 with 10 ton loading capacity at peak production period, but around 50 in average. So, it is projected to invest 50 trucks or 5 for each collecting point, and the rest of requirement is to be hired whenever they are needed. $22x10^9$ Lei is required to purchase the minimum fleet at the maturity stage. The total cost of delivery to targeted markets as the initial investment amounts to $46x10^9$ Lei including fleet, and annual running cost of $25x10^9$ Lei should be added to it. Finally, the cost of marketing comes to $32x10^3$ Lei per ton of perishable produce, which is counted in the
production cost of vegetable crops

4.3.7 Agricultural Processing Plan

The crops and related livestock sector is projected to expand their production, but fortunately there found no additional processing unit to be established within the project area, because for traditional crops existing processing units around the area has enough capacity to accommodate the increment of production derived from the Project. Newly introduced crops include forage that is absorbed in the livestocks

The following shows the corresponding facilities and equipment necessary for the processing of products expected in the project phase:

Cereals
A cereal center has already been established by ROMCEREAL at a site adjacent to the Project Area, equipped with silos with the storage capacity of 94,000 tons and modern mills, corn Sheller and a bakery. Therefore, currently existing facilities can fully meet the expected demand for processing in the project phase through their efficient use, and there is no need of creating additional capacity to the existing ones.

Oil Seeds
There already exists private oil extracting/refining factories that market their product thorough ROMCEREAL, including one in Iasi, as well as seven (7) privatized sugar mills within the reach of transportable radius from the Project Area. These have sufficient capacities to process 16,000 tons of oil seed expected from the Project.

Sugar Beet
The expected production in the project phase amounts to only 3,000 tons, while four (4) sugar mills have been established within the transportable circumference, inclusive of Zaharul Sascut in Bacau with a background of older than 100 years since it was established. This implies that any new investment to establish a new mill will not be needed.

Feed Maize
The capacity that seventeen (17) existing feed-processing and marketing enterprises in and around the Project area will meet the processing and storage of salable portion of the expected production, 25,000 tons less the storage portion for self-consumption.

Annual/Perennial Forage Crops
These are mainly bound to self-consumption, hence currently employed way of treatment, or storage in barns/silos after harvest for annual forages and grazing for perennial ones, is relevant. New investment for a new post-harvest facility would bring a risk of over-investment.

Strawberry
The Project Area is located within the major vineyard tract in Romania, where nine (9) private wineries; in which one of the largest wineries in Romania, Beecon, is found, are distributed. Under such circumstances, there won't be any problem in treating 23,000 tons of wine grape expected in the project phase.

Vegetables
There exists twelve (12) private processing enterprises in and around the Project Area with enough capacity to bottle the produce which failed to meet the standard for raw marketing at the stage of quality selection.

Dairy Products
Two (2) private dairy processing units are available adjacent to the Project Area, producing city milk, cheese, yogurt and butter, and they are capable of treating all the products expected from the Project.

Livestock
Forty six (46) livestock products processing enterprises exist around the Project Area forming the largest sub-sector in the aspect of agricultural processing. Therefore, there is no problem as far as the capacity for slaughtering, treatment or processing the expected herds at the project phase is concerned.

As mentioned above, sufficient facilities with enough capacity are identified for the crops and their quantities expected from the Project, leading to a conclusion that there is no additional need to invest for any new capacity. However, it will be imperative to solve the problems coping with the dilapidated processing facilities, out-dated technology and scarcity of low-interest credit-funds. The best formula to solve these problems will be found in a joint venture with overseas enterprises, envisaging innovation of operational management and technology; faster acquisition of transferable know-how/strategies for sales. In this context, early implementation of plans for promoting joint ventures is advised.

Existing facilities and systems can be fully utilized to meet the requirement of supporting farmers for better techniques and higher investment. It is advised to expand the functions of Camera Agricola equipping more specialists ranging market economy, plant protection and advanced mechanization. They should be equipped with higher mobility including vehicles and audio-visual kits. Banca Agricola will be requested to provide more long term loans for investing meat or animal fattening activities as well as for agricultural machinery to supplement dilapidated fleets in AGROMEC or machinery holding associations.

4.3.8 Agricultural Supporting Plan

(1) General

Agricultural supporting will play a key role in the developing process of modernized and market-oriented agricultural production. The apparent gap between current levels of technology or farm economy and those envisaged in the proposed Project attaches particular importance to the supporting activities for technical extension/education, smooth/timely input/credit supply and promotion of mechanization/marketing. They should cover a vast area of technical, financial and agro-business sub-sectors in order to realize the planned levels of crop/animal production. Since crop diversification by introducing cash crops is almost inevitable in order to

meet the profit-seeking principle in free market economy, it will be essential for the farmers to acquire new cropping techniques through expansion media.

It wouldn't be too much to say that higher yield levels of planned crops brought about by irrigation can only be sustained by various supporting systems to which the farmers in the beneficiary area are easily available or accessible. These supporting systems should cover technical, financial and marketing sub-sectors, as if they are a set in a basket. New forms of inputs should be properly and timely supplied to them along with the popularization of modern techniques. It is also advisable to resort to foreign commercial agents who wish to export their input goods or materials because they are willing to transfer techniques and in most cases they offer free service therefor. Besides, as mentioned Chapter 2, the Government of Romania has already started to tackle development of agricultural supporting with new subsidizing systems or organizing/strengthening the framework of administration/infrastructure to this end. So, it is advised to make full use of such advantages officially offered.

For the most part, supporting systems have already been established and many of them will be useful at the project stage without organizing new ones with additional cost to the project budget. However, some of them are not currently existing and hence necessary to establish within the Project Area. They mostly belong to marketing sector already mentioned above, because marketing facility is still a serious bottleneck for national economy and the Project Area is not an exception. It should be reminded that in any part of free economy world up-dated information is indispensable for efficient marketing activities and that, therefore, the farmers should be equipped with sophisticated communication media like CATV system in the project stage.

(2) Technical Supporting

Technical input can be delivered by Camera Agricola established in every town/village, since it is already equipped with horticultural, animal husbanry and cereal cropping experts. There are 19 Cameras existing in the Project Area. The only necessary thing is to add such mobile equipment as motor-cycles/jeeps to visit the farmers more frequently and audio-visual equipment to facilitate better and faster technical diffusion among the farmers. Technological demonstration farms are also useful to extend new techniques among them, and existing state farms will be available to meet the requirement, because they have already been involved in varietal, field tests/trials etc. and their land belongs to the state implying no need of paying extra or clearing time-consuming procedures for land acquisition therefor. Currently 4 such state farms are located in and around the Project Area specialized in horticulture/livestock production.

Camera Agricola will have to absorb up-dated technical know-how from nearby research institutes or from abroad. Their staff should frequently have attend in-service trainings or visiting institutes/universities or more advanced/specialized producing areas to meet the purpose. Especially, since the efficient farm mechanization as well as timely/proper use of chemicals would become key factors for successful farm management particularly in the associations, the staff will have to formulate the best strategy for their utilization. It is advised to establish a technical advisory network, organized among the staff of Camera Agricolas and filials of Banca Agricola concerned, in order to make closer contact with such groups of beneficiary farmers as farming associations.

(3) Financial Supporting and Input Supply

Adequate financial sources will be required for the initiation of crop diversification and marketing of perishable products for both individual farmers and associations. However, needs for financial supports will be more acute for the latter, because of larger area to be allotted for new crop species. Both Banca Agricola and Development Bank (Banca Dezvoltare) provides agricultural loans, but as far as the Project Area ia concerned, the former has better network or filial branches.

Currently 7 filial branches are located in the District, of which 3 are available in and around the Project Area. As regards the loan availability, the formal associations would take advantage in the light of provision of mortgages, but it depends on the actual management performance and eligibility of amortization. The more farm management becomes diversified, ranging various crops and sectors inclusive of food/feed crops, livestock and winery etc., the more potential risk can be dispersed and loan suppliers would welcome such efforts to diversify management.

For the sake of security of input-supply, the farmers in the beneficiary will be advised to make contract with ROMCEREAL and sugar-mill/vegetable oil-extracting foctories through which input/loan requirement can be met, if current contracting system is sustained. It is also suggested to solicit any agricultural credit facilities financed by a foreign financing source, preferably through the intermediate recipient or Banca Agricola. This will be relevant to meet the financing of post-harvest and marketing equipment/facility. The implementation of the Project will provide a convincing appeal towards foreign credit suppliers, since it brings relative advantage to bargaining/amortizing capability of the beneficiary farmers, securing their investment with higher profit and lower risk.

As regards agricultural machinery, current 5 AGROMEC available in and around the Project area are equipped with enough fleet of machinery to cover all the needs that would arise from the beneficiary. However, the key problem lies in delapidated inventory including meager supply of spare-parts and increasing numbers of out-of-order/mal-functioning. On the other hand, purchasing new machinery by the associations or well-off individual farmers never fails to require long-term loans. Therefore, the availability thereof will be the limiting factor on their mechanization.

Anyway, mere dependence on outside suppliers of credits/machinery would not give any radical solution. Only self-help efforts, for example, expanding savings by accumulating from year-to-year farming/off-farm gains could be relied upon, as some sound fruit producers around Focsani are now practising. Expanding savings is the best convincing mortgage for any banks that supply agricultural loans.

It is suggested that well-off farmers or committee members of associations should invest their gain from farming activities to AGROMECs to facilitate them to purchase new machinery, spare parts and fuel/oil so that their service can be improved and timely/efficient offer of their fleet is secured to meet the investors' demand. Finally, closer link/contact should be established and kept between the farmers' associations and these supporting agencies for better technical transfer and economic functions for the beneficiary by consolidating organizational framework as shown in **Fig 4.3.8-A1**.

(4) Mechanization and Organizational Usage System

In order to perform the proposed cropping schedule smoothly and effectively, it is indispensable to equip an agricultural machnery of sufficient number with well-maintained condition by establishing an effective utilization system of machines. The presently existing agricultural machines which exist in and around the Project Area is sufficient in number to meet their requirement with the implementation of the Project (**Table 4.3.2-A9**). However, as regard to the effective use of those machines, it is proposed to newly establish users' associations where proper number of operators and mechanics are secured by improving the present AGROMEC's facilities at Adjud, Panciu, Marasesti, Odobesti and Cimpineanca in addition to ROMCEREAL's facilities. It is also proposed to introduce a rental system of machines in which the respective farmers can operate the machines by themselves.

4.4 IRRIGATION AND DRAINAGE PLAN

4.4.1 Irrigation Plan

Based on the land use and farming plans of the Project mentioned in the previous sub-chapters, the irrigation plan is prepared.

(1) Irrigation Water Requirement

1) Computation of Irrigation Water Requirement

The crop water requirements (ETcrop) are estimated using the crop coefficients (Kc) set based on the measured values in the respective experimental farms of ICITD. The net water requirements are estimated based on the water balance among ETcrop, precipitation and effective soil moisture. The calculation results of net water requirements for respective crops during April to September based on the rainfall records between 1950 and 1993 in Adjud Station and the Pedological study of the Study are as shown in **Table 4.4.1-A1**.

The crop coefficient for grape (vineyard) is estimated based on the observed value at Valea Calugareasca, and those of the other crops are based on the average value observed at the experimental farms in Podul Iloaiei, Iasi and Cosmesti-Tecuci. They are shown in **Fig. 4.4.1-A1** together with cropping calendar and cropping ratio in the Project Area. The farming plan of the Project includes various types of vegetables and the cropping calendar varies vegetable by vegetable. Through the discussion with ICITID, the crop coefficient of vegetables given by them is the observed average of various types of vegetables. Therefore, single crop coefficient is adopted for vegetables in the estimation of the irrigation water requirements.

2) Design Net Irrigation Water Requirement

The probability of occurance of the droughty year usually adopted for irrigation planning in Romania is 80% (or drought occurs once five years). The Project also apply this design criteria for the irrigation plan. The maximum irrigation water requirement appears for sunflower in July as shown in **Table 4.4.1-A1**. The unit irrigation requirement of 1,460 m^3/month/ha for maize, which is the major crop in the Project, in July is set as a design irrigation water requirement for the facility planning of booster pumps and antenna.

On the other hand, the weighted total unit water requirement excluding vineyard of 1,244 m^3/month/ha, which appears in July, is set as the design irrigation water requirement for the facility planning of CDs and SRPs. In the case of vineyard being included in the command area of SPP, CD or SRP, the weighted total is calculated respectively.

(2) Irrigation Efficiency

The irrigation efficiency (Ep) is estimated using the following formula:

$$Ep = Ea \times Eb \times Ec$$

where; Ea : Field application efficiency
Eb : Distribution efficiency between SPP and sprinkler
Ec : Conveyance efficiency between intake pump and SPP

Field application efficiency depends on the meteorolological condition especially window speed and topographic condition of the field. It also depends on the quality of irrigation water, contents of foreign materials and chemicals, and pressure and quality of sprinkler itself. In consideration of actual operation conditions in irrigation projects in Romania and the manual shifting method of antenna and sprinklers, Ea and Eb are set at 85% and 95%, respectively.

The conduits between distribution pumping station and distribution canal and re-pumping station to distribution canal is of steel pipes. The bed of the distribution canal is lined with cast-in-place concrete, but its slopes are lined with concrete blocks. Therefore, the seepage through the joints of blocks and evaporation from water surface have to be considered. Usually open canal with concrete lining loses water about 5 %, but considering the storage function of the distribution canal and allowance of seepage losses and operational mistakes of water level control, Ec is set as 90%. Then the irrigation efficiency is set at 80.75% for SPP and 72.7% for CDs and SRPs.

(3) Gross Unit Irrigation Water Requirement

As described above, the gross irrigation water requirements for the facility planning are estimated to be 0.810 and 0.305 lit/s/ha for arable land without vineyard and the vineyard at the SPPs level, respectively. On the other hand, one used for the SRPs level is estimated at 0.636 lit/s/ha for arable land without vineyard. In the case vineyard is included in the area, the gross unit irrigation water requirement is calculated in consideration of the ratio of the vineyard area against the area of upland crops.

(4) Irrigation Method

1) Kinds of Upland Irrigation Method

In generally, the method of upland irrigation is classified into the following systems;

- Sprinkler irrigation:	a) Sprinkler irrigation
	b) Micro-sprinkler irrigation
- Fixed pipe irrigation:	c) Perforated pipe irrigation
	d) Drip irrigation
- Surface irrigation:	e) Furrow irrigation
	f) Border irrigation
	g) Contour ditch irrigation
	h) Basin irrigation
- Sub-irrigation:	i) Sub-irrigation

a) Sprinkler Irrigation

A method of irrigation in which water (under adequate pressure) is sprinkled over the land through nozzle lines, perforated pipes or sprinkler. Also called "spray irrigation" and sometimes referred to as "overhead irrigation". Sprinkler irrigation is the most popular irrigation method in Romania. Total 2.6×10^6 ha of arable land were irrigated with sprinkler, which were almost 84% of the irrigation command area in 1992.

On the viewpoint of the piping method, sprinkler irrigation is divided into the following method;

Permanent sprinkler method : The method made up of permanently located pipeline systems, usually buried, conveying the water from the source of supply to sprinklers.

Semi-permanent sprinkler method : The method made up both permanently located pipelines and portable pipelines.

Potable sprinkler method : The method made up entirely of portable pipeline from the pumping plant or water-pressure source (portable or permanent) to the last sprinkler.

Self moving method : Center pivot system

b) Micro-sprinkler irrigation

Micro-sprinkler irrigation is suitable for tree crops, under-the-canopy and arid climates, because the irrigation efficiency of micro-sprinklers (94 to 97%) was found to be higher than that of any other irrigation methods. Compared to other sprinkler systems, micro-sprinkler system is economical to install and have low discharge rate.

c) Perforated pipe irrigation

A sprinkler method consisting of portable, light-weight pipes in which small holes (perforations) have been drilled in such an arrangement as to cause the water to be distributed fairly evenly over trips of land on both sides of the pipe.

d) Drip irrigation

Drip irrigation is the frequent, slow application of water to the soil for the purpose of sustaining plant growth. This is done through mechanical devices called emitters that are located at selected points along water delivery line. Most emitters are placed on the soil surface, but they can be buried at shallow depths for protection. This method is installed at the vineyard in Constanta.

e) Furrow irrigation

A method of surface irrigation in which water is run in furrows between crow rows. This method was applied in Romania at 0.27×10^6 ha of arable land irrigated, which were almost 8.5 % of the irrigation command area in 1992. In the Project Area, vegetable cultivation in the Putna system is made by the furrow irrigation. And orchard in the Milcov system is irrigated by furrow. The furrow irrigation does not require high pressure at the end of irrigation, but it needs more water.

The original plan of the Project, the furrow irrigation is proposed at 185 ha and mixed irrigation method at 1,278 ha (refer **Table 4.2.2-A1**). In the Project, they are considered to be all sprinkler irrigation area. In the case of furrow irrigation is desired, the water through hydrants of lateral pipes can be led to the furrow by using pressure regulators at the hydrants.

f) Border irrigation

Flood irrigation in which land is divided into border strips and water is delivered into each strip from a head or field ditch at its upper end.

g) Contour ditch irrigation

Controlled flood irrigation in which water flows through irrigation-ditch openings or over ditch bank as a sheet across fields, its distribution being controlled by size and side of ditch opening and by spacing between ditches. Ditches formed by building longitudinal ridges approximately parallel to contour.

h) Basin irrigation

A method of irrigating orchards by which each tree or a group of trees is surrounded by a border, to form a pool or a small basin when water is applied. The water is usually turned direct from the supply ditch into the basin but may sometimes be turned from one basin into another.

i) Sub-irrigation

Watering of plants by applying the water below the ground surface. Irrigation by effecting the rise of the water table to within or near the root zone.

2) Selection of Irrigation Method

Due to the following reasons, the sprinkler irrigation system (semi-permanent sprinkler method) is proposed to introduce into the Project:

- With viewpoint of the topography, soil conditions, cropping plan and field size, sprinkler irrigation is the most suitable one for the Project;

- Sprinkler irrigation (semi-permanent sprinkler method) is the most popular irrigation method in Romania. The farmers are experienced in the operation and maintenance works for this system; and

- Taking into consideration the water saving, sprinkler irrigation has advantages over the furrow irrigation.

3) Rotation Blocks and Irrigation Interval

As described in 4.2.2 of this Chapter, the standard size of the rotation block is set 17 to 23 ha in consideration of sprinkler area (24 x 18 m), interval of lateral pipes (24 m) and irrigation interval 12 days.

4) Farm Pond

Pump operation time of SPPs and SRPs are 20 and 24 hours a day, respectively. These 4 hours different of pump operation hours requires the irrigation water storage pond, which is called a farm pond. In the Project, any farm pond or regulation reservoir is not considered and their function is given to the distribution canals as a usual practice in Romania.

(5) Irrigation Block

The Project Area is divided by 4 major tributaries, the Carecna, Zabraut, Susita and Putna rivers, and allotted for 49 irrigation blocks in total. It is further divided by the distribution canals which run along the contour line at 25 to 60 m high interval from the distribution pump stations as shown in **Table 4.4.1-A2.** The boundaries of irrigation blocks in the existing design are modified due to the following points:

- to avoid the increase of land owner within one irrigation block, especially SCM (**Table 4.4.1-A3**)
- to avoid the drainage canal to cross the lateral lines or CP which needs high cost for protection works

(6) Irrigation System

Based on the irrigation water requirement and the irrigation blocks, the irrigation system of the Project is planned as shown in **Figs 4.4.1-A2** and **A3**.

(7) Phasing due to the Progress of Siret-Baragan Canal

1) Construction Progress of the Siret-Baragan Canal

The main water source for the Project is the Calimanesti Dam and Siret-Baragan Canal which intakes water from the Calimanesti Dam. The major construction of the Calimanesti Dam was

completed by RENEL, the State Company of Romanian Electricity Supply (formerly Ministry of Energy) in 1992. The Siret-Baragan Canal between the intake and 5.5 km point where the main pumping station (SRP-V) of the Project locates and the intake gates has been completed by the Ministry of Water, Forest and Environmental Protection (MoE). The test operation of intake gates and completed canal was made in September 1994. For the remaining canal portion related to the Project between 5.5 km point and 32 km point where the lowest pumping station SPP-27 locates, MoE has not any definite construction schedule. Therefore, the Project Area to be irrigated by Siret-Baragan Canal after SRP-V will be deleted due to the delay of construction of the Canal. The total area to be affected by the delay of the Canal Construction is 4,900 ha in net. These irrigation areas are considered to be the Second Stage Project Area.

2) Study on the Change of Irrigation System

The following alternative studies for the irrigation of these areas has been made:

Alternative I : Partial Construction of Siret-Baragan Canal to meet the water requirement of these second stage irrigation area.
Alternative II : Irrigate the area under SRP-IX by SRP-V system through connecting distribution canals of CD-7 and CD-11 with siphon crossing the Putna River.

Alternative I needs construction of temporary canal with length 24 km and flow capacity 3.7 m3/s. The minimum water depth of the canal shall be 50% of original design (about 3 m) for the pump operation.

Alternative II needs construction of Putna River crossing structure with flow capacity approx. 2.5 m^3/s and 6 connecting canals or pipe lines with SPPs. The canal bed elevation difference between the end of CD.7 and CD.11 is 7.8 m and beginning point of CD.11 is 7.09 m (=95.39 - 87.57(88.30)). Layout and canal sections of both alternatives are shown in **Fig 4.4.1-A4**.

Construction cost comparison among the original plan and these two alternatives are summarized in **Table 4.4.1-A4**. Alternative I and II costs increase 26% and 72% against the cost of original plan, respectively. Therefore the original plan is most economical on the investment cost. Therefore, the irrigation of these areas shall be omitted until the completion of the Siret-Baragan Canal. In the Study, the area is considered as a phase II construction area.

(8) Automatic Irrigation Control Method

Considering the manual operation after the hydrants, automatic irrigation control system shall be limited within SPPs and SRPs. Based on the following basic criteria, the automatic irrigation control system has been studied:

- Each pump of SRP or SPP is remote controlled by telemetry radio links from the control center which is installed at the SRP-V pumping station,
- Each SRP or SPP, except SRP/SPPs along the Siret-Baragen Canal or Calimanesti Dam, send the massage of intake water level in CD to the control center,
- Each water level regulating structure also send the message on the water level in CD to the control center,
- The on-off message of SRP/SPP pump operation is send from the control center based on the irrigation water requirement and received intake water level of each SRP/SPP, and
- The frequency band for telemetry radio is 2 bands (within 70, 150 and 400 MHz).

The system diagram of automatic irrigation control is shown in **Fig 4.4.1-A5**. Function of each telemetry station for the automatic irrigation control system is described as follows:

Central Control Station
- Supervise and monitor each local station which include SRP, SPP and water level regulating structure by telemetry radio link,

- Collect the data on the water level in CDs,
- Control remotely each SRP/SPP pump operation (on-Off) by telemetry radio link,
- Record operation hours of each SRP/SPP pump and water level data,
- Data processing the collected data for the operation and amount of irrigation water supplied,
- Mimic display of the conditions of total irrigation system including the condition of pump operation and water level and alarming the water level in CDs,
- Supervise the control setting to pumps and display the pump status by the operation console, and
- Print out the collected operation record, alarming record, and daily report.

SRP/SRP Stations except for SRP-V Irrigation System
- Direct control by manual or remote control by telemetry radio link from central control station, and
- Monitor the pomp status and transmit to the central control station.

SRP or SRP and SPP Combined Station in SRP-V Irrigation System
- Direct control by manual or remote control by telemetry radio link from central control station,
- Monitoring intake water level and transmit the data to the central control station, and
- Monitor the pomp status and transmit to the central control station.

Independent SPP Stations in SRP-V Irrigation System
Direct control by manual or remote control by telemetry radio link from central control station,
- Monitoring intake water level and transmit the data to the central control station, and
- Monitor the pomp status and transmit to the central control station.

Water Level Regulating Structure Stations
- Collecting the water level in CD and transmit to the central control station.

Installation cost of this automatic irrigation control system is estimated at 6.4×10^6 US$, additionally the engineering cost for designing the system requires 0.5×10^6 US$.

Considering the present condition of existing automatic operation project in Romania and the Milcov Irrigation Project, which locates near Focsani, the introduction of automatic irrigation operation is not recommended in this Project at present. The problems of the automatic irrigation control at present is operation maintenance when the system broken down on the modification of system and availability of spare parts at present. Therefore the most simple method which operated as same system adopted in the Milcov Irrigation Project. In the Project, the communication devices such as walky talky and transportation vehicles are prepared.

4.4.2 Drainage Plan

(1) Internal Drainage and Other Drainage

Drainage in the Project Area is consisted with the following 2 categories:

1) Drainage of the runoff coming from hillside areas which are located outside of the Project Area through tributaries and catch drains,
2) Drainage of internal runoff within the Project Area including the catch drains along the distribution canals and drains along the boundary of the irrigation blocks.

The drainage within the first category is described in the Soil Conservation study and the other is described below in this sub-chapter.

(2) Degree of Flood Protection

As same as the irrigation planning, the degree of the drainage is set as a flood probability at 1/5 year (20%). Normally 5% probability (1/20) flood is adopted in Romania, but it is not rational in the light of the probability for the irrigation being 1/5 year, 80% of drought. The probable storm rainfall are analyzed in Sub-chapter 3.4 and summarized as follows:

(Unit : mm)

Duration (hr)	Return Period (year)	Adjud	Hilly Area Average *	Project Area **
24	5	56.2	64.7	60.5
	10	63.9	79.7	71.8
	20	70.9	95.3	83.1
48	5	69.9	83.7	76.8
	10	81.6	102.9	92.3
	20	92.8	123.4	108.1
72	5	79.6	96.3	88.0
	10	91.5	119.5	105.5
	20	102.3	147.7	125.0

Notes : * Average among Fitnesti, Panciu and Odbesti
** Average between Adjud and Hilly area average

(3) Unit Runoff in the Project Area

The unit runoff amount in the agricultural land is estimated with the following Formula:

$$q = \frac{10{,}000 * f * R}{86{,}400 * T} \quad \text{lit/s/ha}$$

where, q unit runoff (lit/s/ha)
f runoff coefficient
R design rainfall (mm)
T allowable drainage period (day)

Runoff coefficients by soil texture, month and slope are shown in **Table 4.4.2-A1**. The rainfall intensity (R mm) is estimated based on the following criteria by scale of catchment area:

Catchment Area (ha)	Rainfall Duration (hr)	Remarks
less than 500	24	
500 - 2,000	24 or 72	
2,000 - 5,000	72	
more than 5,000	72 or 120	usually 72 hr.

The allowable inundation duration, which can be said the drainage period, for respective crops are shown as follows:

Type of Crops	Green house	Vegetables	Orchard	Cereal Crops	Fodder	Pasture
Duration (day)	0.3 - 0.5	1 - 1.5	1.5 - 2	1.5 - 3	2 - 3	7 - 15

In this case, surface slope 2.5 %, medium to high texture soil (f=0.60-0.50), catchmnet area 500-1,000 ha (24 hr -rainfall with 20% of probability, R= 60.5 mm), for the vegetable (drainage period 1 day), the unit drainage amount is estimated to be 4.20 - 3.50 lit/s/ha. Then the unit drainage discharge "q" is set at 4.20 lit/s/ha in the Project.

(4) Drainage System

The drainage system in the Project Area is divided by the tributaries running west to east and the distribution canals running along the contour lines, usually south-north. The catch drains on the boundaries of the Irrigation Area and Soil Conservation Area discharge to the tributaries, so

that there is no bad influence to the Project Area. At the eastern boundary of the Project Area, two drains of the Calimanesti Dam and Siret-Baragan-Canal are constructed or are to be constructed. Basically, drains are planned at the lowest part of each irrigation block, and they sometimes function as drainage along the distribution canals and discharge to the tributaries. The plan of the drains is shown in **Fig 4.4.2-A1**.

4.5 SOIL CONSERVATION PLAN

4.5.1 General

The soil conservation plan in the Study Area has been prepared mainly focusing the soil erosion. Where soil erosion occurs within the arable land, losses of top-soil and soil fertility results in reduction of the agricultural productivity. According to the MAF Report "Instructions for Studies and Necessary Calculations for Soil Erosion Control, 1973", the agricultural yield in Dobrogea decreased averagely by 15% on moderately eroded soils and by 50% on strongly eroded soils. Once a soil in arable land is severely eroded and gullys begin to form, its restoration is generally too expensive. Therefore, the first priority should be given to the prevention of further erosion. The main objectives of the soil conservation plan are summarized below:

Stabilization of Agricultural Productivity
Erosion control for irrigated area where has high erosion potential, directly contributes to the stabilization of the agricultural productivity by preventing top-soil loss.

Prevention of Destruction of Arable Land and Farm Roads
Erosion control contributes to the prevention of the disappearance of arable land and the destruction of farm roads and irrigation facilities.

Sustaining of Functions of Irrigation Facilities
Erosion control contributes to sustaining of quality of the irrigation facilities for maximizing the irrigation efficiencies by the prevention of siltation in the irrigation canals and elated facilities.

Strengthening of Maintenance for Soil Conservation Works
Strengthening of the operation and maintenance for erosion control contributes to sustaining of agricultural productivity and quality of the irrigation facilities, and to the minimization of the expense on operation and maintenance.

4.5.2 Selection of Soil Conservation Project Area (SCPA)

A reconnaissance survey for the Soil Conservation was made by JICA Study Team with Romanian Counterparts from July to August 1994 (Phase I) to determine the nature and extend of soil conservation in the Study Area. Based on the reconnaissance survey, soil conservation study area (SCSA) were selected and initial assessment of SCSA was conducted. More detailed survey on the erosion conditions in SCSA was made from October to December (Phase II).

Taking into consideration the "basic concepts in project formulation (Chapter 4.2.1)" and financial allocation for the required works, the following areas have been selected for futher analysis as soil conservation project area (SCPA) in the Project . Location of these areas is listed below and shown in **Fig 4.5.2-A1**. Soil conservation for the remaining areas is also very important for the rural developments. However more detailed survey and budget are required for its implementation. It should be considered as future projects to be executed with other financial sources.

Sub-SCPA	Coverage (ha)
Odobesti	1,544
Tifesti	472
Panciu	2,278
Movilita	2,477
Paunesti	2,815
Total	9,586

Present situations of Sub-SCPA are shown in **Table 4.5.2-A1** and summarized below:

(1) Odobesti SCPA

The Odobesti SCPA lies between the Milcov and Putna rivers. Slope declination in this area is flat, less than 3 %. Present land use is mainly for vineyard and upland crops. The potential for soil erosion in this area is low. There is one existing drainage canal called Soimului. Capacity of this canal used for rehabilitation design in 1971 is 22.5 m^3/s. There are 9 existing dams in the Soimului canal and a large quantity of siltation is observed.

But, slope declination of western area adjacent to SCPA is steep, between 5 - 10 %. Present land use is mainly for vineyard. The potential for soil erosion in this area is very high and many gully erosion has been observed. But, many dams and drainage canals have been constructed in this area. Most of drainage water from this area concentrate in Soimului drainage canal. Its drainage area at the final conjunction point (BP) is 3,420 ha and 10-year probable maximum discharge is assumed to be 48.3 m^3/sec. Due to lack of canal capacity, SCSA is exposed to danger of flood and inundation.

(2) Tifesti SCPA

The Tifesti SCPA lies between the Putna and Susita rivers. Slope declination in this area is also flat, less than 3 percent. Present land use are mainly for vineyard and upland crops. The potential for soil erosion in this area is low.

Slope declination of the western area adjacent to SCPA is less than 3 %. Present land use is mainly for vineyard. The direct drainage area for SCPA is 490 ha. There is one existing drainage system in this area and its drainage area is 100 ha. The potential for soil erosion in this area is low. But, to protect the irrigation area, boundary drainage canal of SCSA is required.

(3) Panciu SCPA

The Panciu SCPA lies between the Susita and Zabraut rivers. Present land use is mainly for vineyard and upland crops. Slope declination in this area is a little steep, between 3 - 5 %. The potential for soil erosion in this area is a little high. To avoid soil erosion, the soil conservation practices (counter cultivation, grass strip, deep ploughing) or broad terrace is required. There is one natural waterway in SCPA.

Slope declination of the western area adjacent to SCPA is between 3 - 5 %. Present land use is mainly for vineyard. The direct drainage area for SCPA is 1,430 ha. There are the following two existing drainage systems in this area. These drainage canals can be used as boundary drainage canal (B.D.C) of SCPA.

Susita Drainage System: Drainage area = 380 ha
Zabraut Drainage System: Drainage area = 820 ha

(4) Movilita SCPA

The Movilita SCPA lies between the Zabraut and Carecna rivers. Present land use is mainly for vineyard and upland crops. Slope declination of this area is between 3 - 5 %. The potential for soil erosion in this area is a little high. The existing irrigation canal (CD4) has been damaged by small-scaled erosions. Therefore, the soil conservation practices or broad terrace is required. There are 3 natural waterways in this area. Gullys are growing in some parts of these waterways and several dams have been constructed as gully prevention works. Siphons are planned at crossing points of these waterways and irrigation canals (CD4, CD5 and CD6).

Slope declination of the western area adjacent to SCPA is 3 - 5 %. Present land use is mainly for vineyard. The direct drainage area for SCPA is 840 ha. There is no existing drainage system. To protect irrigation area, the boundary drainage canal is required.

(5) Paunesti SCPA

The Paunesti SCPA lies between the Carecna and Trotus rivers. Present land use is mainly for vineyard and upland crops. Slope declination of this area is between 3 - 10 %. The potential for soil erosion is the highest in SCPA. To avoid the soil erosion, soil conservation practices or broad terrace is required. There is a ravine called Boului. Eight (8) dams and one chute have been constructed on the main stream of Boului. 3 drops have been constructed in the tributary of Boului called the Domosita Secata. Siphons are planned at crossing point this ravine and irrigation canals (CD2 and CD3). To protect these siphons, some dams are required.

Slope declination of the western area adjacent to SCSA is between 3 - 10 %. Present land use is mainly for vineyard. The direct drainage area for SCPA is 1,400 ha. There is no existing drainage system in this area. To protect irrigation area, soil conservation practices and boundary drainage canal are required.

4.5.3 Countermeasures

Generally, the situation in irrigated area becomes worse, if rainfall occurs immediately after an irrigation application. The soil is then already full of water and its ability to absorb rain water is less than normal. Consequently, water ponds where the surface topography is level, but moves rapidly across sloping sites, causing erosion of the soil surface. Uncontrolled concentrated runoff within the irrigated area can also induce gully formation and sedimentation, causing damages in the downstream area as well as reduction of soil fertility due to the outflow of top-soil. The basic countermeasures against water erosion are summarized as follows:

- To promote percolation of rainfall into sub-soil and to take measures to minimize surface runoff;
- To take measures to minimize the velocity of the surface runoff;
- To drain out the concentrated water safely through drainage facilities;
- To make the barren period of fields as short as possible; and
- To modify soil structure to improve durability (single grained - aggregated structure)

To protect the irrigated area and irrigation facilities, the following countermeasures are required;

(1) Soil Conservation Farmings

As soil conservation farming, contouring and contour-strip-cropping and are effective to promote infiltration of rain water, to retain capacity of soil moisture and to minimize the velocity of surface runoff. These soil conservation farmings should be encouraged more in and around SCPA. Contour-strip-cropping is illustrated in **Fig 4.5.3-A1**.

Actual soil loss in SCPA has been estimated by the USLE method as shown in **Table 4.5.3-A1**. The annual soil loss is about 19,600 ton (=15,100 m^3). If contouring is introduced into SCPA, the annual soil loss decrease is to 9,800 ton (=7,500 m^3) from 19,600 ton. (**Table 4.5.3-A2**)

(2) Level Terrace

Generally, a level terrace is constructed with non-channel grade (**Fig 4.5.3-A2**). The channel and ridge top are built level so that runoff is stored along terrace. The end of the terrace usually are closed. Therefore, the soil absorbs the water and serves as the terrace outlet. Due to the following reasons, level terrace is proposed to introduce in SCPA.

- Terracing is one of the best practices for soil conservation on sloped land;
- Level terrace is effective to promote infiltration of rain water, to retain capacity of rain water and to minimize the velocity of surface runoff;
- Level terrace is adaptable to arable land due to its capacity for cultivation even on the terrace area;
- Level terrace is effective against siltation in the distribution canal (CD); and
- Level terrace is effective for the reduction of discharge through the drainage canals in the Field.

Level terrace has been planned in the following two alternative areas (**Fig 4.5.2-A1**). In the case of Alternative-A, level terrace is introduced to all the arable land in SCPA and the annual soil loss in SCPA will be decreased to 2,900 ton (=2,200 m^3) from 19,600 ton (without soil conservation) (**Table 4.5.3-A3**). In the case of Alternative-B, level terrace is introduced to the arable land which is classified as moderately eroded area (1,839 ha) and soil conservation farming (contouring, contour-strip-cropping) is introduced to the remaining area of the arable land in SCPA.

Alternative-A

Sub-SCPA	Block No.	Area of Level Terrace (ha)
Odobesti	23, 31	777
Tifesti	18	462
Panciu	13, 14A, 15, 16, 17, 14*	2,233
Movilita	5, 6, 8, 8A, 9, 12	2,431
Paunesti	1, 2, 3, 4, 4A	2,758
Total	19 blocks	8,661

Alternative-B

Sub-SCPA	Area of Level Terrace (ha)	Area of Soil Conservation Farmings (ha)	Total (ha)
Erosion Condition	Moderate	Slight	
Odobesti	0	777	777
Tifesti	0	462	462
Panciu	129	2,104	2,233
Movilita	703	1,728	2,431
Paunesti	1,007	1,751	2,758
Total	1,839	6,822	8,661

(3) Grassed Waterway

The grassed waterway is one of the basic soil conservation practices commonly used by the farmers. When rainfall exceeds the rate or volume at which the soil can take in and store

moisture, surplus water passes over the land in the form of runoff. Since the success of any soil conservation plan depends on the removal of this surplus water without undue erosion, the area needed for waterway should be dedicated to this purpose and consideration of the production of crops should be secondary. This practice is applicable only to those areas where rainfall or irrigation provides the moisture needed to grow and sustain a good grass cover. Generally, grassed waterway is used for the following purposes:

- As outlets for diversions and terraces;
- To dispose of water collected by road ditches or catch drain; and
- To rehabilitate natural drains carrying concentrations of runoff.

Grassed waterway has been planned at the following natural waterways (**Fig 4.5.2-A1**).

Sub-SCPA	Name of Waterway	Length (km)
Panciu	PAN-GW1	5.5
	PAN-GW2	5.5
Movilita	MOV-GW1	7.0
	MOV-GW2	6.5
	MOV-GW3	4.0
Paunesti	PAU-GW1	2.5
	PAU-GW2	2.0
Total		33.0

(4) Boundary Drainage Canal (BDC)

To prevent the occurrence of soil erosion in the irrigated area, the countermeasures at the upstream side should be emphasized. Generally, Distribution Canals (CD) and its maintenance roads are planned along the boundary of the upstream side of the Project Area. BDC has been planned at the upstream side of these maintenance road. On the viewpoint of the scouring of siltation in BDC, velocity will be required more than 3 m/s. Therefore, BDC hasn't be parallel to CD. Route of each BDC is shown in **Fig 4.5.2-A1**. Canal name, drainage river and length of BDC are as follows:

Sub-SCPA	Canal Name	River to be drained	Length (km)
Tifesti	TIF-BD1	Susita	3.50
Movilita	MOV-BD1	Zabraut	3.30
	MOV-BD2	Carecna	3.50
Paunesti	PAU-BD1	V.Voului	2.85
	PAU-BD2	V.Voului	3.20
Total			16.35

(5) Gully and Ravine Control Works

1) Sabo Dam

There are several gullys and ravines in the Project Area. Distribution Canals (CD) cross these gullys and ravines. Siphons are planned at these points. To protect the siphons, Sabo dams are planned at downstream section of the siphons. Furthermore, to control the growth of gully, several Sabo dams are required. Proposed sites are shown in **Figs 4.5.3-A3** and **A4**.

(unit: nos.)

Sub-SCPA	Type-A (h=6.0m)	Type-B (h=4.0m)	Total
Movilita	0	1	1
Paunesti	2	3	5
Total	2	4	6

2) Soimului Canal

The 10-year flood discharge at the base point (catchment area = 3,420 ha) of the Soimului canal in Odobesti SCPA is estimated at 48.3 m^3/s. The flow capacity of the Soimului canal after dredging is estimated at 22.5 m^3/s. Therefore, 25.8 m^3/s of surplus water will overflow at the base point. To dissolve the uneasiness of flooding, rehabilitation works are required at the Soimului canal (L=8.0 km) in Odobesti SCPA. Main works are dredging the siltation and lining. Locations of Soimului canal are shown in **Fig 4.5.2-A1**.

(6) Maintenance of Soil Conservation Works

The maintenance of the soil conservation works consists of the following items:

- Administrative affair;
- Enlightening education and training for the soil conservation to farmers and associations;
- Round patrol for soil conservation area;
- Planning and design of maintenance works; and
- Rehabilitation of the soil conservation facilities

Responsibilities for maintaining the soil conservation works shall be born basically by the beneficiaries (state farms, associations and individual farmers) in the Project Area with the assistance of the Government.

Since the farmers in SCPA are not familiar with the soil conservation farming as well as the management of the large-scale irrigation scheme, a certain period for training the farmers in maintenance of the facilities as well as soil conservation farming will be required. For the smooth and successful initiation of the soil conservation works, the stepwise maintenance strengthening program for SCPA is proposed. The basic concepts of the proposed maintenance strengthening program is summarized below:

Step-1:

- At the initial stage of 5 years after the completion of the Project implementation, the Government through RAIF shall directly manage the maintaining works. The farmers and associations provide their labour forces to the maintaining works, as required.
- RAIF shall train the individual farmers in the management of soil conservation farming and the maintenance of soil conservation facilities.
- The required expenses for execution of the O/M works will be responsible by the Government.

Step-2:

- All the maintaining works will be handed over to the water users' association .
- O/M Office of the Project shall assist the water users' association in maintenance work.
- The expenses required for the maintenance works except for the government's assistant components shall be born by the water users' association.

4.5.4 Selection of Soil Conservation Plan

Based on the above study, the following two alternative soil conservation plans have been formulated. From the viewpoint of soil conservation, the grade of Alternative-A is higher than that of Alternative-B. The final plan will be selected after the comprehensive project evaluation in Japan. The salient features of the plans are shown below:

(1) Alternative-A

In Alternative-A, level terrace system is introduced to all the arable land in SCPA. Main countermeasures for Sub-SCPA are summarized below:

1) Odobesti SCPA

- Level Terrace:		777 ha
- Rehabilitation of the Soimului Canal:		8.00 km

2) Tifesti SCPA

- Level Terrace:		462 ha
- Boundary Drainage Canal:	TIF-BD1:	3.50 km

3) Panciu SCPA

- Level Terrace:		2,233 ha
- Grassed Waterway:	PAN-GW1:	5.50 km
	PAN-GW2:	5.50 km

4) Movilita SCPA

- Level Terrace:	2,431 ha	2,431 ha
- Grassed Waterway:	MOV-GW1:	7.00 km
	MOV-GW2:	6.50 km
	MOV-GW3:	4.00 km
- Boundary Drainage Canal:	MOV-BD1:	3.30 km
	MOV-BD2:	3.50 km
- Sabo Dam:	Type-B:	1 nos.

5) Paunesti SCPA

- Level Terrace:		2,758 ha
- Grassed Waterway:	PAU-GW1:	2.50 km
	PAU-GW2:	2.00 km
- Boundary Drainage Canal:	PAU-BD1:	2.85 km
	PAU-BD2:	3.20 km
- Sabo Dam:	Type-A:	2 nos.
	Type-B:	3 nos.

(2) Alternative-B

In Alternative-B, level terrace system is introduced to the moderately eroded area (1,839 ha) of the arable land in SCPA. Therefore, the soil conservation farming (contour-strip-cropping) should be introduced to the remaining area (6,822 ha, slightly eroded area). Main countermeasures for Sub-SCPA are summarized below:

1) Odobesti SCPA

- Level Terrace:		0 ha
- Introduction of SCF:		777 ha
- Rehabilitation of the Soimului Canal:		8.00 km

Note: SCF=Soil Conservation Farming (Contour-strip-cropping)

2) Tifesti SCPA

- Level Terrace:		0 ha
- Introduction of SCF:		462 ha
- Boundary Drainage Canal:	TIF-BD1:	3.50 km

3) Panciu SCPA

- Level Terrace:		129 ha
- Introduction of SCF:		2,104 ha
- Grassed Waterway:	PAN-GW1:	5.50 km
	PAN-GW2:	5.50 km

4) Movilita SCPA

- Level Terrace:		703 ha
- Introduction of SCF:		1,728 ha
- Grassed Waterway:	MOV-GW1:	7.00 km
	MOV-GW2:	6.50 km
	MOV-GW3:	4.00 km
- Boundary Drainage Canal:	MOV-BD1:	3.30 km
	MOV-BD2:	3.50 km
- Sabo Dam:		1 nos.

5) Paunesti SCPA

- Level Terrace:		1,007 ha
- Introduction of SCF:		1,751 ha
- Grassed Waterway:	PAU-GW1:	2.50 km
	PAU-GW2:	2.00 km
- Boundary Drainage Canal:	PAU-BD1:	2.85 km
	PAU-BD2:	3.20 km
Sabo Dam:	Type-A:	2 nos.
	Type-B:	3 nos.

The above-mentiond two alternatives were proposed at end of the Phase II field survey and a comparative study was made in Japan. Alternative-B is selected as definitive plan for soil conservation in consideration of the following matters:

- About 1.63×10^9 Lei (US$ 932,000) of construction cost can be reduced as shown below (**Tables 4.5.5-A1** and **A2**):

Alternative	Construction Cost (10^6 Lei)
A	5,000
B	3,367
Deduction	1,693

- The farmers in the Project Area still have not accustomed themself to the level terrace on gentle slope land (less than 3%). Phased introduction of soil conservation works is desirable; and
- Although there exist a fearis about siltation in CD, other countermeasures (soil conservation farming, grassed waterway and drainage canal along CD) are effective to minimize the siltation in CD.

4.6 RURAL INFRASTRUCTURE DEVELOPMENT PLAN

4.6.1 Road Network

(1) General

Roads in the Project Area can be divided into the following 5 categories:
- *National Highway (No.2 or E85)* : running the eastern border of the Project Area and will be major access road for the construction and agricultural production marketing, maintained by the Ministry of Transportation and Communication (MTC);
- *National Roads diverted from the National Highway (2D)* : crossing east to south in southern part of the Project Area and connecting Focsani, Bolotesti and Tirgu Secuiesc over crossing the Carpathian Mountains;
- *District Roads* : connecting major towns/villages in and around the Project Area, which will also be the major roads of the Project during the construction and agricultural activities;
- *Village Roads* : which will be the secondary roads for the Project;
- *Farm roads* : running the boundary of each cultivation plot which will be maintained as a farming and operation and maintenance road of the Project; and
- *Operation and Maintenance Roads along the distribution canals* : working as the operation and maintenance roads for the re-pumping stations and distribution canals

(2) Road Network Improvement

In order to maintain the access to the sites/field during the construction stage and agricultural production stage after construction, the improvement of the existing road network is essential. In the Project, the improvement of district roads and village roads in the Project Area is planned. The new construction of operation and maintenance roads is also proposed.

The existing national roads (No. 2 and 2D) and District roads (Dj 205F and Dj 205A) are considered to be maintained or up-graded by the Ministry of Transportation and Communication or the Road Authority of Vrancea District. Therefore, the improvement of these roads is excluded from the Project.

The road improvement and new construction with the Project is composed of the following 12 existing roads, 17 operation maintenance roads along the distribution canals including connecting road to the operation and maintenance roads;

1) Artery roads to be widened and asphalt-paved;
   - District road Dj 206H, the section between Dominesti Sat and Paunesti
   - District road 37, the section between Ciorani and Movilita
   - District road Dj 204 E, the section between Haret and Panciu
   - District road Dj 205 E, the section between Bizighesti and Tifesti

2) Secondary roads to be widened and gravel-surfaced;
   - District road 26, the section between Dominesti and Ruginesti
   - District road 35, the section between Calimanesti and Domnesti
   - Village roads connecting Padureni and Movilita along the Zaburaus River
   - Village roads along the Panciu-Marasesti Railway, the section between National highway and Dj 205F

- Village roads along the right bank of Putna River connecting Galofa and Putna through Jianesti

3) Operation and maintenance roads along the distribution canals to be gravel-surfaced named CD.1A, CD.2-A, CD.2-B, CD.3, CD.4, CD.5, CD.6, CD.7-A, CD.8-A, CD.9, CD.7-B, CD.8-B, CD.10-A, CD.11, CD.8-C CD.10-B

4) Connection road connecting SRP-II and SRP-IV.

4.6.2 Other Rural Infrastructures

(1) Domestic Water Supply

As stated in Chapter 3 of the Report, the existing domestic water supply facilities for the villages concerning the Project face the difficulties in their operation and maintenance. And the urgent countermeasures to improve the existing conditions are eagerly requested. The improvement of these existing domestic water supply systems is not included in the Project. It shall be solved by the individual towns/villages with the assistance of the Romanian Government.

(2) Agricultural Marketing and Agro-industry Facilities

It is essential to install the collecting points and storage houses for vegetable or other agricultural products in order to reach the final target of the Project. Under the new economic system, they will be installed by the private commercial company or associations under their best efforts in the financial and management conditions. Therefore, these facilities are excluded from the Project. The details are described in the Agricultural Supporting Activities separately.

4.7 INFRASTRUCTURE FACILITIES PLANNED

4.7.1 Irrigation Facilities

(1) Calimanesti Dam and Siret-Baragan Canal

The Calimanesti Dam and the Siret Baragan Canal, which intakes water from the Calimanesti Dam, are the main water sources of the Project. The Calimanesti Dam is almost completed by the state owned Romanian Electric Supply Company (RENEL), former Ministry of Energy. The Siret-Baragan Canal is planned and its construction has been started under the Ministry of Water, Forest and Environmental Protection (MoE). In the Project, these facilities are considered as the given conditions.

(2) Distribution Pump Stations (SRP)

Distribution pumps are planned to be operated for 24 hours a day throughout the irrigation period, April to September. As stated in sub-Chapter 4.2 of this Chapter, ten (10) distribution pump stations are planned. The installation of 4 stations among them, i.e. SRP-I, IV, V and VII has been almost completed as of 1994. Typical drawings of SRP are shown in **Fig 4.7.1-A1** and **A2.**

1) Method of Water-taking

The water resources and methods of water-taking for respective distribution pump stations are as follows:

Name of Pump Station	Water Resources	Method of Water-taking
SRP-IA	Calimanesti Dam	Minus-back type
SRP-V and -IX	Main Canal	Plus-back type with Siphon
SRP-I and -VII	Distribution Canal	Minus-back type (Vertical-type Pump)
SRP-II, III, IV, VI and VIII	Distribution Canal	Plus-back type (Horizontal-type Pump)

2) Number and Size of Pumps

The combined installation of pumps of different sizes is planned for respective stations in consideration of economical operation of pumps or minimizing the operation cost of pumps in coping with the seasonal big change of water requirements in the field. The proposed number and size of pumps for respective pump stations are finalized as shown in **Table 4.7.1-A1** in due consideration of minimization of probable troubles in pump operation in addition to the above factors. However, the pump facilities in SRP-I, -IV, -V and -VII which have already been installed are to be used without modifying or changing any part of the facilities in consideration of the capacities of the existing pumps and design requirements for them.

3) Type of Pump

Judging from the required pump head and discharge, horizontal-axial single-stage volute type mixed flow pump (BRATES), horizontal-axial single-stage volute type centrifugal flow pump (NDS, RDN, NC and LOTRU) and vertical-axial multi-stage mixed flow pump (MV and MA) are adaptable. Due to cheaper price and easier operation & maintenance because of simpler structure of the horizontal-axial type pumps compered with the vertical-axial type ones, the horizontal-axial type pumps are adopted in the Project (**Table 4.7.1-A1**). However, the vertical-axial mixed flow pumps are adopted for SRP-I and -VII, because the pump facilities of these stations have already been installed at the site.

4) Operation Control and Protection of Pumps

The control of water discharge is to be made by increasing or decreasing number of pumps to be operated with the seasonal fluctuation of irrigation water requirement. The operation of pump is to be made locally by manual control at each station; 24-hour continuous operation and 3-sifts a day is planned. The counter facilities against the unexpected decrease of water level at the suction side or increase at the pressure tank are planned to install.

5) Ancillary Facilities

A flow meters is to be installed at the outlet of each pump station; an electromagnetic-type flow meter and ultrasonic-type one are selected for pump of 400 mm diameter or less and 500 mm or more, respectively, due to the economy of them. Furthermore, a vacuum pump is to be installed in the case of minus-back type horizontal-axial pump and siphon type horizontal-axial pump. The manual operation type screen and stop log for maintenance are planned for respective pump stations except for the ones which take water directly from the Main Canal. A drainage pump is planned for plus-back type horizontal-axial pump and vertical-axial pump. The overhead crane is planned for all pump stations.

6) Motor

A 3-phase erectric asynchlonous motor is adopted. The receiving service electric pressure is 20 kV. The specified voltages of the motor are 400 V in the case of low voltage (the motor output is less than 315 kW) and 6,000 V in the case of high voltage (more than 315 kW), respectively.

7) Pump House

The pump house of reinforced concrete is planned to protect the pump's mechanical and electrical equipment in consideration of the following:

- to secure easier maintenance of the pump facilities during winter season;
- to protect the mechanical and electrical equipment from severe weather;
- to decrease maintenance cost such as painting of mechanical equipment;
- to make sure the insulation among electric cables; etc.

(3) Distribution Pipeline

Water lifted by the distribution pumps is conveyed to the distribution canals through the distribution pipelines. Distribution pipelines are considered as a part of pump station facilities, whose lifting heights are determined in consideration of friction losses of distribution pipes. Most of the existing design of distribution pipes are applied in the Project. Distribution pipes crossing the tributaries are carefully designed in due consideration of degradation of drainage canals. The concrete ground sills are provided within 20 m downstream of the structure, and also the revetments on the bank slopes are provided where necessary. Distribution pipes are of steel pipe or prestressed concrete pipe and the earth cover over the pipe is more than 90 cm in view of the protection of pipes from frost heaving.

In the case of SRP-III and -VII, each pump of which covers two different areas, the distribution of water is made by single line of pipe up to the edge of the areas and water is diverted to respective areas there due to the economy of the pipeline facilities. The control of water volume at diversion point is made by butterfly valve. Furthermore, the water pressure regulation tank is planned to protect the facilities from their damage by probable water hammer except for SRP-VII and IX.

(4) Distribution Canals

There are 11 lines of distribution canals with the total length about 76 km in the Project (**Fig 4.7.1-A3** to **A15**). They are located at 3 stages depending on the pump lifting capacity and irrigation field alignment. They run along the contour line with gentle gradient between 1/5,000 and 1/10,000 with open canal and most of the flow section are arranged under the excavated section. Twenty one (21) control gates, 13 discharge gates, 14 road crossing structures and 15 river/drain crossing structures are required.

1) Lining of Distribution Canal

In Romania, most of the main distribution canals are lined by pre-cast concrete slab. In the Project Area, based on the original design, the distribution canals are constructed as a lining canal by pre-cast concrete slab. Because of the insufficient compaction and surface treatment of excavated canal and poor construction of concrete slab joints, the lining is damaged. Therefore the lining shall be cast in situ reinforced concrete as shown in **Fig 4.7.1-A17**. The canal lining machine is shown in **Fig 4.7.1-A18** for reference.

2) Flow Capacity and Cross Section

The cross section of distribution canal is determined by the required flow capacity and storage capacity for the pump operation lags between SRP and SPPs. The flow capacity of the canals at each section are shown in **Fig 4.7.1-A16**. The basic cross section of canal is determined by the flow capacity, and then the required storage capacity is added to the section. At the point where the required flow capacity changes by 20 % or at SRP, the water level regulating structure is installed in order to change the cross section. The stretch of each distribution canal is shown in **Table 4.7.1-A2**.

In order to obtain the easy construction and maintenance, the canal bottom widths are set at 1.0, 1.5 and 2.0 m with side slope of 1 to 1.5. Standard section of the distribution canal are shown in **Fig 4.7.1-A16**. The canal lining shall be cast-in-situ concrete with slide forms, because the presently used precast concrete slab lining causes poor joint works and increases the seepage losses.

3) Water Level Regulating Structures

To maintain the water level in the canal upstream or downstream for the safety drive of pumps of SRPs and SPPs which suck water from the distribution canals. In Romania, automatic regulating gates are widely used in the irrigation canal, at which the gate with counter weight is mechanically operated by the balance of the upstream and downstream water level set. Typical design of the water regulating structure is shown in **Fig.4.7.1-A19**. Totally 22 water level regulating structures and 13 sets of side gates at the end of distribution canal are planned, which are usually connected to the spillway for discharging excess water and evacuate the water in the canal for the inspection and maintenance (**Table 4.7.1-A2**).

4) Road/River Crossing Structures

Totally 43 road crossing structures and 15 river/drain crossing structures are required.

a) Road crossing structures

Basically road crossing structures are the precast reinforced concrete culvert covered with concrete for reinforcing the concrete culvert depending on the coverage of culvert and traffic loads. The diameter of the pipes shall be determined by the discharge and maximum velocity at 1.0 m/s or the minimum diameter 1.0 m considering its easy maintenance. In order to avoid the silting in the culvert, the bottom of the culvert shall be above the downstream canal bed elevation. The minimum coverage of the soil above the culvert crest shall be 1.5 m. In the case it becomes less than the minimum, the road surface shall be elevated. Road crossing structures and their diameter of pipes are shown in **Table 4.7.1-A3** and typical design is shown in **Fig 4.7.1-A20**.

b) River/drain crossing structures

The aqueducts with flume and pipe and siphons can be considered as a river/drain crossing structures. Considering that most of the rivers or drains in the Project Area are shallow, the siphon type is adopted in the Project as that of the river/drain crossing structures. The cross section and material of the siphon are determined based on the allowable head losses, the maximum velocity 1.0 m/s and water pressure in the siphon with minimum diameter 1.0 m as same as road crossing structures. Even the future plan of river training exists, the siphon shall be buried due to the present river/drain course with minimum coverage 1.5 m above the top of structure. And ground sill shall be installed downstream of the structure against the degradation of the river, and the minimum 20 m revetment shall be provided at both up and down streams on the both bank. The de-silting basin at the inlet and screen to protect the foreign materials and safety of the people at both ends of siphon. Design conditions of river/drain crossing structures are shown in **Table 4.7.1-A3** and typical syphon design is shown in **Fig 4.7.1-A21** to **A23**.

(5) Booster Pump Stations (SPP)

Booster pumps are planned to be operated for 20 hours a day throughout the irrigation period, April to September. Totally 49 booster pump stations are planned, 13 stations (SPP-6, 7, 9A, 10, 11, 14-2, 14-3, 15A, 17A, 19, 22, 25 and 28) out of which have been almost completed as of 1994. Typical drawings of SPP are shown in **Fig 4.7.1-A24** and **A25**.

1) Method of Water-taking

The water resourses and the methods of water-taking for respective booster pump stations are summarized below:

Name of Pump Station	Water Resources	Method of Water-taking
SPP-10, 11, 20, 20A, 21, 26, 27 and 28A	Calimanesti Dam and Main Canal	Plus-back type with Siphon
SPP-6, 7, 14-2, 14-3, 15A, 17A, 19, 22, 25 and 28	Distribution Canals	Minus-back type (completed vertical-axial pump)
31 SPPs other than the above	Distribution Canals	Plus-back type

2) Number and Size of Pumps

The combined installation of pumps of different sizes is planned for respective stations in consideration of economical operation of pumps or minimizing the operation cost of pumps in coping with the seasonal change of water requirements in the field. The proposed number and size of pumps for respective pump stations are finalized in due consideration of minimization of probable troubles in pump operation in addition to the above factors. Furthermore, the design unit discharge of irrigation facilities is set based on the water requirement of maize. Therefore, the adjustment of irrigation water amount to the fields of different crops shall be made by adjusting the operation time of sprinkling.

3) Type of Pump

Judging from the required pump head and discharge, horizontal-axial single-stage volute type centrifugal flow pump (RDN, NC and LOTRU) and vertical-axial multi-stage mixed flow pump (MV and MA) are adaptable. Due to the same reasons as for SRP, the horizontal-axial type pumps are adopted in the Project (**Table 4.7.1-A5**). However, for the pumps which have already been installed at the site, the following arrangements are planned:

SPP with Vertical-axial Pumps
- Increase of pump unit for SPP-6, 7, 14-2, 14-3, 15A, 17A, 19, 22, 25 and 28
- Transfer of 4 pump units of MA 200x2 at SPP-7, 14-2 and 14-3 to other projects

SPP with Horizontal-axial Pumps
- Transfer of 3 pump units of RDN 200-150-220 and 3 units of AN 200-150-315 at SPP-9A to other projects
- Transfer of 5 pump units of RDN 200-150-235 at SPP-11 to SPP-9A by adding one more same unit
- Construction of new station at SPP-11 by demolishing the existing one

4) Operation Control and Protection of Pumps

The control of water discharge which is changed due to the seasonal change of cropping areas is to be made by increasing or decreasing number of pumps to be operated. The operation of pump is to be made locally by manual control at each station, 20-hour operation and 3-sifts a day is planned. The counter facilities against the unexpected decrease of water level at the suction side or increase at the pressure tank are planned to install.

5) Ancillary Facilities

An electromagnetic-type flow meter is to be installed at the outlet of each pump station in consideration of the size of pumps being 400 mm diameter or less. A vacuum pump is to be installed in the case of siphon type horizontal-axial pump. The manual operation type screen and stop log for maintenance are planned for respective pump stations except for the ones which take water directly from the Calimanesti Dam or Main Canal. A drainage pump is

planned for boosting-type horizontal-axial pump and vertical-axial pump. The overhead crane is planned for all pump stations.

6) Motor

A 3-phase erectric asynchronous motor is adopted. The receiving service electric pressure is 20 kV. The specified voltage of the motor is 400 V in low voltage for all SPPs.

7) Pump House

The pump house of reinforced concrete is planned to protect the pump's mechanical and electrical equipment with the same reasons as for SRP.

(6) Distribution Pipes(CPs), Sub-distribution Pipes(Antenna) and Hydrants

The pressed water is delivered to the field through distribution pipes, sub-distribution pipes and hydrants installed on the sub-distribution pipes. They are installed based on the filed geometrical condition and in consideration of land ownership of the field. The alignment of sub-distribution pipes is designed considering the sprinkler facilities not crossing the farm roads as much as possible.

1) Water Conveyance Method

Irrigation water is to be conveyed directly to CPs and Antenna through the pressure water tank to be provided at the outlet of each pump station in consideration of the following:

- The field is generally flat and practically no place is available for constructing a distribution reservoir;
- Easy control of water pressure at the nozzle of sprinkler;
- Adjustability to the small discharge;
- Easy control of design pressure of pipeline; and
- Prevension of water hammer.

Steel pipe is used around the pump unit. Prestressed concrete pipe, asbestos cement pipe or PVC pipe is used for CPs and Antenna depending on the site conditions. The minimum earth cover over the pipes is 90 cm due to protection of pipe from its frost heaving.

2) Hydrants

Hydrants are the point of the lateral pipe connecting with sub-distribution pipes. The hydrant is installed in the sub-distribution pipe at the interval of 72 m, considering sprinklers to be installed. In Romania, all the lateral pipes are of 100 mm diameter, therefore, the hydrants are of the same standard at 100 mm diameter with maximum pressure of 10 kgf/cm^2.

(7) Field Irrigation Equipment

1) Sprinklers

Based on the following design criteria, type of sprinkler is determined at diameter 7 mm with sprinkling pressure 3.5 kgf/cm^2;

a.	design net water requirement :	1,460 m^3/month/ha or equivalent to 4.71 mm/day
b.	the irrigation interval :	12 days with sprinkling time of 10 hours
c.	Size of one sprinkler unit	24 m x 18 m
d.	Standard length of Antenna :	400 m