Fainal Report
of
The Trial Agricultural Development Project
for
Semi Arid Areas in Turkey

September 1996

JAPAN INTERNATIONAL COOPERATION AGENCY

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FOREWORD

Japan International Cooperation Agency (JICA) has implemented technical cooperation for seven years (September 1989 through September 1996) under the Trial Agricultural Development Project for Semi-arid Areas in Turkey in acordance with the record of discussions (R/D) between the Ministry of Agriculture and Rural Affairs (MARA) and JICA.

The Project involves verification tests for field crops,vegetables and fruit trees in the semi-arid areas that utilize economical irrigation systems.

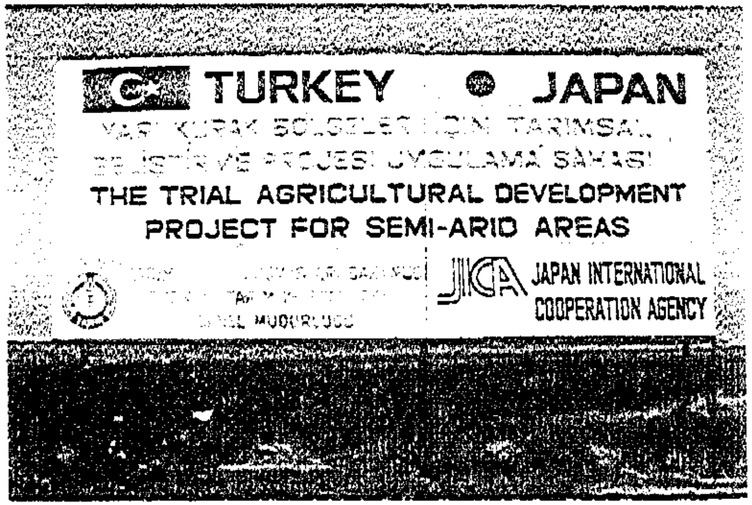
This report represents the results of verification tests and necessary basic data for agricultural development in the semi-arid areas throughout the seven years of Project activities. We hope it will be serve as a useful tool for agricultral development in Turkey.

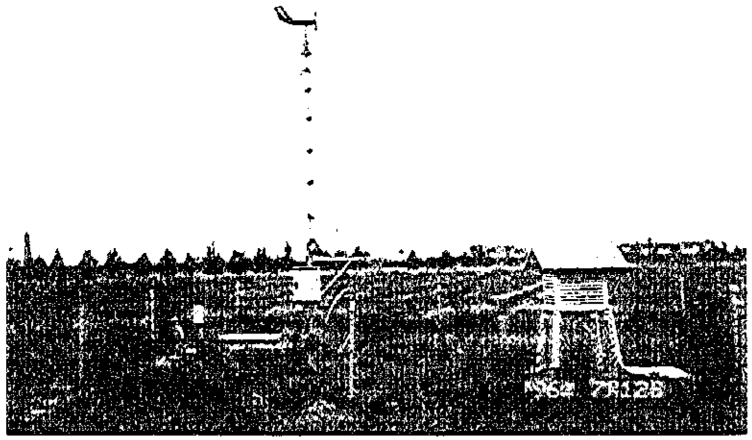
Finally, I would like to express my sincere appreciation to MARA, the General Directorate of Agricultural Enterprises (TIGEM),and other concerned officiales of both Japan and Turkey for their close cooperation.

August. 1996

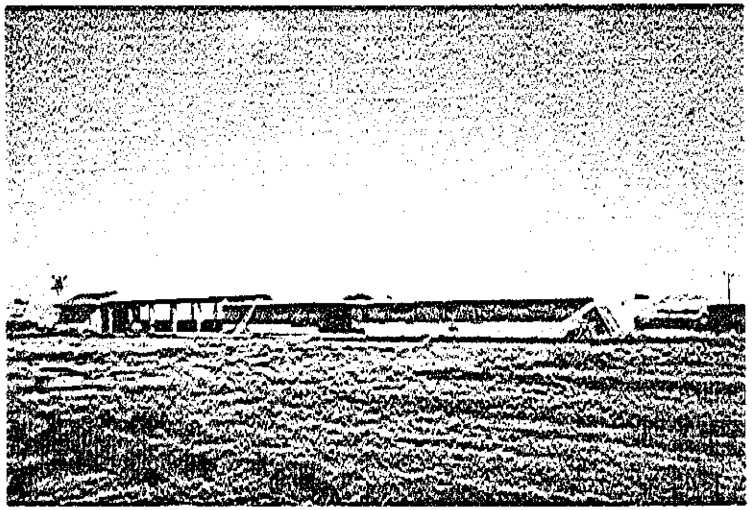
Shinsuke OTA

Managing Director,
Agricultural Development
Cooperation Department,
Japan International
Cooperation Agency

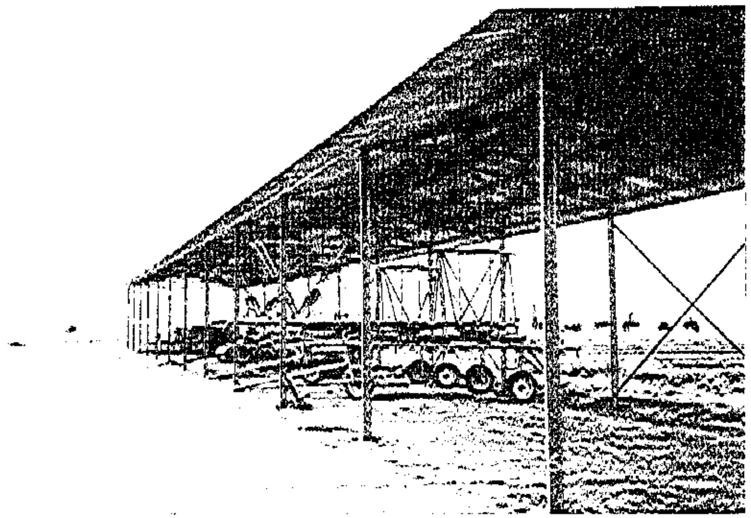




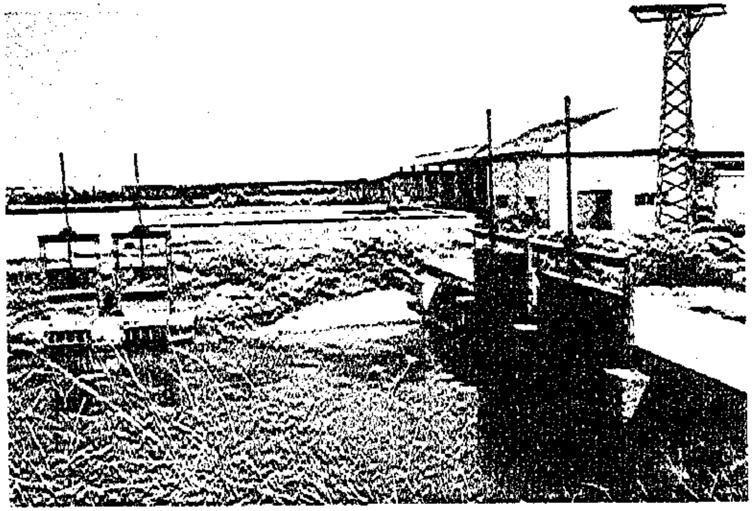
Weather data collection equipments.



On farm office.

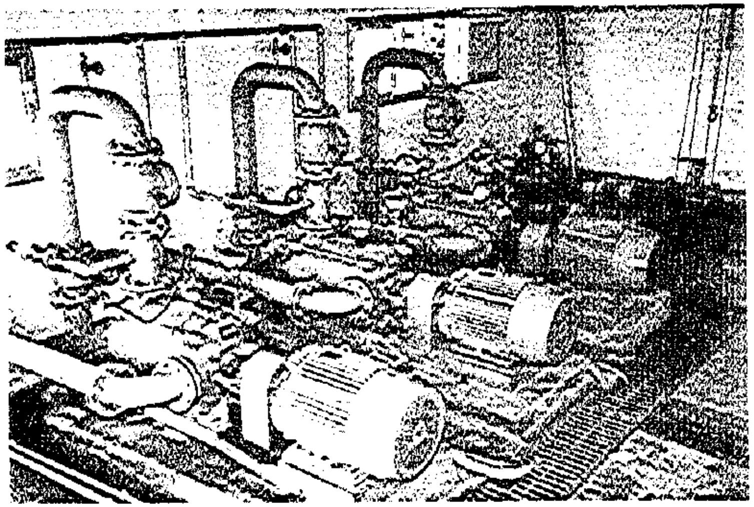


Temporary machineries shed.



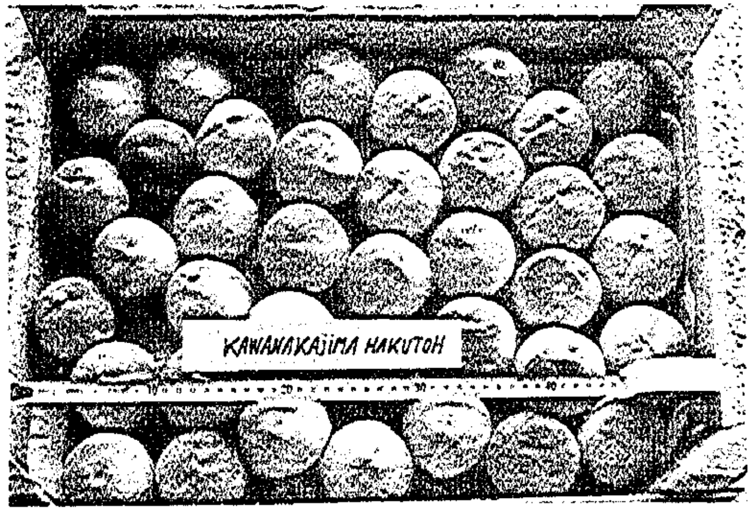
Intake facilities and pump house : two (2) intake gates (left) and two (2) check gates (right) on near side, and a storage pool (middle) and a pump house (right) over there.

A raingun set in operation; from the left side, turnout valve so called Hydrant, a traveller and a reel.

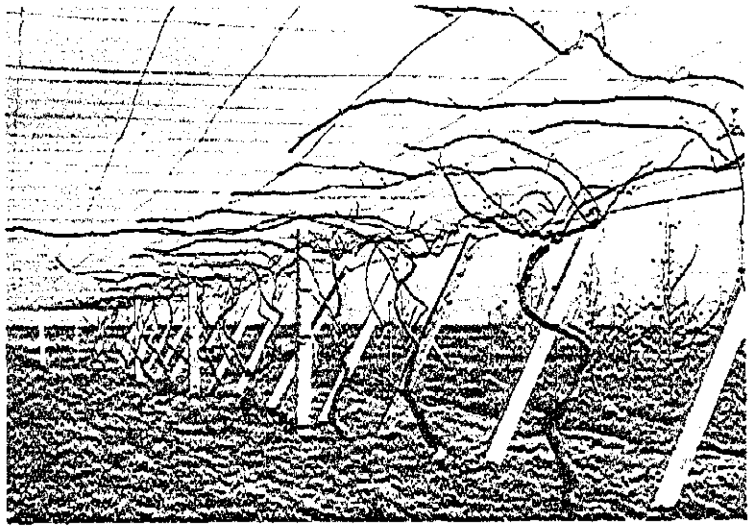


Three (3) set of sprinkler irrigation pumps on near side for field crops and vegetables, and two (2) set of drip irrigation pumps over there for orchard and vegetables.

Terminal irrigation equipments for kiwi lot; a drip tube fit on diaphrugm type emitters, and a mini sprinkler tube with rotated type mini sprinklers, for 1996 experiments.



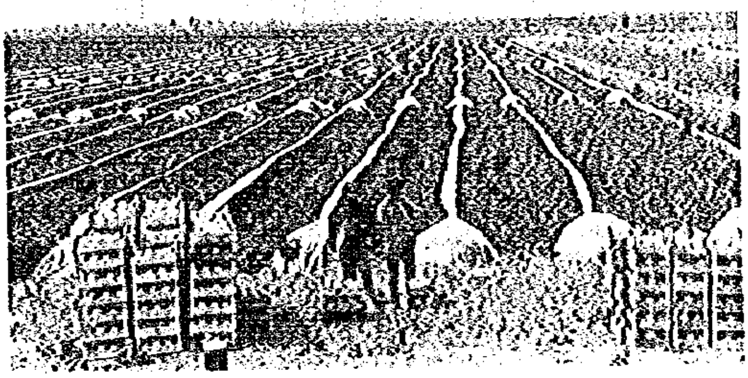
"KAWANAKAJIMA" Peach applied bagging culture and bags had taken off 5 days before harvest.



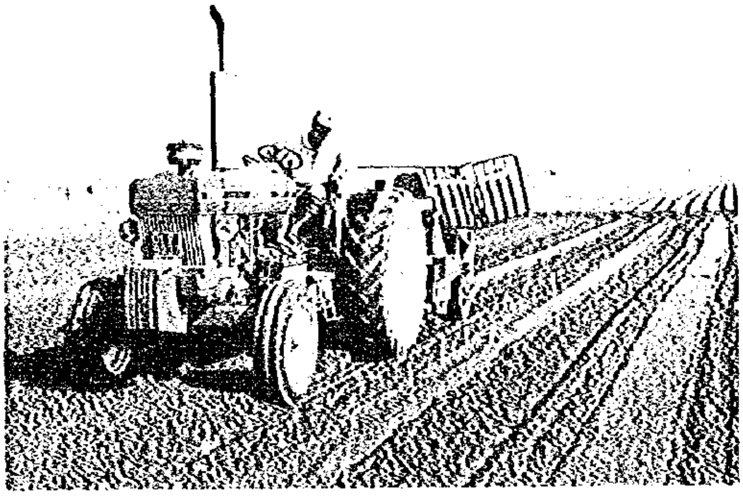
"KYOHOH" Grape vines changed to Horizontal trellis training from Hedge-row training.

Well fruited "PAPAZ" Plum.

"DIXI RED" Peach tree after pruning by open-center farm training.



Melon cultivation field and harvested melon for export.



Mechanical planting test in Broccoli cultivation.

Daikon shipment used wooden boxes.

A List of Acronyms

a.	:	are (100 m²)
CAP	:	Common Agriculture Policy
da.	:	dekar (1,000 m² = 10 ares, Turkish)
Dfl	:	Dutch Florin (Currency)
DM	:	Deutsche Mark (German Currency)
DSI	:	General Directorate of State Hydraulic Works
EC	:	Electric Conductivity
EC	:	European Communities
ECU	:	European Currency Unit
EFTA	:	European Free Trade Area
El.	:	Elevation
EU	:	European Union
FIRR	:	Financial Internal Rate of Return
GAP	:	Southeastern Anatolia Project (Turkey)
ha.	:	hectare (10,000 m² = 100 ares)
JICA	:	Japan International Cooperation Agency
JIS	:	Japan Industrial Standards
MARA	:	Ministry of Agricultural and Rural Affairs (Turkey)
M/U	:	Memorandum of Understanding
PVC	:	Polyvinyl Chloride
R/D	:	Record of Discussion
TIGEM	:	General Directorate of Agricultural Enterprises (Turkey)
TIP	:	Tentative Implementation Plan
TL	:	Turkish Lira (Turkish Currency)
TSI	:	Tentative Schedule of Implementation
VAT	:	Value Added Tax

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[1]　Outline of the Project

[1] Outline of the Project

1-1. Background and Objectives of the Project

1-1-1. Background of the Project

The Government of the Republic of Turkey gives priority on the development of semi-arid areas, which occupy a large portion of the country, in its GAP(Southeastern Anatolia Project), etc. Hence the Turkish government requested for the technical cooperation covering the latest irrigated agriculture technology from the Japanese Government.

The Government of Japan recognized that implementation of this cooperation would promote agriculture business for Japanese enterprises in semi-arid areas not only in Turkey but also in other countries of the world in the future through the provision of technical and management data.

Therefore, this project was formulated by both governments.

1-1-2. Objectives of the Project

The Project was aimed at the following.

① Selection of appropriate plants and their varieties
② Improvement and development of cultivation technologies, and collection and analysis of related basic data
③ Improvement and development of irrigation technology, and collection and analysis of related basic data
④ Preparation of a basic idea for agricultural development

1-2. Details of Implementation

a. March 1987

The first Japan-Turkey Joint Economic Committee was held in Istanbul, and Dr. Demir, Deputy Undersecretary of the Ministry of Agriculture, Forestry and Rural Affairs made a request for Japan's cooperation regarding the introduction of frontier technologies for the production of oil crop and vegetable seeds.

b. March 12 through 26, 1988

In response to the request mentioned a. above, Japan International Cooperation Agency (JICA) conducted the "First Basic Study on Cooperation for Agricultural Development in the Republic of Turkey." The contents of the study were as follows.

① Specific needs of the Government of Turkey regarding agricultural development
② Possibility of access of Japanese enterprises to agribusiness in Turkey

③ Collection of relevant data and information necessary for determining the scope of undertakings and selecting proposed sites, and field survey

c. September 14 through 29, 1988

JICA conducted the "Second Basic Study on Agricultural Development of Semi-arid Areas in the Republic of Turkey."

The main objectives of the study were as follows.

① Study of the Project for Agricultural Development in Semi-arid areas formulated by the Government of Turkey, and study on the Project's implementation on a provincial basis
② Selection of counterparts for the Project's implementation
③ Screening of proposed sites
④ Collection of relevant data and information

d. February 13 through March 2, 1989

JICA dispatched a consultation survey team to cause them to have discussions as follows with the Turkish authorities concerned, based on the findings in the previous study.

① Final selection of project site
② Final selection of counterparts
③ Examination of the draft Record of Discussions (R/D)
④ Study of the draft Tentative Schedule of Implementation(TSI)

e. September 5 through November 3, 1989

JICA dispatched four investigators on the long-term basis to cause them to conduct basic design study. The following were main study items.

① Infrastructure construction plan
② Test plan
③ Undertaking plan

f. September 25 through October 7, 1989

JICA dispatched a Consultation Survey Team to cause them to have consultations with the Turkish authorities concerned on basic items for the Project's implementation and conclude the R/D (signed on September 29). The R/D defined the framework of the Project. Main items are mentioned below.

① Objective (cooperation between the Government of Japan and the Government of Turkey for establishing cultivation and irrigation technologies in semi-arid areas and thereby contributing to agricultural development in the Republic of Turkey)
② Dispatch of Japanese experts

③ Provision of equipment
④ Special measures taken by the Japanese government
⑤ Training of Turkish counterparts in Japan
⑥ Services for the Turkish counterparts and the Japanese management staff
⑦ Measures taken by the Turkish government
⑧ Management of the Project
⑨ Duration of cooperation (five years from the day the R/D was signed)
⑩ Other items

g. February 3 through 15, 1990

JICA dispatched a Consultation Survey Team cause them to have consultations with the Turkish authorities concerned on the forwarding of concrete cooperation (regarding both technology and formalities) in accordance with the Project. The consultation results were compiled to the TSI, which was signed on February 12. The Team explained the details of experiment field preparation and fruit trees planting, which were planned for the year, and confirmed preparations to be made by both parties.

Main items of the TSI were as follows.

① Background -- the extending of cooperation
② Objectives of the Project
③ Project site and its scale
④ Duration of cooperation
⑤ Management of the Project (Joint Committee, Organizational Chart for the Project's Operation, etc.)
⑥ Infrastructure construction plan
⑦ Test and study schedule (subjects, objectives, items, periods, areas, methods,etc.)
⑧ Expenses for the Project's implementation
⑨ List of pieces of equipment to be provided

h. June 28 through July 5, 1990

JICA had consultations with the General Director of General Directorate of Agricultural Enterprises (TIGEM), who had been invited in Japan by a development cooperation program, regarding the conclusion of a Project Program, and signed the Minutes of Meeting on July 5.

i. August 28 through September 7, 1990

JICA dispatched a Consultation Survey Team to cause them to have detailed discussions regarding the Project Program mentioned in h.above, and signed the Memorandum of Understanding (M/U, two exemplified copies in English) for the Project's implementation.

Main contents were as follows.

① Project site and its area

② Objectives
③ Measures taken by the Japanese government
④ Measures taken by the Turkish government
⑤ Coordination (by the Joint Committee)
⑥ Financing
⑦ Background
⑧ Management (including Joint Committee)
⑨ Proposed project schedule (infrastructure construction, tests and studies, procurement of equipment, dispatch of experts, etc.)
⑩ Construction schedule and details of infrastructure
⑪ Schedule and details of field tests
⑫ Expenses
⑬ Formalities for the Project's implementation (after the signing of the R/D and the TIP(Tentative Implementation Plan))

j. February 7, 1991

Based on the M/U mentioned in i. above, the Government of Turkey performed formalities, and the Cabinet decision was made on February 7. The decision was notified in the Turkish official gazette dated April 8,1991.

1-3. Outline of the Project's Implementation

1-3-1. Implementation Agencies

The following agencies were assigned to the Project's implementation.

Japanese side: Japan International Cooperation Agency (JICA)
Turkish side: General Directorate of Agricultural Enterprises (TIGEM)

1-3-2. Period of Cooperation

It was decided that the period of technical cooperation under the Project will be five years from September 29,1989 through September 28, 1994, in accordance with the R/D.

The period was extended for two years from September 29, 1994 through September 28, 1996, in accordance with the R/D for extension.

1-3-3. Project Site

For the experiment field, a lot was selected in the Cukurova State Farm in Ceyhan District, Adana Province, which was possessed by TIGEM. The Farm, being situated in 37° 03' North Latitude and 35 ° 49' East Longitude, was almost in the center of the Cukurova Prairie, the granary of Turkey. The experiment field lay in Block 26 of the Farm, being in a trapezoid 870 meters east and west and 550 meters to 1,100 meters north and south.The field was irrigable land of 73.6 ha. The land was of alluvial soil 30 meters to 32 meters above sea level, with a descent of

1/700 eastward toward the Çeyhan River.

1-3-4. Infrastructure Construction

JICA concluded a contract with Konoike Corporation for constructing infrastructure including irrigation facilities for the field and the orchard, for the Project's implementation, and executed infrastructure construction through February to September, 1990.

Scales, arrangement, and irrigation areas of the experiment lots are shown in the following table.

Field	Area	Irrigation area
① Orchard lot	8.5 ha	8.5 ha
Kiwi fruit	(2.7)	
Peach	(2.0)	
Plum	(2.0)	
Demonstration field	(1.8)	
② Vegetable lot	4.5	3.0
Experiment lot	(3.0)	
Nursery lot	(1.5)	
③ Upland crop lot	45.0	45.0
④ Traditional irrigation experiment lot	7.0	7.0
⑤ Other lots (road, drainage, pump yard, machine regulation lot, etc.)	8.6	-
Total	73.6	63.5

1-3-5. Planting Fruit Tree Seedlings

Fruit tree seedlings, which had been purchased in Japan and sent to Turkey, were planted by a short-term expert from Japan in February and March, 1990in the Orchard Lot.

1-3-6. Dispatch of Experts

The following long-term experts were dispatched.

Technical field	Name		Period
Team leader & fruit tree	Ryuzo	ISODA	Oct.14,'90 - Oct.09,'92
Team leader	Takashi	KITAMURA	Sep.23,'92 - Sep.28,'96
Irrigation	Shoji	OGAWARA	Apr.03,'92 - Mar.28,'94
Irrigation	Joji	NAKAGAWA	Oct.01,'94 - Sep.28,'96
Upland crop	Kimio	SAKATA	May 22,'91 - May 16,'94
Vegetable	Mitsuo	KIMURA	Apr.03,'91 - Sep.28,'96
Fruit tree	Tsuyoshi	AMEMIYA	May 20,'93 - Sep.28,'96
Coordinator	Kenichi	YAMAGUCHI	Jul.08,'90 - Jun.27,'93
Coordinator	Koji	KOMURA	Apr.01,'93 - Sep.28,'96

Short-term experts were dispatched in the technical fields of irrigation, upland crop, vegetable, fruit tree, and so on, as shown in attached Annex 4.

1-3-7. Dispatch of Consultation Survey Teams

Consultation Survey Teams were dispatched from Japan, to study the present conditions of the Project, to have discussions with the experts from Japan, as well as to have consultations with the Turkish authorities concerned, as shown in attached Annex 5.

1-3-8. Opening Ceremony

On November 14, 1990, the Opening Ceremony was held in the project site, being attended by a large number of people concerned.

1-3-9. Consequences of the Gulf War

The Gulf War broke out on January 15, 1991, just as full-scale cooperation was commenced after completion of the experiment field arrangement in the previous year. The Project could not escape effects of the war, and its implementation was delayed due to the following causes.

① The dispatched experts' leaving the project site for more than two months
② Delayed arrival of the long-term experts on vegetable and upland crop
③ Delayed arrival of fruit tree seedlings and delayed procurement of equipment and materials
④ A considerable delay in study and testing due to the above mentioned causes

1-3-10. Counterparts

In the project site, the agricultural engineers and management staff members concerned, including the Director of TIGEM Cukurova Farm, acted as advisers to the experts from Japan. Since April 1993, the following agricultural engineers were assigned as counterparts.

Technical field	Name	Period
Fruit tree	Hamza KUZDERE	Apr. 1993 - Aug. 1994
Fruit tree	Rasim KARACA	Aug. 1994 - Feb. 1995
Fruit tree	Namik Kemal BALIK	Feb. 1995 - Sep. 1996
Vegetable	Bekir RUZGAR	Feb. 1995 - Sep. 1996

1-3-11. Counterpart Training in Japan

From 1990 to 1995, 38 counterparts were accepted by the Japanese government for training in Japan, as shown in attached Annex 6.

1-3-12. Procurement of Equipment and Materials

A number of pieces of equipment and materials were procured, including rain-guns, rain-booms, tractors, rotary seeders, cultivators, rota-vators, vehicles and meteorological observation equipment.

1-3-13. Financial Inputs

A total sum of financial inputs for the Project's implementation was 1,510,122 thousand yen, or approximately $ 15,101,220.

1-3-14. Holding of the Joint Committee

The Joint Committee had meetings as follows, to report activities relevant to the Project and have consultations on activity plans.

① First meeting : June 12, 1991, Ankara
② Second meeting : April 13, 1992, Ankara
③ Third meeting : April 12, 1994, Ankara
④ Fourth meeting : July 25, 1995, Ankara
⑤ Fifth meeting : May 16, 1996, Ankara

1-3-15. Tests and Studies

The following were main subjects and items of tests and studies have been conducted under the Project.

a. Collection of Basic Data

(a) Measurement of Physical and Chemical Characteristics of Ground Water in the Experiment Area
- Ground water level
- Electric conductivity
- pH

(b) Meteorological Observation
- Temperature
- Rainfall
- Humidity
- Pan evaporation
- Wind velocity and wind direction
- Atmospheric pressure
- Sunshine hours
- Solar radiation
- Rainfall pattern and its' intensity

(c) Examination of Elements for Field Irrigation
- Wind velocity and wind direction
- Atmospheric pressure
- Sunshine hours
- Solar radiation
- Rainfall pattern and its' intensity

(c) Examination of Elements for Field Irrigation
- Wind velocity and wind direction
- Atmospheric pressure
- Sunshine hours
- Solar radiation
- Rainfall pattern and its' intensity

(c) Examination of Elements for Field Irrigation
- Soil test (physical properties, water holding capacity)
- Test on intake rate of soil (for furrow and by means of cylinder)

b. Irrigation and Drainage

(a) Operation and Maintenance of Irrigation System
- Traveling sprinkler system
- Drip irrigation system
- Gravity irrigation system

(b) Test on Irrigation Equipments
- Traveler sprinklers
- Drip irrigation equipments

(c) Improvement of Drainage Function on Farm Level
- Field crop area
- Orchard area

c. Soil Control and Management

(a) Improvement of Tilling Method and Tillage
- Comparative test on crushed soil and tillage

(b) Test on Simultaneous Operations
- Study of the processes of harvesting, tilling, soil crushing,land preparation, fertilization and seeding
- Test of adaptability of the rotary seeder, and measurement

d. Upland Crop

(a) Test of Adaptability of Suitable Crops and Varieties
- Variety comparison on soybean, corn, wheat, barley, sesame, sunflower, cotton and rapeseed

(b) Development of New Crop Systems
- Variety comparison by combinations of winter crop (wheat, rapeseed) and summer crop (soybean, corn)
- Selection of varieties highly adaptable to late seeding (soybean, corn)

(c) Development of a Proper Irrigation System

e. Vegetable

(a) Tomato
- Test for selecting high-yielding, early-harvesting varieties
- Comparative test on mass raising of seedling methods
- Comparative test on rain booms, row irrigation and tube irrigation

- Cultivation test such as the management of fruit bearing
- Trial selling

(b) Melon
- Test for selecting promising varieties
- Comparative test on mass raising of seedling methods
- Comparative test on rain booms, row irrigation and tube irrigation
- Cultivation test such as the management of fruit bearing
- Trial selling

(c) Lettuce
- Test for selecting promising varieties
- Comparative test on mass raising of seedling methods
- Irrigation test with rain booms

(d) Daikon (Japanese radishes)
- Test for selecting promising varieties
- Integrated technical verification test
- Trial selling

(e) Broccoli
- Cultivation test on Japanese varieties
- Comparative test on mass raising of seedling methods
- Trial selling

f. Fruit Tree

(a) Verification Test on Kiwi Fruit
- Study on tree growth
- Study on fruit characteristics
- Test on combinations of micro-sprinkler irrigation and soil surface management methods
- Test on treatment for the promotion of fruit fattening
- Test on artificial pollination
- Test on alkaline soil correction

(b) Verification Tests on Peaches
- Study on tree growth
- Study on fruit characteristics
- Test on alkaline soil correction
- Test on not applying potassic fertilizer
- Test on leaf spray of micro elements
- Test on bagging cultivation
- Test by degree of fruit thinning
- Trial shipment to the market

(c) Verification Test on Plums
- Study on tree growth
- Study on fruit characteristics
- Test for preventing early leaf abscission
- Trial shipment to the market

(d) Demonstration Test on Various Fruit Trees
- Study on tree growth
- Study on fruit characteristics
- Test on bagging cultivation
- Test by degree of fruit thinning

- Survey on taste
- Test on producing seedless Kyohoh, a variety of grapes, and on fruit fattening
- Test on pear storage

The above-mentioned tests were carried out in the experiment field by experts from Japan.

Turkish counterparts mainly took charge of tests and studies on vegetable from August 1995 and those on other items from January 1996, with a view to the smooth transfer of the Project activities to TIGEM.

Studies on general agricultural conditions in Turkey, the agricultural products market, employment of and social insurance for agricultural workers, foreign investments, company establishment,etc., were conducted, and data and information were collected concerning these. Surveys on European vegetable and fruit markets were also conducted.

1-3-16. Farm Management

The verification farm which was intended for the implementation of experiments and studies for the Project was operated by the long-term expert team from Japan.

For the Turkish workers employed for the Project's implementation, the system under which they were employed by a Turkish private company as a matter of form was introduced, because it was necessary for them to been rolled in the social insurance program.

1-3-17. Transfer of Management of Facilities and Equipment

The management of the facilities and equipment which are used in the Project will have been transferred to TIGEM by September 1996.

1-3-18. Closing Ceremony

On September, 1996, the closing ceremony is held in the project site, being attended by a large number of people concerned.

1-3-19. The Project's Completion

The implementation of experiments and studies with the cooperation between JICA and TIGEM is completed on September 28, 1996. After that, experiments and studies will be conducted by TIGEM.

1-4. Report Making

The Project was implemented as part of development study for development cooperation activities. The Project was aimed at identifying private enterprises which would become targets of investment and financing by JICA, and at conducting verification tests and studies on technical feasibility in the project site for these enterprises. The present report, which is the Final Report on the Project, has been so prepared that it will contribute as a verification both technical and economic, for planning and studying agricultural development activity in the Republic of Turkey or in sites similar in condition to the project site in other countries.

In preparing this report, the results and the findings of the experiments and the studies conducted for six years have been integrated and systematized. This report deals with test results on individual technologies, as basic data for defining a basic idea of development activity and agricultural development in recipient regions.

The experiments and the studies were conducted mainly by the long-term experts from Japan who were assigned to these and by the short-term experts who cooperated with them where necessary on a short-term basis, as well as by Turkish counterparts. Advice was given by the Supporting Committee, which had been organized in Japan, as occasion demanded. Agricultural products Marketing research (Europe and Turkey) and farm management survey were also carried out by JICA.

Agriculture is, however, subjected unavoidably to unusual meteorological changes such as unprecedented heavy rains and high temperatures. Fruit tree need a long period of time for growth until they bear fruits. For marketing research for new crops, it is necessary to ship them in sizable quantities continuously. In the Project, new crops were shipped on a trial basis to not only the domestic market but also European markets. In view of all these, the actual period of five years was not sufficient, but every effort was made to carry out various tests and studies through trial and error under the given conditions.

This report has been prepared, with the expectation that the experiences and results obtained in this verification project will contribute to future agricultural development in Turkey and provide basic data for Japanese enterprises planning and studying agricultural development activities.

The English version of the report mainly deals with the tests and the studies, and the section "The Natural Environment and Communities in Turkey" in the Part "General," which is intended for Japanese companies, has been omitted.

This report has been written by the persons mentioned below, and edited by Takashi KITAMURA and Koji KOMURA.

1. Outline of the Project	Takashi KITAMURA
2. Outline of Experiments and Studies	
2-1. Basic Study	Joji NAKAGAWA
2-2. Irrigation	Joji NAKAGAWA
2-3. Upland Crop	Kimio SAKATA

2-4. Vegetable	Mitsuo KIMURA
2-5. Fruit Tree	Tsuyoshi AMEMIYA
3. Outline of Marketing Research	JICA
4. Basic Idea of Agricultural Development	JICA
5. Manual	
5-1. Vegetables Farming Manual	Mitsuo KIMURA
5-2. Facilities, etc.	Joji NAKAGAWA

The writers acknowledge data and materials provided by a number of people for the preparation of this report.

1-5. Comments for Future Project Activities

The verification activities carried out principally by the Japanese experts are to terminate in September 1996, and TIGEM, the counterpart agency of the Project, will be succeeded to the same works by means of the Project facilities and the accomplishments.

Regarding to the future activities to be succeeded by TIGEM staffs, the Japanese team has contemplated to be included the following items into the future plan, prepared by TIGEM.

It is great pleasure for the team to see these assignments be included into the items for experiments and studies to be conducted in TIGEM.

1-5-1. Collection of Basic Data

a. Measurement of Ground Water Level and Nature

Measurement of depth, alkalinity and electric conductivity of ground water in the orchard area will be continued.

b. Observation of Rainfall Intensity

It is known that the region often has a local concentrated heavy rain with thunder. In this connection, data collection on rainfall intensity at the project site, which was commenced on April,1995, will be continued. It is quite useful to accumulate data on rainfall intensity, in order to utilize for any drainage scheme in the future.

1-5-2. Irrigation

a. Micro-sprinkler

The micro-sprinkler irrigation, experimented in a part of orchard area since 1994, will be continued.

b. Experiments on Drip Irrigation

Experiments on drip irrigation in the orchard area will be continued, as the principal irrigation means.

c. Surface Irrigation for Orchard

Experiments on surface irrigation conducted in a part of orchard area since 1996 will be continued, in order to collect practical data on surface irrigation practice.

1-5-3. Vegetables

a. Experiments on Early Season Culture of Melons

Experiments on early season culture of melons (Japanese varieties) have been conducted in the Verification Farm (nearby farmer has been also entrusted with the task) since the end of 1994, but sufficient data have not yet been collected. The experiments will be conducted under more advantageous conditions, such as those in the Antalya region.

b. Trial Selling of Broccoli

Though it is thought that broccoli suit Turkish people's taste, marketing research was carried out with only small quantities shipped to the Istanbul and Adana markets. In order to understand its marketability, it is necessary to conduct marketing research by shipping the product continuously in sizable quantities for general people of Turkey, as in the case of Japanese radishes, and/or conduct more comprehensive, continuous research.

c. Vegetable Seed Production

Regarding vegetable seed production in Turkey, future demand and production cost will be studied regarding promising Japanese varieties such as Japanese radishes and melons. Studies will be made to ascertain whether the use of vegetable seeds of Japanese varieties already introduced in Turkey is possible or not.

1-5-4. Fruit Trees

a. Trial Culture of Kiwi Fruit

Trial culture of kiwi fruit in the Verification Farm has not produced satisfactory results yet, partly due to soil and meteorological conditions. Trial culture will be continued (although the culture area is reduced) for obtaining necessary data. As it appears that the natural conditions in the Verification Farm are not suitable for kiwi fruit growing, trial culture and management data collection will be conducted in a more suitable farm such as in the coastal region of the Black Sea.

b. Culture and Trial Selling of Pears (Japanese Variety)

Nijisseiki is a variety whose sarcocarp contains less stone cells among Japanese varieties. However, regarding pears produced in the Farm on a trial basis, it has been pointed out by some persons to exist a lot of stone cells does not suit Turkish consumers' taste, impeding their buying. There are other opinions that the stone cells make nothing of problem on Turkish consumers' taste. In this connection, trial selling of Nijisseiki will be continued to be collected necessary data confirming the Turkish consumers' preference.

c. Culture and Trial Selling of Persimmons (Japanese Varieties)

As Izu and Matsumoto Wase Fuyuu, sweet, early-maturing varieties, and Hiratanenashi and Kohshuu Hyakume, soft table varieties, have been proved to suit Turkish consumers' taste, tests will be continued until it is ascertained whether profit-making culture is possible or not.

d. Experiments on Alkaline Soil Correction in the Peach Orchard and the Kiwi Fruit Orchard

Experiments will be continued, as alkaline soil correction by treatment with sulfur powder in the Peach orchard and with peat moss in the Kiwi fruit orchard needs a long period of time until treatment effect becomes apparent.

e. Experiments on Iron Preparation Application in the Peach Orchard

Soil treatment with the application of an iron preparation was carried out in the beginning of 1996 in the Peach orchard. As improving effect for leaf chlorosis lasts for a long period of time, studies will be made to ascertain the result.

[2] Outline of Examination and Survey

[2] Outline of Examination and Survey

2-1. Basic Study and Design for Making a Manual on Irrigation Management

2-1-1. Soil Tests

(1) Physical and Chemical Characteristics of Soil

The soil around the Project area is mainly consisted of clay, which has high alkalinity and strong cohesion when it is moistened. The series soil tests for physical and chemical characteristics were mostly carried out in the summer of 1994. The soil samples collected from specific depth of several sites in the Project area was tested in laboratory.

The characteristics of soil, obtained from the soil tests in the field crops and the orchard areas, are shown in the following tables.

1) Physical Properties, Alkalinity(pH) and Electric Conductivity(EC S/m)

The physical properties of soil, such as real specific gravity (Real) and volume weight (Volume), composition ratio of particles classified by sand silt and clay in %, name of soil classified from the composition, pH and electric conductivity(EC), are shown in the following tables:

Table 2-1-1 Physical properties, pH and EC of soil in the crop field areas

Soil Depth	S. G.		Composition Ratio (%)			Name of Soil	pH	EC S/m
	Real	Volume	Sand	Silt	Clay			
0- 15	2.53	1.21	25.1	26.9	48.0	C	7.7	8.8
15- 30	2.60	1.37	24.2	28.6	47.2	C	7.7	8.5
30- 45	2.59	1.46	25.6	30.0	44.4	C	7.8	6.9
45- 60	2.61	1.51	25.0	33.2	41.9	C	7.8	6.3
60- 75	2.58	1.51	23.4	35.7	40.9	C	7.9	5.6
75- 90	2.63	1.53	29.8	34.8	35.4	CL	7.8	6.0
Mean	2.59	1.43	25.5	31.5	43.0	C	7.8	7.0

Table 2-1-2 Physical properties, pH and EC of soil in the orchard areas

Soil Depth	S. G.		Composition Ratio (%)			Name of Soil	pH	EC S/m
	Real	Volume	Sand	Silt	Clay			
40 - 60	2.56	1.39	20.9	26.7	52.5	C	7.8	10.5
60 - 80	2.62	1.37	20.4	28.0	51.7	C	8.0	8.1
80 -100	2.55	1.40	17.3	29.0	53.7	C	8.0	8.8
100 -120	2.55	1.40	17.3	29.0	53.7	C	8.0	8.8
Mean	2.58	1.41	19.3	27.4	53.2	C	7.9	8.8

2) Porosity and Coefficient of Permeability of Soil

Those tests were carried out in laboratory by meas of undisturbed soil samples, collected from each two places of both vegetable area and field crops area, and one place of orchard area. Average ratio of porosity and particles of soils in percent, and the coefficient of permeability(P.C.)

are shown in the following table:

Table 2-1-3 Porosity and coefficient of permeability of the soil in vegetable, field crop and orchard areas

Areas	Depth cm	Void %	Particle %	P.C. cm/s
Vegetables	0–15	50.0	50.0	6.4×10^{-3}
	15–30	45.5	54.5	2.0×10^{-3}
	30–45	44.5	55.5	4.9×10^{-4}
	45–60	43.8	56.2	3.1×10^{-5}
	60–75	44.1	55.9	3.0×10^{-5}
	75–90	42.5	57.5	2.3×10^{-5}
Field Crop	0–15	52.2	47.8	1.3×10^{-3}
	15–30	48.1	51.9	2.3×10^{-4}
	30–45	45.3	54.7	1.0×10^{-4}
	45–60	46.5	53.5	1.6×10^{-5}
	60–75	45.5	54.5	1.4×10^{-5}
	75–90	45.7	54.3	5.8×10^{-6}
Orchard	0–15	48.1	51.9	4.8×10^{-3}
	15–30	40.9	59.1	1.3×10^{-3}
	30–45	45.9	54.1	6.7×10^{-4}
	45–60	45.0	55.0	2.8×10^{-4}
	60–75	46.8	53.2	8.3×10^{-4}
	75–90	46.8	53.2	8.3×10^{-4}

(2) Available Soil Moisture

1) Characteristics of Moisture in Soil

The characteristics of moisture in soil is expressed by the relation between ratio of moisture and the corresponding moisture tension. The characteristics of moisture in soil in the Project area were obtained by laboratory tests in 1993, by means of soil samples collected at each one place from vegetable cultivated area in 3-A, field crop area in 3-C and in peach area. The following Table 2-1-4 to 2-1-6 show averaged moisture characteristics of the soil samples obtained by the laboratory tests.

Table 2-1-4 Moisture characteristics of soil in vegetable cultivated areas obtained from soil samples

Soil Moisture Tension	Depth of Soil (cm)					
	0–15	15–30	30–45	45–60	60–75	75–90
0.0KPa	51.0	49.2	47.3	45.9	45.2	45.0
1.0KPa	47.3	46.8	44.8	42.9	42.0	41.1
3.2KPa	45.0	45.6	43.1	40.7	39.8	39.0
10 KPa	43.8	44.4	42.2	39.5	38.3	37.1
32 KPa	42.5	43.2	41.1	38.2	36.6	35.0
100KPa	41.4	42.2	40.2	37.0	35.5	33.4
320KPa	37.0	39.8	36.1	33.0	31.4	28.1
1.6MPa	35.0	38.4	35.0	31.9	29.3	26.4
A M	9.1	7.2	8.2	9.6	10.5	12.5
M F	3.6	3.5	2.9	3.7	4.3	5.6

Table 2-1-5 Moisture characteristics of soil in field crops cultivated areas obtained from soil samples

Soil Moisture Tension	Depth of Soil (cm)					
	0－15	15－30	30－45	45－60	60－75	75－90
0.0KPa	57.1	50.0	49.0	50.5	50.6	50.5
1.0KPa	51.6	47.2	46.8	46.9	48.0	47.5
3.2KPa	43.8	43.5	43.9	44.3	45.6	44.8
10 KPa	37.8	41.1	42.1	42.7	43.9	43.2
32 KPa	35.4	39.5	40.4	41.3	42.0	41.6
100KPa	34.1	38.3	39.4	40.3	40.7	40.5
320KPa	31.1	34.7	36.8	37.0	38.2	37.3
1.6MPa	28.5	31.3	33.5	33.9	35.6	34.9
A M	15.4	12.2	10.3	12.9	10.0	10.0
M F	9.8	5.0	4.4	3.9	4.7	4.2

Table 2-1-6 Moisture characteristics of soil in orchard areas obtained from soil samples

Soil Moisture Tension	Depth of Soil (cm)					
	0－20	20－40	40－60	60－80	80-100	100-120
0.0KPa	55.6	49.7	53.1	51.7	51.0	51.0
1.0KPa	53.6	48.2	50.4	49.3	48.7	48.7
3.2KPa	50.3	46.2	46.7	45.9	45.6	45.6
10 KPa	45.4	43.6	43.0	42.2	43.3	43.3
32 KPa	42.1	40.5	40.0	39.2	40.9	40.9
100KPa	39.7	38.6	37.6	37.3	39.3	39.3
320KPa	37.8	36.8	34.3	35.2	37.4	37.4
1.6MPa	35.2	34.4	31.7	32.7	35.1	35.1
A M	15.1	11.9	15.1	13.2	10.7	10.7
M F	10.6	7.7	8.9	8.6	6.3	6.3

2) Field Capacity of Moisture

The field capacity of moisture of soil in the Project area is assumed to be equivalent to the value of moisture in the soil with soil tension of 3.2 KPa, which is corresponding to pF 1.5, as shown in the following table, on the basis of the water holding capacity, as described in the preceding section.

3) Moisture Content at Permanent Wilting Point

Moisture content at the permanent wilting point is assumed to be equal to the water holding capacity at a tensile force of water of 1.6 MPa or pF 4.2, as shown in the following table.

Table 2-1-7 Moisture-holding capacity of soil in the Project areas obtained from laboratory tests

Depth cm	Vegetables	Crop Field	Depth cm	Orchard
0– 15	45.0 %	43.8 %	0– 20	50.3 %
15– 30	45.6 %	43.5 %	20– 40	46.2 %
30– 45	43.1 %	43.9 %	40– 60	46.7 %
45– 60	40.1 %	44.3 %	60– 80	45.9 %
60– 75	39.8 %	45.6 %	80– 100	45.6 %
75– 90	39.0 %	44.8 %	100– 120	45.6 %

Table 2-1-8 Moisture content at permanent wilting point in the Project areas

Depth cm	Vegetables	Crop Field	Depth cm	Orchard
0– 15	35.0 %	28.5 %	0– 20	35.2 %
15– 30	38.4 %	31.3 %	20– 40	34.4 %
30– 45	35.9 %	33.5 %	40– 60	31.7 %
45– 60	31.9 %	33.8 %	60– 80	32.7 %
60– 75	29.3 %	35.6 %	80– 100	35.1 %
75– 90	26.4 %	34.9 %	100– 120	35.1 %

4) Available Moisture Capacity of Soil

The available moisture capacities of soil in the Project area are shown in the following table, which is obtained by the balance between the field capacity and the permanent wilting point.

Table 2-1-9 Available moisture capacity of soil in the Project area

Depth cm	Vegetables	Crop Field	Depth cm	Orchard
0– 15	13.7 %	23.1 %	0– 20	30.2 %
15– 30	10.8 %	18.3 %	20– 40	23.8 %
30– 45	12.3 %	15.5 %	40– 60	30.2 %
45– 60	14.4 %	19.4 %	60– 80	26.4 %
60– 75	15.8 %	15.0 %	80– 100	21.4 %
75– 90	18.8 %	15.0 %	100– 120	21.4 %

(3) Intake Rates of Soil

1) Measurement of Intake Rate

Intake rate, or infiltration capacity, of soil is an indicator for identifying degrees of water infiltrating into soil in unsaturated condition. They are generally expressed by mm/hr. Intake rates were measured at 33 points in the Project area, which had been carried out from 1994 to 1996 as shown in the following table.

Number of Test Points	Date of Tested
C1～C4, F1～F3 1 ～20 No.1～No.6	June 14 to 21, 1994 August 29 to September 15, 1994 September 7 to 13, 1995

The location of measured places and the results of tests are listed in Table 2-1-10.

Each value of total intake volume in depth . (D mm), intake rate (I mm/hr) and basic intake rate (Ib mm/hr), calculated from the field tests are arranged and show in the following table.

Table 2-1-10 Place of field test and the constant number on intake rate

No. and Place Tested	C	n	D (mm)	I (mm/h)	Ib
Cylinder Intake Rate					(mm/h)
1 : Peach South	8.37	0.65	$4.9t^{0.76}$	$225.3t^{-0.24}$	68.6
2 : Peach North	2.81	0.20	$10.4t^{0.27}$	$170.4t^{-0.73}$	2.0
3 : Plum South	5.40	0.62	$7.4t^{0.69}$	$261.9t^{-0.41}$	27.5
4 : Plum North	2.87	0.48	$2.4t^{0.50}$	$72.5t^{-0.50}$	4.1
5 : 3C East Middle	6.38	0.74	$10.0t^{0.71}$	$421.8t^{-0.29}$	91.7
6 : 3C Center	16.0	0/76	$19.3t^{0.73}$	$842.4t^{-0.36}$	210.6
7 : 3C West Middle	35.3	0/60	$33.4t^{0.60}$	$1200.2t^{-0.40}$	132.9
8 : 3B North Middle	24.2	0/67	$16.3t^{0.74}$	$721.3t^{-0.26}$	193.1
9 : 3A North West	5.08	0/69	$4.7t^{0.71}$	$201.5t^{-0.29}$	46.5
10 : 3A West Center	4.96	0/63	$5.0t^{0.64}$	$191.3t^{-0.38}$	27.6
11 : 3A South West	5.25	0.64	$4.7t^{0.64}$	$179.6t^{-0.36}$	25.2
12 : 4C East Middle	3.92	0.82	$3.6t^{0.83}$	$178.5t^{-0.17}$	79.6
13 : 4C Center	7.97	0.70	$7.0t^{0.76}$	$319.2t^{-0.24}$	96.1
14 : 4C West Middle	3.41	0.85	$3.3t^{0.84}$	$167.3t^{-0.16}$	80.8
15 : 4B North Center	5.38	0.73	$5.3t^{0.74}$	$237.5t^{-0.26}$	63.8
16 : 4B Center	3.09	0.86	$3.3t^{0.86}$	$170.2t^{-0.15}$	88.8
17 : 4B South Middle	6.64	0.82	$7.3t^{0.81}$	$354.5t^{-0.19}$	148.1
18 : 4A South Middle	13.6	0.81	$16.8t^{0.76}$	$766.7t^{-0.24}$	234.3
19 : 4A Center	18.5	0.61	$16.3t^{0.82}$	$603.0t^{-0.38}$	75.9
20 : Kiwi North	2.57	0.62	$3.4t^{0.73}$	$146.6t^{-0.27}$	36.1
C1 : Kiwi South	10.1	0.57	$3.8t^{0.79}$	$3.9t^{-0.29}$	31.8
C2 : No.2 South Middle	6.99	0.50	$4.0t^{0.53}$	$4.0t^{-0.42}$	15.7
C3 : 3B South Middle	21.4	0.53	$21.4t^{0.68}$	$11.5t^{-0.38}$	56.8
C4 : 4A North Middle	12.0	0.62	$12.0t^{0.63}$	$12.0t^{-0.63}$	48.0
No.4: 3B South					112.4
Furrow Intake Rate					
F1 : No.2 South Middle	47.9	0.59	$47.9t^{0.59}$	$42.1t^{-0.60}$	99.4
F2 : No.2 South Middle	51.3	0.73	$51.5t^{0.73}$	$84.9t^{-0.49}$	318.6
F3 : 3A Center	16.4	0.90	$16.4t^{0.90}$	$22.4t^{-0.26}$	370.5
No.1 : 3B West					2.3
No.2 : 3B North West					14.5
No.3 : 3B South East					51.1
No.5 : 3B North West					5.8
No.6 : 3B North East					148.9

2) Intake Rate and Optimum Irrigation Method

There is a general guide line to apply irrigation method by the value of intake rate as follows:

Intake rate = 75 mm or more : suitable for sprinkler irrigation
Intake rate = less than 50 mm: suitable for surface irrigation
Intake rate is 75 mm to 50 mm: both irrigation methods are possible

3) Findings on Intake Rate Test

a. Orchard Areas

The basic intake rates of the orchard areas have ranged from 68.6 mm/hr to 2.0 mm/hr, and an average intake rate of six places was 28.4 mm/hr. And all of these intake rates, except for one place, remained in 50 mm/hr or less. In this connection, it is said that surface irrigation method is suitable for orchard area.

b. Vegetable and Field Cropping Area

When the basic intake rates (Ib) in these area, shown in Table 2-1-11, classify into two groups, one is 100 mm/hr and more and the other is less than 100 mm/hr, averaged intake rate for the two groups are 171.9 mm/h and 61.2 mm/h respectively.

Range of Intake Rate	No. of Sample	Mean Intake Rate
234.3---112.4 mm/h	6	171.9 mm/h
91.7--- 15.7 mm/h	13	61.2 mm/h

Generally said that the Physical characteristics of soil among the field crop and vegetable planted areas are not so different from each other, which have been verified not only by the soil tests but also through experiences of past irrigation applications. Accordingly, it seems that the former group of soils were in specially permeable conditions or in dried at the time, and the soil condition of latter group, on the other hand, were in normal conditions.

When averaged intake rate of the latter group is assumed to be normal intake rate, both irrigation methods, sprinkler irrigation and surface irrigation, are suitable for these areas.

4) Findings on Furrow Intake Rate Test

a. Field Conditions

There are eight(8) tests for furrow intake rate were carried out, as shown in the above Table 2-1-10. The first tests of F1 was carried out by means of the furrow of vegetables put under drip irrigation and the other F2 and F3 are on the vacant furrows in dried condition. On the other hand, the latter test of No.3 and No.6 were carried out in moisture furrow, and No.1, No.2 and No.5 were tested few days after since furrow irrigation was carried out.

b. Findings

The value of intake rate obtained the above test is classified into three(3) groups by the magnitude of the value, such as; more than 300 mm/h, between 150 to 50 mm/h and less than 50 mm/h. The following table shows a mean intake rate in each group.

Range of Intake Rate	No. of Sample	Mean Intake Rate
More than 300 mm/h	2	344.3 mm/h
148.9--- 51.1 mm/h	3	99.8 mm/h
14.5--- 2.3 mm/h	3	7.5 mm/h

The three different value of intake rates are assumed to be obtained from three different moisture conditions of soil, such as in dried, in optimum moisture and in high moisture, and it is considered that the difference in the value of intake rate is caused by the changes of permeability of soil in different moisture content.

According to the field observation of furrow irrigation practice. At the first irrigation, a plenty of water and hours is required before the water have reached to the end of the area to be irrigated. And at the second and third time, the required water volume and application hours become shorter than the former application and have reached to the normal application rates in both volume of water and hours.

2-1-2. Groundwater

(1) Fluctuation of Groundwater Level

1) Gauging Well

Fluctuation of the groundwater level in the Project area was observed from November 1992 to August 1993, by means of eleven(11) gauging wells, numbered from No.1 to No.11, newly provided in the project area. And since June 1994 two(2) gauging wells of No.12 and 13 were installed in the Peach area. In addition, three(3) gauging wells of No.14 to 16 are newly added in 1996, one is in kiwi area and the other two are in grape area which was newly transplanted in the part of former kiwi area, based on the new experimentation scheme by the TIGEM after the Project. Location of these gauging wells are shown in Fig. 2-1-1.

As to arrangement of wells, seven(7) wells in total are allocated in the orchard areas. Out of the seven(7), four(4) wells are in the peach area, in order to get more detailed data on the groundwater level,due to a nature of peach tree that is known quite sensitive against water stress. And the other nine(9) wells are installed in the field crop area, to make up a broad grid to cover the whole sprinkler irrigation field.

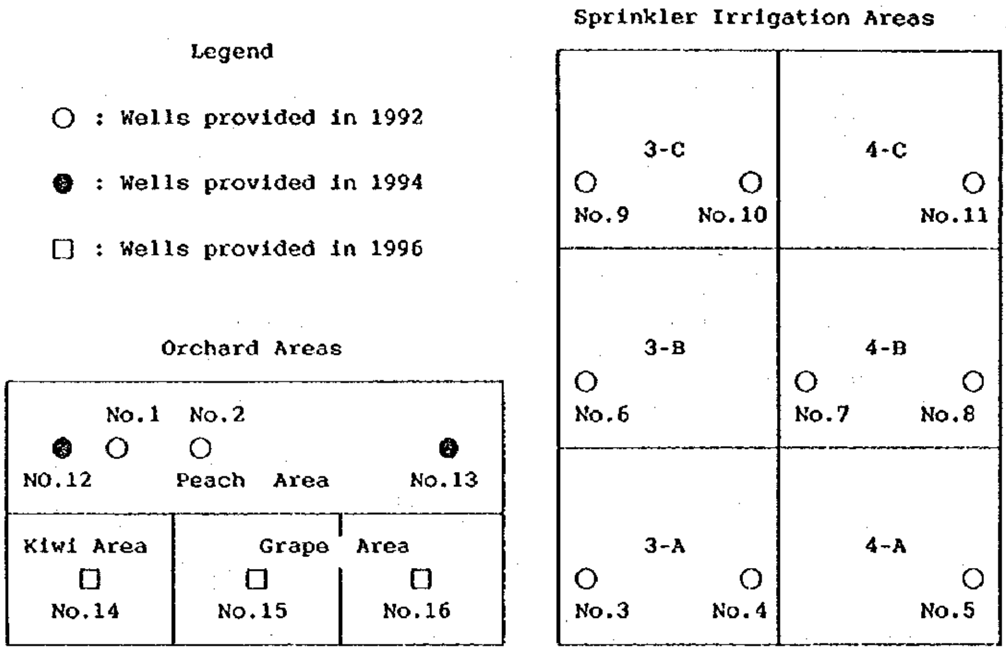

Fig. 2-1-1 Location of gauging wells provided in the Project area

The body of the gauging well is consisted of a plastic pipe with three(3) m length and 10 cm diameter, with a number of small holes made by a drill. And filter layer of sand with 10 cm thick is surrounded the pipe. Most of these wells were made by manual excavation. The depth of these wells from the ground surface are about 2.5 meters.

2) Observation of Groundwater Level

The groundwater level was observed several times in a month. Since October 1994, observation day was fixed to the last day of every half decade of months. When it have rained at the scheduled day, optimum arrangement was taken to meet weather condition, such as postponing it for the following fine day.

3) Processing of Collected Data

The records of water level of each gauging wells were averaged on monthly basis, for better understanding. The record of groundwater level since June 1994 were summarized and shown in Table 2-1-11, together with the corresponding rainfall depth and evaporation. The monthly evaporation depth, listed in the table, is only for a reference, in order to get general concept on evaporation rate of the area, as the evaporation depth is not always to be substituted for transpiration depth.

Table 2-1-11 Rainfall and evaporation depth and groundwater level in monthly average from June 1994 to June 1996

Unit : cm

Year & Month	Rain-fall cm	Evapo-ration cm	Peach Area					3 A		4A	3B	4 B		3 C		4C	Mean	Mean
			12	1	2	13	Mean	3	4	5	6	7	8	9	10	11		
1994 : 5	5.9																	
6	0.5		2.10	1.57	1.65	1.84	1.79	1.68			1.87	1.54	1.73		1.25	1.88	1.66	1.71
7	0.0		2.03	1.41	1.70	1.84	1.75	1.70	1.50		1.96	1.45	1.93	0.51	1.10	2.32	1.56	1.62
8	0.2		1.62	1.39	1.83	1.75	1.65	1.57	1.50		1.04	1.24	2.02	0.66	1.14	2.43	1.45	1.52
9	0.5		1.93	1.46	2.11	1.78	1.82	1.63	1.50		0.67	1.41		0.34	1.16		1.12	1.40
10	7.3	9.3	1.98	1.64	2.20	1.80	1.91	1.50	1.46		0.89	1.34	2.05	0.67	1.26	2.46	1.45	1.60
11	24.6	6.7	2.05	1.45	1.44	1.72	1.67	1.58	1.16	0.37	0.93	1.34	1.63	0.51	1.35	2.05	1.21	1.35
12	10.5	2.9	0.78	0.48	0.64	1.46	0.84	1.33	0.34	0.34	0.69	0.48	0.34	0.00		0.85	0.55	0.64
1995 : 1	13.3	1.7	0.20	0.06	0.41	1.46	0.53	1.37	0.20	0.20	0.71	0.06	0.05	0.34	0.69	0.20	0.42	0.46
2	2.4	4.3	0.35	0.38	0.68	1.48	0.72	1.50	0.36	0.36	0.84	0.38	0.24	0.28	0.76	0.33	0.56	0.61
3	6.7	6.9	0.54	0.78	0.95	1.68	0.99	1.61	0.70	0.73	1.07	0.78	0.59	0.33	0.95	0.52	0.86	0.90
4	9.6	7.5	1.16	0.64	0.77	1.64	1.05	1.56	0.78	0.89	0.92	0.70	0.53	0.60	0.90	0.71	0.84	0.91
5	5.3	15.0	1.36	0.84	0.88	1.67	1.19	1.49	0.87	1.18	1.16	1.12	1.03	0.81	0.95	1.07	1.08	1.11
6	7.9	18.2	1.56	1.30	1.43	1.61	1.48	1.36	1.18	1.44	1.97	1.04	1.27	1.04	1.05	0.74	1.23	1.31
7	3.5	18.3	1.74	1.70	1.75	1.63	1.71	1.54	0.90	1.06	2.48	1.15	0.67	1.27	1.30	0.88	1.25	1.39
8	0.2	16.3	1.81	1.49	1.96	1.74	1.75	1.51	1.08	1.67	2.70	1.26	0.58	1.49	1.47	0.89	1.41	1.51
9	3.6	13.2	1.93	1.35	1.80	1.50	1.65	1.57	1.14	2.13	2.70	1.51	1.00	1.92	1.60	1.51	1.68	1.67
10	5.1	11.0	2.06	1.04	1.32	1.55	1.49	1.65	1.37	2.25	2.70	1.38	1.70	1.21	1.38	1.72	1.71	1.64
11	16.3	3.4	1.58	0.26	0.69	1.34	0.97	1.40	0.72	1.53	0.85	1.12	0.79	0.42	1.00	0.82	0.96	0.96
12	1.9	2.7	1.41	0.35	0.77	1.38	0.98	1.49	0.90	0.89	1.02	0.94	0.42	0.57	1.08	1.23	0.95	0.96
1996 : 1	8.0	3.4	1.21	0.42	0.56	1.30	0.87	1.37	0.60	0.61	0.80	1.14	0.25	0.33	0.99	0.75	0.76	0.79
2	7.4	3.5	1.20	0.51	0.57	1.33	0.90	1.76	0.65	0.69	0.90	1.17	0.30	0.38	1.02	0.73	0.84	0.86
3	15.2	3.5	0.91	0.28	0.39	1.24	0.71	1.44	0.42	0.56	0.75	1.13	0.17	0.15	0.94	0.47	0.67	0.68
4	8.0	7.9	1.10	0.47	0.60	1.32	0.87	1.42	0.68	0.94	1.09	1.22	0.43	0.25	1.13	0.76	0.88	0.88
5	0.9	14.7	1.39	0.88	0.97	1.53	1.19	1.63	0.98	1.58	1.29	1.35	1.06	0.69	1.45	1.27	1.26	1.24
6	1.2		1.56	0.80	1.21	1.59	1.29	1.66	1.15	1.67	1.83	1.42	1.46	0.97	1.55	1.68	1.49	1.43
Mean			1.42	0.92	1.17	1.57	1.27	1.53	0.92	1.05	1.35	1.11	0.93	0.68	1.14	1.18	1.10	1.16

4) Findings

Major factors to affect the fluctuation of groundwater level on monthly basis are considered to be rainfall, evapo-transpiration and irrigation water supplied by sprinkler and surface irrigation methods. As to the effect of drip irrigation water on the groundwater level, for orchard and vegetable cultivation, it is possible to neglect so far as in normal application rate, because of the volume of water is much smaller than the other irrigation methods.

As mentioned in the preceding section, major factors which affected fluctuation of the groundwater level were, supplied water from the surface of ground (i.e., rainfall and supplied water through irrigation) and evapo-transpiration from the ground surface and through plants.

The ratio of moisture decreasing from the soil to seepage into deeper layers by gravity, and to move horizontally by gravity are negligibly small due to characteristics of soil in the Project area, compared with the ratio of evapo-transpiration.

(2) Electrical Conductivity

1) Observation of Electrical Conductivity

Since October 1994, the electrical conductivity of groundwater was measured at the same time when water level was measured, by sample water collected from the thirteen(13) gauging wells. The first period From October 1994 through September 1995, it was measured at the sampling spots, by means of a portable equipment. Since October 1995, however, it was measured in the office by the sample of water collected from the 13 wells.

2) Processing of Collected Data

The records of electrical conductivity of each gauging wells since October 1994 were averaged on monthly basis, as shown in Table 2-1-12, together with the corresponding rainfall and evaporation depth, for better understanding.

3) Findings

a. General Tendency

In general, the value of electrical conductivity of groundwater in the peach area is about 80 % higher than the other area in the total average. And the value of the lot 3A is the highest among the other area, or about 27 % higher than the average.

Table 2-1-12 Rainfall and evaporation depth and electrical conductivity of groundwater in monthly average from October 1994 to June 1996

Unit : μS

Year & Month	Rain-fall cm	Evapo-ration cm	Peach Area					3 A		4A	3B	4 B		3 C		4C	Mean	Mean
			12	1	2	13	Mean	3	4	5	6	7	8	9	10	11		
1994 :10	7.3	9.3	1718	1760		1616	1598	1266	1249		1713	1124	1268	654	1126	1683	1260	1380
11	24.6	6.7	1593	1751	1590	1326	1565	1262	1044	407	1150	948	1004	725	1119	1915	1064	1218
12	10.5	2.9	939	1786	1735	1291	1438	1102	917	497	920	768	522			828	793	1028
1995 : 1	13.3	1.7	978	1843	2014	1438	1568	1123	880	617	861	831	545	709	862	782	801	1037
2	2.4	4.3	1242	1755	2200	1634	1708	1145	967	663	951	996	554	694	805	800	842	1108
3	6.7	6.9	1339	1770	2253	1815	1794	1139	1074	616	1013	971	713	626	875	820	872	1156
4	7.9	7.5	1162	1707	1975	1695	1635	997	1161	522	1160	905	697	545	906	826	858	1097
5	5.3	15.0	1507	1768	2342	1579	1799	1177	1198	632	1141	899	740	596	832	863	898	1175
6	9.6	18.2	1714	1887	2087	1524	1803	1258	1224	770	1311	930	1295	949	717	604	1006	1252
7	3.5	18.3	979	1746	2108	1717	1638	1267	1143	762	1486	1011	1126	545	961	720	1002	1198
8	0.2	16.3	767	1282	2067	1668	1446	1097	903	867		988	899	865	926	653	900	1082
9	3.5	13.2	771	1306	1898	1495	1368	1024	1023	840		853	1062	598	854	570	853	1025
10	5.1	11.0	1080	1396	1950	1357	1446	1090	1012			929	1354	701	859	991	991	1156
11	16.3	3.4	1224	1441	1909	1461	1509	1002	995	578	574	1132	865	658	627	794	803	1020
12	1.9	2.7	1450	1612	1785	1637	1621	1138	1096	724	807	884	818	557	585	908	835	1077
1996 : 1	8.0	3.4	1519	1522	1643	1605	1572	1086	1130	603	1068	815	811	664	738	946	873	1088
2	7.4	3.5	1404	1514	1568	1352	1460	1032	1094	701	952	796	722	569	655	846	819	1016
3	15.2	3.5	1332	1403	1646	1412	1448	1026	818	633	649	644	774	664	564	783	728	950
4	8.0	7.9	1552	1591	1966	1674	1696	1148	908	711	874	847	863	614	684	777	825	1093
5	0.9	14.7	1303	1502	1816	1440	1515	1087	985	711	910	705	830	491	570	786	786	1010
6	1.2		1241	1666	1943	1454	1576	1144	1031	805	965	622	713	590	680	941	832	1061
Mean	10.94-	6.96	1277	1619	1925	1533	1586	1124	1041	666	1028	886	865	651	797	897	886	1108

b. Value and the Fluctuation Range

The value of the electrical conductivity in the peach area, during the period of the total observation period since October 1994 to June 1996, is 1,586 μS in average. On the other hand, average value of the other, during the same period, is 886 μS, or about 80 % higher than the peach area.

The ratio of fluctuation ranged between 117 % to 93 % in the groundwater of peach area, and between 113 % to 90 % in the groundwater of the sprinkler irrigation area. With regard to the seasonal fluctuation, winter season presents lower level and summer season is in higher level as a general tendency.

Value of the Well No. 2 shows about 20 % higher than the average in the peach area, throughout the observation period.

(3) Alkalinity (pH)

1) Measurement of Alkalinity

The measurement of alkalinity of groundwater collected from the thirteen (13) gauging wells was continued since the last September 1995, with a pH meter or a ion meter of Japanese made. The table 2-1-13 is shown the value of alkalinity of the groundwater collected from the each gauging wells, averaged in monthly basis, together with rainfall and evaporation depth.

2) Findings

Although, the collected data as of July 1996 are only 10 months, the alkalinity of each wells range between 7.43 to 7.60 in average, and seasonal fluctuations in monthly average of all wells range between 7.31 to 7.84, which is fluctuated on monthly basis without any tendency relevant to season.

2-1-3. Meteorological Survey

(1) Meteorological Conditions in Ceyhan

1) General Meteorological Conditions

The Ceyhan district, where the Project site is situated, is a warm climate in general belonged to the Mediterranean climatic zone. The region, however, also presents characteristics of a continental climate, with considerable difference between the maximum and the minimum in temperature and relative humidity within a day. Annual rainfall depth is about 700 mm on the average, and it rains mostly during winter from December to March of the following year. On the other hand, it rains very few throughout summer from June to September, and the other months have average depth of rain. Annual and monthly rainfall depth, however, sometimes differ extremely from the average depth.

The following table shows the mean meteorological data on monthly basis at the Ceyhan Observatory from 1968 to 1988.

Table 2-1-13 Rainfall and evaporation depth and alkalinity of groundwater in monthly average from September 1995 to June 1996

Unit : pH

Year and Month	Rain-fall cm	Evapo-ration cm	Peach Area					3 A		4A	3B	4 B		3 C		4C	Mean	Mean
			12	1	2	13	Mean	3	4	5	6	7	8	9	10	11		
1995 : 8	0.2	16.3																
9	3.6	13.2	7.71	7.47	7.22	7.37	7.44	7.32	7.22	7.33		7.38	6.93	7.39	7.32	7.14		7.33
10	5.1	11.0	7.47	7.50	7.29	7.28	7.39	7.14	7.35			7.58	7.01	7.33	7.25	6.99	7.24	7.31
11	16.3	3.4	7.46	7.59	7.29	7.46	7.45	7.43	7.35	7.51	7.56	7.60	7.35	7.73	7.53	7.42	7.50	7.48
12	1.9	2.7	7.50	7.41	7.40	7.59	7.48	7.55	7.64	7.64	7.63	7.71	7.63	7.84	7.67	7.49	7.64	7.59
1996 : 1	8.0	3.4	7.72	7.63	7.64	7.75	7.69	7.75	7.77	7.89	7.72	7.89	7.80	7.94	7.89	7.63	7.81	7.77
2	7.4	3.5	7.46	7.48	7.35	7.40	7.42	7.44	7.51	7.51	7.53	7.73	7.63	7.73	7.61	7.53	7.58	7.53
3	15.2	3.5	7.47	7.43	7.28	7.43	7.40	7.43	7.53	7.39	7.47	7.65	7.57	7.65	7.60	7.50	7.53	7.49
4	8.0	7.9	7.61	7.86	7.49	7.50	7.62	7.50	7.52	7.51	7.62	7.53	7.61	7.84	7.56	7.57	7.58	7.60
5	0.9	14.7	7.85	7.97	7.87	7.86	7.89	7.82	7.86	7.72	7.78	7.84	7.74	8.05	7.87	7.68	7.82	7.84
6	1.2	23.0	7.66	7.56	7.51	7.54	7.57	7.58	7.64	7.33	7.52	7.75	7.67	7.83	7.66	7.54	7.61	7.60
Mean			7.59	7.59	7.43	7.52	7.53	7.50	7.54	7.54	7.60	7.67	7.49	7.73	7.60	7.45	7.60	7.56

Table 2-1-14 Mean climatic data on monthly basis in Ceyhan Meteorological Observatory

Month	Mean Temperature ℃			Rain-fall Depth mm	Rainfall Days		Sun-Shine	Relative Humidity %		Mean Wind Speed m/s
	Max.	Min.	Mean		day	5mm<	hours	Max.	Min.	
1	18.9	-1.7	8.0	113.9	12	6	4.54	71.2	29	1.3
2	20.6	-1.3	9.1	78.6	11	5	5.37	69.7	24	1.4
3	25.4	0.3	12.4	78.8	12	5	6.16	70.6	24	1.4
4	31.2	5.9	16.6	73.5	10	4	7.37	70.6	22	1.5
5	34.6	9.9	20.4	57.9	9	3	9.44	69.3	20	1.5
6	36.7	13.8	24.6	28.2	4	2	11.17	66.4	16	1.7
7	38.1	17.2	27.3	7.7	1	0.5	11.40	67.5	17	1.7
8	37.9	17.4	27.3	10.5	1	0.3	11.20	67.2	18	1.5
9	37.5	13.8	25.0	19.8	1	0.3	9.48	64.1	17	1.2
10	33.8	8.1	20.0	55.5	7	3	7.52	62.7	15	1.1
11	27.3	2.3	13.8	62.1	9	4	6.28	67.0	22	1.1
12	20.3	-0.4	9.5	102.0	9	4	4.40	69.6	25	1.3
Annual				688.5	86	37	8.06	68.0	21	1.4

2) Annual Rainfall Depth

Annual rainfall depth differs considerably from year to year, and it is difficult to forecast it. The following table 2-1-15 shows the monthly rainfall records in the Çukurova National Farm for 27 years from 1968 through 1994, the table shows the range of fluctuation in the rainfall in monthly basis and annual basis.

(2) Observation Records at the Project Site

1) Period and Record of Observation

The meteorological data was collected by means of a meteorological station, since the middle of February 1993. Table 2-1-16 and 2-1-17 shows monthly records from March 1993 through June 1996. All data observed by the station is printed by a printer in a sheet of paper on daily basis, five(5) days basis, ten(10) days, and monthly basis.

2) Mean Temperature and Humidity in Monthly basis

Table 2-1-17 shows monthly mean values of daily maximum and minimum temperature and humidity, which have been calculated from daily records. According to the table, daily difference in temperature is about 14 centigrade(°C) on the average through the year, while daily difference in humidity reaches about 50%.

3) Daily Evaporation

The daily evaporation in depth is measured with a large size evaporimeter (A-type evaporimeter), which has a tub-style tank with aperture of 120 cm and depth of 20 cm, and a magne-scale sensor with a

Table 2-1-15 Monthly rainfall record in Cukurova Farm near the Project site from 1968 to 1994

Unit : mm

Year	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Annual
1968	201.4	82.2	47.8	6.0	44.0	17.1	8.6	46.0	33.7	10.0	154.6	173.1	824.5
1969	114.4	15.9	103.1	20.5	96.3	22.7	0.1	0.0	20.8	78.8	27.7	111.8	612.1
1970	33.4	104.5	49.4	20.3	53.9	15.7	18.9	0.0	9.7	53.2	83.8	44.3	487.1
1971	20.7	71.1	58.0	159.6	1.2	24.1	0.0	9.1	0.2	10.1	43.9	60.4	458.4
1972	18.8	37.9	38.9	56.1	53.1	64.5	26.0	16.0	114.9	58.7	25.8	0.0	510.7
1973	17.1	68.6	55.4	160.9	79.5	51.6	2.2	0.0	64.2	9.9	49.1	73.4	631.9
1974	133.6	39.4	65.7	77.9	16.3	0.0	0.0	81.3	27.9	62.8	17.1	188.9	710.9
1975	100.4	82.4	56.6	156.2	82.2	3.4	0.0	0.0	2.6	7.1	29.0	28.8	548.6
1976	238.7	79.3	60.8	107.1	148.2	21.8	14.2	3.6	35.3	98.2	90.1	116.4	1013.7
1977	99.7	60.9	91.4	109.3	123.2	11.5	11.2	0.0	2.0	55.8	20.1	134.4	719.5
1978	176.6	150.8	79.9	74.7	13.7	22.1	0.0	0.0	32.0	57.2	17.9	108.2	733.1
1979	74.5	42.0	34.5	67.1	43.0	46.3	12.1	20.1	2.9	61.2	118.1	178.2	700.0
1980	145.6	87.0	144.6	95.2	33.4	34.9	0.0	0.0	4.2	58.9	40.2	64.1	708.1
1981	233.5	63.5	43.1	37.0	108.9	90.0	3.2	0.0	0.3	18.4	80.1	203.8	881.8
1982	71.2	41.2	48.7	45.9	62.2	14.6	37.3	0.1	24.3	105.8	22.4	42.8	516.5
1983	131.8	149.3	92.4	101.4	45.5	9.5	0.0	3.9	10.9	4.1	88.2	61.3	698.3
1984	119.1	95.0	68.8	118.5	24.8	2.0	13.8	7.8	0.0	1.8	73.2	58.5	583.3
1985	167.4	94.8	96.2	59.1	32.9	9.8	0.0	0.0	2.8	165.5	57.4	17.9	703.8
1986	91.9	52.3	20.6	5.1	109.4	56.7	0.0	0.0	24.5	105.8	87.8	184.5	732.8
1987	171.6	110.2	192.6	29.4	33.9	3.9	15.2	31.1	0.0	29.6	90.8	125.6	834.2
1988	31.6	117.3	207.9	36.9	74.5	52.2	0.0	0.0	21.0	89.5	90.0	79.5	800.0
1989	27.5	0.8	47.5	0.5	31.6	17.5	0.0	3.5	18.6	36.5	95.1	124.2	403.3
1990	34.0	142.3	43.6	73.0	18.8	47.2	2.0	0.0	44.5	43.0	60.3	67.0	575.7
1991	58.6	90.9	44.4	145.0	42.7	2.0	9.0	5.0	18.0	68.6	117.7	546.9	1148.8
1992	8.0	51.8	26.5	15.2	122.6	36.6	5.9	0.2	40.0	11.8	262.9	131.9	713.4
1993	99.0	39.9	83.9	45.4	78.2	45.0	0.0	3.0	32.5	0.0	27.7	70.9	525.5
1994	180.8	123.5	74.8	23.2	68.4	17.5	27.8	11.0	7.5	85.9	266.7	101.9	994.0
Mean	103.7	77.8	73.2	68.4	60.8	27.4	7.7	9.0	22.0	51.4	79.2	114.8	695.2
Min.	8.0	0.8	20.6	0.5	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	403.3
Max.	238.7	150.8	207.9	160.9	148.2	90.0	37.3	81.3	114.9	165.5	266.7	546.9	1148.0

Table 2-1-16 Metrological record on the Project site on monthly basis from March 1993 to June 1996

Year and Month	Sun-shine Hours	Rain-fall mm	Radia-tion M.J	Evapo-ration mm	Air Press. hpa	Temperature ℃			Humidity %			Wind Velocity m/s			Major Wind Direct	Remarks
						Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean		
1993 : 3	7.95	62.5	7.34		1010.1	28.0	0.2	10.8	99.3	16.6	67.5	11.0	0.0	2.2	NE	
4	8.00	49.5	6.05		1006.7	29.0	2.5	15.2	99.7	2.5	70.0	9.5	0.0	2.1	SW	
5	7.68	49.5	7.73		1004.6	35.2	8.8	18.8	95.4	19.7	73.2	8.4	0.0	1.8	SW	
6	8.98	15.0	16.95		1002.0	40.7	11.3	23.5	95.7	3.2	62.5	15.6	0.0	2.1	SW	
7	11.0	0.0	23.20		999.0	41.2	16.5	27.7	97.4	10.2	60.1	9.7	0.0	2.8	SW	
8	10.4	0.0	21.81		999.0	39.5	16.3	27.8	94.0	12.2	63.7	9.2	0.0	2.5		
9	10.3	0.0	17.99		1002.2	38.2	10.9	24.9	93.6	20.1	58.6	11.0	0.0	2.3	S	
10	9.05	3.5	12.47		1007.8	37.0	7.7	22.0	91.5	14.2	46.7	10.5	0.0	1.8	NNE	
11	6.33	15.5	5.07		1012.3	27.6	-4.2	11.4	97.0	20.3	53.1	13.0	0.0	3.0	NNE	
*12		54.5				20.8	-1.9	10.8	96.9	26.5	70.1					
1994 : 1	5.63	169.0	3.82		1011.2	20.1	-0.8	9.8	96.1	28.3	74.6	11.0	0.0	2.1	ENE	
2	6.67	106.5	6.45		1011.3	19.4	-3.1	8.4	96.7	25.8	71.4	11.7	0.0	2.1	N	
3	7.95	82.0	*11.18		1009.1	23.4	0.4	11.8	95.8	26.8	72.0	12.1	0.0	2.1	N	
4	9.30	9.5	15.74		1005.4	32.1	4.7	17.1	95.8	22.3	70.6	11.5	0.0	1.9	SW	
5	9.97	59.0	20.30		1003.5	39.3	8.9	20.8	95.5	14.1	66.9	6.6	0.0	1.8	SW	
6	11.7	4.5	22.44		1000.1	38.0	12.3	25.1	94.4	8.6	55.7	13.9	0.1	3.2	SSE	
7	10.8	0.0	21.99		996.4	38.9	17.4	27.4	96.3	9.4	67.0	9.3	0.1	2.8	SW	
8	11.1	2.0	22.85		997.6	41.6	16.1	27.2	96.3	10.7	64.7	8.2	0.1	2.3	SW	
9	9.58	4.5	17.20		1002.0	39.7	16.0	26.7	93.4	20.1	62.2	13.6	0.0	1.8	SSE	
10	4.83	73.0	11.14	93.0	1006.5	38.0	10.4	22.4	96.1	17.0	61.8	13.8	0.0	1.6	N	
11	3.29	246.0	4.29	67 0	1008.2	30.0	1.1	13.0	95.0	20.8	64.8	15.4	0.0	3.0	N	
12	2.64	105.0	7.54	28.5	1015.1	16.5	-2.6	7.1	99.1	31.1	72.5	13.4	0.0	2.7	N	
1995 : 1	4.95	133.0	3.40	16.5	1014.2	18.8	-1.2	9.1	97.4	34.1	77.2	9.4	0.0	1.8	N	
2	7.83	24.0	7.95	43.0	1011.5	21.4	0.6	10.6	97.9	26.5	72.3	8.9	0.0	1.9	N	
3	8.12	66.5	16.32	68.5	1009.1	25.8	1.2	12.2	97.8	15.1	73.2	9.0	0.0	1.9	SW	
4	8.57	96.0	25.92	74.5	1005.6	28.6	2.1	15.1	97.5	22.1	72.5	8.3	0.0	2.0		
5	9.98	53.0	18.75	150.0	1003.9	41.3	7.5	21.6	95.8	10.7	66.5	9.2	0.0	1.9	S	
6	9.67	79.0	17.44	181.5	1000.7	38.7	14.7	25.2	97.0	14.9	67.8	12.3	0.0	2.3	SW	
7	10.72	35.0	21.17	182.5	995.8	38.0	16.4	26.3	96.6	14.4	68.3	15.4	0.0	2.0	SW	
8	10.32	1.5	19.61	162.5	997.9	37.4	16.1	27.0	96.9	20.4	71.5	10.0	0.1	1.8	SW	
9	9.37	35.5	14.83	131.5	1002.6	39.5	8.9	24.3	96.5	14.8	65.3	13.7	0.0	1.9	S	
10	9.07	51.0	10.65	110.0	1007.7	33.7	5.6	19.0	97.4	14.7	58.4	9.5	0.1	1.7	NNE	
11	6.17	163.0	4.16	33.5	1002.6	25.8	-1.7	11.6	96.8	37.3	72.4	8.3	0.0	1.6	N	
12	5.65	18.5	3.23	26.5	1016.1	18.9	-1.8	8.3	90.9	51.2	75.5	8.9	0.0	2.0		
1996 : 1	5.33	79.5	3.33	33.5	1012.1	17.4	-1.7	8.1	90.1	53.7	72.9	9.7	0.0	2.4	N	
2	6.75	73.5	6.33	34.5	1009.4	22.0	-5.2	10.0	90.9	46.7	74.9	11.3	0.0	2.2	ENE	
3	5.73	152.0	6.87	35.0	1005.5	23.6	2.3	11.3	90.4	55.4	79.8	8.7	0.0	1.7	NE	
4	8.10	80.0	12.89	79.0	1006.6	31.0	3.1	14.4	91.0	48.4	76.5	8.8	0.0	1.6	SW	
5	10.45	8.5	18.95	148.5	1002.1	36.5	10.8	22.3	91.6	41.5	69.2	9.2	0.0	1.8	SW	
6	12.05	12.0	24.40	230.0	1000.1	41.3	11.8	26.1	91.8	32.9	61.6	9.3	0.1	2.5	SW	

Table 2-1-17 Maximum and minimum temperature and humidity from May 1993 to June 1996

Year and Month	Temperature ℃			Mean Temperature℃			Humidity %			Mean Humidity %			Remarks
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	
1993 : 3	28.0	0.2	10.8	18.5	3.5	11.0	99.3	16.6	67.5	93.1	36.0	64.6	
4	29.0	2.5	15.2	22.0	8.4	15.2	99.7	2.5	70.0	90.2	39.3	64.8	
5	35.2	8.8	18.8	25.9	13.2	19.6	95.4	19.7	73.2	92.4	43.2	67.8	
6	40.7	11.3	23.5	32.9	19.4	26.2	95.7	3.2	62.5	90.4	24.7	57.6	
7	41.2	16.5	27.7	34.8	19.9	27.4	97.4	10.2	60.1	86.3	33.9	60.1	
8	39.5	16.3	27.8	35.1	21.0	28.1	94.0	12.2	63.7	89.7	38.3	64.0	
9	38.2	10.9	24.9	33.1	17.2	25.2	93.6	20.1	58.6	83.5	33.5	58.5	
10	37.0	7.7	22.0	32.2	13.0	22.6	91.5	14.2	46.7	65.9	27.8	46.9	
11	27.6	-4.2	11.4	19.7	4.0	11.9	97.0	20.3	53.1	69.5	32.4	51.0	
*1 12	20.8	-1.9	10.8	17 8	5.0	10.0	96.9	26.5	70.1	87.2	46 9	47.4	
1994 : 1	20.1	-0.8	9.8	16.3	4.2	10.3	96.1	28.3	74.6	91.5	42.7	67.1	
2	19.4	-3.1	8.4	15.2	2.7	9.0	96.7	25.8	71.4	91.9	41.7	66.8	
3	23.4	0.4	11.8	18.8	5.3	12.1	95.8	25.8	72.0	92.2	38.1	65.2	
4	32.1	4.7	17.1	25.8	9.4	17.6	95.8	22.3	70.6	92.6	31.5	62.1	
5	39.3	8.9	20.8	30.7	12.7	21.7	95.5	14.1	66.9	92.1	29.7	60.9	
6	38.0	12.3	25.1	33.6	16.7	25.2	94.4	8.6	55.7	85.5	39.9	62.7	
7	38.9	17.4	27.4	34.3	21.2	27.8	96.3	9.4	67.0	89.9	34.0	62.0	
8	41.6	16.1	27.2	35.6	19.7	27.7	96.3	10.7	64.7	91.0	38.0	64.5	
9	39.7	16.0	26.7	34.5	19.6	27.1	93.4	20.1	62.2	88.6	20.1	54.4	
10	38.0	10.4	22.4	31.0	15.2	23.1	96.1	17.0	61.8	87.6	33.8	60.7	
11	30.0	1.1	13.0	19.0	8.1	13.6	95.0	20.8	64.8	82.2	44.6	63.4	
12	16.5	-2.0	7.1	12.5	2.9	7.7	99.1	31.1	72.5	89.7	48.4	69.1	
1995 : 1	18.8	-1.2	9.1	14.5	5.1	9.8	97.4	34.1	77.2	93.3	51.8	72.6	
2	21.4	0.6	10.6	17.7	4.5	11.1	97.9	26.5	72.3	93.6	42.9	68.3	
3	25.8	1.2	12.2	19.7	5.9	12.8	97.8	15.1	73.2	94.2	41.3	67.8	
4	28.6	2.1	15.1	22.4	8.6	15.5	97.5	22.1	72.5	94.5	39.8	67.2	
5	41.3	7.5	21.6	30.0	14.1	22.1	95.8	10.7	66.5	93.1	35.0	64.1	
6	38.7	14.7	25.2	32.5	18.9	25.7	97.0	14.9	67.8	92.5	40.7	66.6	
7	38.0	16.0	26.3	33.4	19.8	26.6	96.6	14.4	68.3	93.0	38.0	65.5	
8	37.4	16.1	27.0	33.4	21.0	27.2	96.9	20.4	71.5	93.2	45.7	69.5	
9	39.5	8.9	24.3	32.2	17.4	24.8	96.5	14.8	65.3	90.8	36.4	63.6	
10	33.7	5.6	19.0	28.6	10.7	19.7	97.4	14.7	58.4	88.4	26.6	57.5	
11	25.8	-1.7	11.6	18.2	5.3	11.8	96.8	37.3	72.4	91.1	52.4	71.8	
12	18.9	-1.8	8.3	15.0	3.1	9.1	90.9	51.2	75.5	88.2	60.3	74.3	
1996 : 1	17.4	-1.7	8.1	13.8	3.6	8.7	90.1	53.7	72.9	86.7	71.9	79.3	
2	22.0	-5.2	10.0	16.4	4.5	10.5	90.9	46.7	74.9	89.3	56.8	73.1	
3	23.6	2.3	11.3	16.8	6.8	11.8	90.4	55.4	79.8	89.8	60.3	75.1	
4	31.0	3.1	14.4	21.1	8.4	14.8	91.0	48.4	76.5	89.8	58.1	74.0	
5	36.5	10.8	22.3	30.9	14.0	22.5	91.6	41.5	69.2	89.1	51.4	70.3	
6	41.3	11.8	26.1	35.0	17.1	26.1	91.8	32.9	61.6	86.2	41.7	64.0	

float gauge.

Since September 17, 1995, an automatic water level recorder made in Japan is used for a measurement of water level in the tank, for the purpose of investigating hourly evaporation rate on daily basis and cross checking of rainfall and evaporation records, from the hourly change of water level.

The monthly evaporation rate observer in the Project site during the summer is shown in the following table.

Table 2-1-18 Monthly evaporation rate an the Project site

Year	May	June	July	August	Sept.
1995	150.5	181.5	182.5	162.5	131.5
1996	148.5	230.0			
Mean	149.5	205.8			

4) Wind Velocity and Direction

Table 2-1-19 shows data on winds among the meteorological observation records, in the form of daily average for each month. The table shows that six(6) months from April through September, which fall under the irrigation period of summer, have mainly southerly winds, while the other months have mainly northerly winds. The table also shows it is no wind for about half a day.

Although there are no observation records on daily patterns of blowing, usual pattern of wind blowing in a day, it blows gently or calm during the night through the following morning, while it blows harder around the noon toward the evening.

5) Characteristics of Rainfall Shown in Observation Records

a. Precipitations Maximum and Minimum

From Table 2-1-14, it became clear that there was an extreme difference in monthly maximum and minimum rainfalls. However, rainfall during the principal irrigation period from June to September, is extremely small in average and in the most of observation records.

b. Maximum Rainfall on Daily Basis

Tables 2-1-20 and 2-1-21 show records of daily and successive rainy days observed in the Project site. The following Table 2-1-22 shows the first to the fifth largest precipitations during the observation period.

Table 2-1-19 Average speed of wind and direction in monthly basis from March 1993 to June 1996

Year and Month	Wind Speed m/s Peak	Wind Speed m/s Max.	Wind Speed m/s Mean	Windy Hour %/day	Wind Speed km/day	Maximum Direction & Ratio (%)		Ratio of Wind Direction in percent (%) on Monthly Basis: N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Calm
1993 : 3	16.1	11.0	2.2	56.9	108	NE	8.0	6.1	6.6	8.0	5.0	2.9	1.3	1.0	0.7	2.2	2.3	4.4	4.3	1.6	0.7	2.3	6.5	43.1
4	13.9	9.5	2.1	45.1	82	SW	8.9	2.9	3.0	1.5	2.6	1.2	1.3	1.0	0.6	2.0	2.8	8.9	6.4	2.3	1.2	1.9	3.8	54.9
5	12.6	8.4	1.8	38.8	60	SW	6.5	2.3	1.1	3.2	2.0	1.4	1.0	0.7	1.2	5.1	4.2	6.5	4.9	1.3	0.9	1.0	1.0	61.2
6	23.3	15.6	2.1	41.3	75	Sw	12.0	0.8	1.3	1.3	1.2	0.6	0.3	0.6	1.8	5.5	5.7	12.0	5.6	1.3	0.5	1.6	1.2	58.7
7	14.3	9.7	2.8	55.4	134	SW	14.2	1.8	7.3	2.7	0.2	0.2	0.2	0.7	4.2	8.6	6.4	14.2	6.4	1.1	0.1	0.2	0.3	44.6
8																								
9	15.7	11.0	2.3	43.4	86	S	8.1	6.4	3.2	0.4	0.1	0.1	0.2	0.6	5.7	8.1	5.6	7.2	4.0	0.3	0.1	0.1	0.5	56.6
10	14.0	10.5	1.8	32.7	51	NNE	6.5	3.1	6.5	4.0	1.5	0.6	0.2	0.2	1.1	3.0	3.5	3.4	1.0	0.3	0.3	0.6	2.4	67.3
11	17.6	13.0	3.0	57.0	148	NNE	12.3	11.0	12.3	7.5	6.5	5.4	1.5	0.5	0.6	0.7	0.9	0.4	0.3	0.4	1.0	2.0	5.1	43.0
12																								
1994 : 1	15.6	11.0	2.1	45.8	83	ENE	8.2	6.2	6.0	7.2	8.2	5.8	1.8	0.6	0.4	0.8	0.8	0.7	0.3	0.3	0.1	1.1	4.6	54.2
2	16.8	11.7	2.2	48.1	91	N	11.0	11.0	6.8	6.0	5.5	3.8	0.8	0.2	0.5	0.8	0.9	1.1	1.1	0.4	0.7	2.2	5.3	51.9
3	16.9	12.1	2.1	40.2	73	N	9.4	9.4	6.0	2.2	1.3	0.6	0.4	0.2	0.7	1.1	4.0	4.8	2.1	0.7	0.7	1.3	4.0	59.8
4	15.4	11.5	1.9	37.5	62	SW	7.2	2.6	2.5	1.7	1.1	0.8	0.2	0.4	0.9	3.2	4.9	7.2	6.4	1.2	0.7	1.1	1.6	62.5
5	11.6	6.6	1.8	36.5	57	Sw	7.0	1.5	1.5	1.4	1.1	0.8	0.5	0.8	2.0	6.8	5.3	7.0	3.3	0.9	0.6	0.9	1.3	63.5
6	20.5	13.9	3.2	58.6	162	SW	13.9	4.9	10.7	2.4	0.7	0.4	0.2	0.6	2.4	4.3	6.8	13.9	27.4	0.7	0.4	0.4	1.2	41.4
7	14.5	9.3	2.8	61.5	149	SW	23.3	0.4	0.2	0.1	0.0	0.0	0.1	0.4	2.3	11.3	9.5	23.3	10.7	1.4	0.2	0.2	0.3	38.5
8	16.0	8.2	2.3	48.6	97	SW	12.1	1.9	1.1	0.8	0.3	0.5	0.3	1.0	6.4	8.0	5.9	12.1	7.4	0.7	0.2	0.1	1.0	51.4
9	25.0	13.6	1.8	37.3	58	SSE	7.7	1.4	1.0	1.1	0.9	0.5	0.4	1.1	7.7	7.1	3.6	5.2	4.0	1.0	0.3	0.3	0.8	62.7
10	21.3	13.8	1.6	30.3	42	N	4.7	4.7	4.7	2.8	2.5	2.8	1.1	0.2	0.7	1.7	1.7	1.6	0.6	0.2	0.3	0.8	3.2	69.7
11	21.2	15.4	3.0	66.4	172	N	21.8	21.8	16.9	7.3	4.8	2.6	1.1	0.5	0.4	0.6	0.4	0.5	0.3	0.3	0.3	1.1	4.7	36.6
12	17.3	13.4	2.7	77.5	181	N	13.9	13.9	10.8	7.0	9.9	5.8	1.6	0.4	0.1	0.1	0.2	0.2	0.0	0.1	0.4	1.2	4.9	42.5
1995 : 1	13.3	9.4	1.8	40.5	63	N	9.1	9.1	6.2	5.6	6.1	4.2	1.2	0.4	0.4	0.9	0.7	0.1	0.3	0.1	0.2	1.0	3.2	59.5
2	12.3	6.9	1.9	40.4	66	N	8.6	8.6	8.4	4.2	3.9	1.0	0.3	0.4	0.4	0.9	1.4	2.6	1.8	0.6	0.2	0.9	4.0	59.6
3	15.6	9.0	1.9	39.4	65	SW	5.1	4.4	3.3	2.2	2.8	2.9	1.2	0.5	0.6	1.9	2.9	5.1	3.2	1.4	0.9	1.6	3.7	60.6
4																								
5	14.2	9.2	1.9	39.9	65	S	8.5	1.4	1.2	1.1	1.3	1.0	0.8	1.0	2.5	8.5	7.1	6.8	3.5	0.7	0.3	0.5	1.2	60.1
6	17.6	12.3	2.3	44.0	87	SW	12.8	1.8	2.3	1.8	1.0	0.9	1.2	0.7	1.2	5.6	5.7	12.8	6.2	0.8	0.4	0.3	0.4	56.0
7																								
8	14.6	10.0	1.8	42.2	66	SW	10.8	0.2	0.8	0.2	0.0	0.0	0.1	0.6	5.3	10.0	5.0	10.8	7.8	0.5	0.0	0.0	0.0	57.8
9	24.1	13.7	1.9	37.3	61	S	6.8	1.5	4.8	1.8	1.3	0.6	0.4	0.5	3.1	6.8	4.6	6.2	3.8	0.3	0.1	0.5	0.2	62.7
10	15.6	9.5	1.7	36.9	54	NNE	9.0	6.7	9.0	6.0	2.4	1.1	0.8	0.5	1.3	2.4	1.1	1.2	0.6	0.1	0.3	0.7	1.9	63.1
11	12.6	8.3	1.6	33.3	46	N	6.0	6.0	5.1	3.2	2.0	1/6	1.3	1.6	1.4	2.0	0.9	1.2	0.8	0.6	0.6	0.7	3.4	66.7
12																								
1996 : 1	16.3	9.7	2.4	58.5	121	N	13.3	13.3	9.8	6.4	12.3	7.8	0.6	0.5	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.6	4.7	41.5
2	17.3	11.3	2.2	41.5	79	EN	9.7	3.0	5.0	8.2	9.7	5.1	1.5	0.3	0.3	1.1	0.8	1.4	1.6	0.3	0.4	0.5	0.7	58.5
3	12.7	6.7	1.7	34.2	50	NE	4.9	2.4	4.0	4.9	4.5	2.8	1.4	1.7	0.9	1.6	2.2	2.3	1.2	0.4	0.2	0.9	1.9	65.8
4	15.6	8.8	1.6	30.8	43	SW	4.7	2.4	3.2	1.6	2.2	1.7	0.9	0.3	0.7	2.4	3.1	4.7	3.5	1.1	0.7	0.5	0.9	69.2
5	13.6	9.2	1.8	37.5	58	SW	7.9	1.7	1.8	1.0	1.0	0.4	0.7	0.6	1.4	6.0	5.3	7.9	5.6	1.1	0.4	0.7	1.1	62.5
6	14.5	9.3	2.5	50.9	110	SW	10.8	2.5	8.5	3.1	1.4	0.4	0.2	0.4	1.5	5.1	4.4	10.8	7.8	1.5	0.6	0.6	1.2	49.1

Table 2-1-20 Daily rainfall and successive rainfall from March 1993 to March 1995 Unit: mm

Year Month Day	Rain Fall mm	Successive		Year Month Day	Rain Fall mm	Successive		Year Month Day	Rain Fall mm	Successive		Year Month Day	Rain Fall mm	Successive	
		Days	mm			Days	mm			Days	mm			Days	mm
1993				11 Sum	15.5			4 8	1.0			1995			
3 4	2.0	6	57.0	12 1	2.0			24	0.5			1 1	13.0	2	26.5
5	2.5			13	37.5			29	8.0			2	13.5		
6	4.5			25	12.0			4 Sum	9.5			7	0.5		
7	14.5			28	3.0			5 1	15.5	2	18.0	10	2.5	6	79.5
8	23.5			12 Sum	54.5			2	2.5			11	11.5		
9	10.0			1994				4	24.0	3	36.0	12	14.5		
20	5.5			1 1	74.0	4	78.0	5	11.5			13	44.5		
3 Sum	62.5			2				6	0.5			14	4.0		
4 2	0.5			3				8	1.5			15	5.0		
8	1.0	4	29.5	4	4.0			12	3.5			18	0.5		
9	0.5			14	9.5	2	20.0	5 Sum	59.0			25	1.5		
10	27.5			15	10.5			6 16	4.5			28	22.0		
11	0.5			22	8.5			8 1	2.0			1 Sum	133.0		
19	2.5	2	12.5	28	7.0	4	62.5	9 7	4.5			2 6	11.0	3	19.0
20	10.0			29	12.5			10 1	14.0			7	7.5		
26	6.5			30	37.0			17	27.5	2	34.5	8	0.5		
30	0.5			31	6.0			18	7.0			10	0.5	2	1.0
4 Sum	49.5			1 Sum	169.0			24	21.0			11	0.5		
5 2	3.5	4	24.9	2 8	3.5			26	3.5			20	1.0	2	4.0
3	5.5			10	6.0	4	15.5	10 Sum	73.0			21	3.0		
4	0.5			11	3.5			14	6.5	2	7.5	2 Sum	24.0		
5	14.5			12	5.5			15	1.0			3 7	7.5	3	22.0
12	4.0	3	16.5	13	0.5			18	24.0	5	238.5	8	3.5		
13	2.0			15	26.5	2	27.0	19	132.			9	11.0		
14	10.5			16	0.5			20	56.0			11	5.5	2	6.0
22	7.0			21	1.0	6	60.5	21	25.5			12	0.5		
27	2.0			22	3.5			22	1.0			14	4.0	4	30.5
5 Sum	49.5			23	1.0			11 Sum	246.0			15	1.5		
6 2	3.0	2	9.0	24	1.5			1	13.0	2	26.5	16	24.5		
3	6.0			25	8.5			2	13.5			17	0.5		
7	1.0			26	45.0			11	0.5			24	1.5	2	4.5
17	4.0			2 Sum	106.5			14	2.5	3	28.5	25	2.5		
19	1.0			2	1.0			15	11.5			28	4.0		
6 Sum	15.0			5	52.5	2	60.5	16	14.5			3 Sum	66.5		
10 15	1.0			6	8.0			18	44.5	2	48.5				
10 23	2.5			13	3.0			19	4.0						
10 Sum	3.5			15	8.0			28	5.0						
11 1	9.0			17	0.5			31	1.0						
14	1.0	2	4.0	23	2.0			12 Sum	105.0						
15	3.0			31	7.0										
17	2.5			3 Sum	82.0										

Table 2-1-21a Daily rainfall, continued rainfall and rainfall intensity from April to December 1995

Year Month Day	Daily Rainfall Depth: Daily Rain mm	Peak Intensity: Time min.	Peak Intensity: Rain mm	Peak Intensity: Int. mm/h	Continued: Days	Continued: Total Depth mm
1995 4 2	2.0				2	5.5
3	3.5					
9	0.5				3	42.5
10	37.0					
11	5.0					
13	5.5				2	6.0
14	0.5					
18	30.5	85	11.0	8	2	41.5
19	11.0	15	6.0	24		
		25	3.0	7		
28	0.5					
4 Sum	79.0					
5 4	13.5	35	13.0	22	4	51.5
5	25.0	15	12.0	48		
		90	7.0	5		
		12	12.0	60		
		60	4.5			
6	10.0	100	7.0	4		
7	3.0					
9	1.0					
5 Sum	53.0					
6 1	1.5				2	8.5
2	7.0	20	6.5	20		
9	32.0	20	30.5	92	2	33.0
10	1.0					
28	34.0	42	31.0	44	2	37.5
		2	3.0	90		
29	3.5					
6 Sum	79.0					
7 1	16.5	15	5.5	22		
		10	4.0	24		
		30	5.5	11		
3	6.0	30	5.0	10		
24	12.5	70	11.0	9		
7 Sum	35.0					

Year Month Day	Daily Rainfall Depth: Daily Rain mm	Peak Intensity: Time min.	Peak Intensity: Rain mm	Peak Intensity: Int. mm/h	Continued: Days	Continued: Total Depth mm
1995 8 22	1.5					
8 Sum	1.5					
9 24	34.0	55	32.5	35		
28	1.5	15	1.5	6		
9 Sum	35.5					
10 2	28.5	75	14.0	12		
		180	5.0	2		
28	22.5	40	19.0	29		
		20	4.0	12		
10 Sum	51.0					
11 1	1.0				4	26.5
2	12.5	60	8.0	8		
3	10.0	90	8.0	5		
4	3.0	30	2.5	5		
7	24.5	10	9.5	57	2	27.5
		40	5.5	8		
8	3.0	10	2.0	12		
19	12.5	60	11.0	11	5	109.0
20	42.5	230	15.0	4		
		180	20.0	7		
21	29.5	90	14 0	9		
		30	3.0	6		
22	23.5	270	18.0	5		
23	1.0					
11 Sum	163.0					
12 9	8.0	9 180	8.0	3	4	15.0
10	4.0					
11	1.0					
12	2.0					
21	0.5					
26	0.5				2	3.0
27	2.5					
12 Sum	18.5					

Table 2-1-21b Daily rainfall, continued rainfall and rainfall intensity from January to June 1996

Year Month Day	Daily Rainfall Depth				Continued	
	Daily Rain mm	Peak Intensity			Days	Total Depth mm
		Time min.	Rain mm	Int. mm/h		
1996 1 2	5.0	30	2.5	5	5	72.0
3	8.0					
4	35.0	180	17.0	6		
		180	15.5	5		
5	14.0	50	4.0	4		
6	15.0	60	6.5	7		
		100	6.0	4		
18	2.0					
20	0.5					
1 Sum	96.0					
2 5	1.0				6	60.5
2 6	16.5	110	8.0	4		
7	8.0	50	2.5	3		
8	5.0	180	9.5	3		
9	26.0	140	8.0	3		
10	4.0	95	3.0	2		
19	2.0				2	2.5
20	0.5					
26	0.5				2	9.5
27	9.0	110	7.5	4		
29	1.0				8	112.0
2 Sum	1.0	73.5				
3 1	20.0	80	8.0	6		
		50	5.0	6		
2	21.0	200	19.5	6		
3	10.5	110	8.0	4		
4	9.5	120	3.5	2		
5	5.5	210	3.5	1		
6	34.5	330	31.5	6		
7	10.0	40	3.5	5		
		140	5.5	2		
9	1.0				3	5.0
10	3.0					
11	1.0					

Year Month Day	Daily Rainfall Depth				Continued	
	Daily Rain mm	Peak Intensity			Days	Total Depth mm
		Time min.	Rain mm	Int. mm/h		
3 20	7.5	20	5.0	15	8	33.5
21	7.5	20	4.5	14		
22	1.5					
23	7.0	40	3.0	5		
24	6.0	60	6.0	6		
25	0.5					
26	2.5					
27	1.0					
29	1.0				2	2.5
30	1.5					
3 Sum	152.0					
4 6	1.5				4	9.5
7	3.0					
8	1.0					
9	4.0					
12	16.0				2	21.0
13	5.0					
15	16.0					
17	2.5					
20	4.5				2	31.0
21	26.5					
4 sum	80.0					
5 10	6.5					
24	0.5					
30	1.5					
5 Sum	8.5					
6 2	10.0					
20	1.5					
21	0.5					
6 Sum	12.0					

Table 2-1-22 The five largest daily and successive rainfall at the Project site from March 1993 to June 1996

Order	Daily Rainfall (mm)		Successive Days Rainfall		
	Total	Date	Days	Total	Date
1	132.0	20 Nov. 1994	5	238.5	18 Nov. o 22 Nov.1994
2	56.0	21 Nov. 1994	8	112.0	29 Feb. to 7 Mar.1996
3	52.5	5 Feb. 1994	6	109.5	19 Nov. to 23 Nov.1995
4	45.0	26 Feb. 1994	6	79.5	10 Jan. to 15 Jan.1994
5	42.5	20 Nov. 1995	4	78.0	1 Jan. to 4 Jan.1994

c. Intensity of Rainfall

The intensity of rainfall means average rainfall within a given times, it is usually expressed by hourly depth of rainfall. A given hour is shorter the intensity of the rainfall becomes bigger. The study on rainfall intensity becomes possible since April 19, 1995, when a automatic rain gauge, procured in Japan, was in operation.

Among the records for about 15 months from the beginning of observation until the end of June, 1996, continued rainfalls more than 10 mm within a short period of time are picked up and listed with order on the following Table 2-1-23.

Table 2-1-23 Record of rainfall intensity observed the Project site from 18 April 1995 through 30 June 1996

Rainfall	Duration	Intensity	Date
32.5 mm	65 min	35 mm/h	24 Sep. 1995
31.0 mm	42 min	44 mm/h	28 June 1995
19.0 mm	40 min	29 mm/h	10 Oct. 1995
13.o mm	35 min	22 mm/h	4 May 1994
30.5 mm	20 min	92 mm/h	9 June 1995
12.0 mm	15 min	48 mm/h	5 May 1995
12.0 mm	12 min	60 mm/h	5 May 1994

A intensity of rainfall in short period is the essential data required for design of terminal drainage system on farm level.

2-2. Operation Tests on Irrigation and Drainage Facilities

2-2-1. Operation Tests for Field Crop Irrigation System

(1) Physical Data of Irrigated Area

1) Name and Dimensions of Irrigated Area

The name and dimensions of irrigated area is shown in Fig. 2-2-1. The names of farming lots are composed of combination of the numbers from 1 to 4 put in order from the North to the South, and the characters from A to C put in order from the West to the East. The farming lots for traveling sprinkler irrigation methods, applied to field crops and vegetables cultivation, are composed of six lots: lots 3A - C and 4A - C from the North. On the other hand, lots 1 and 2 are used for conventional irrigation methods.

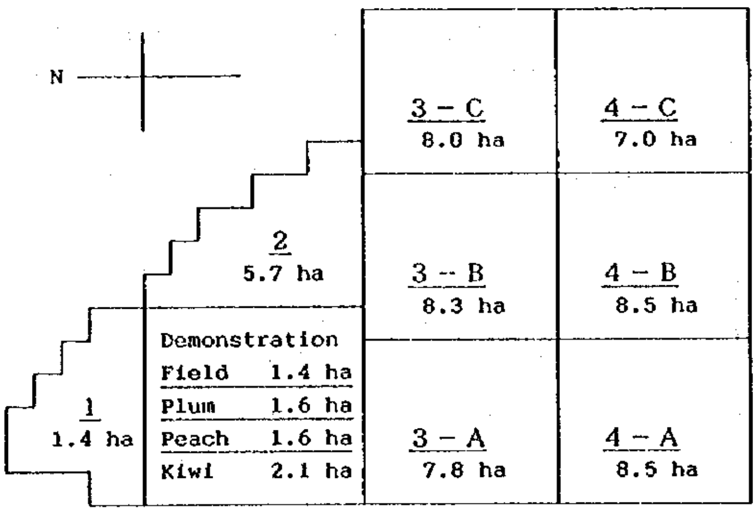

Fig. 2-2-1 Name and dimension of irrigated area in field crop area

2) Status on Ground Slope and Unevenness of the Field

An adjustment of ground slope and leveling on the surface of each lot was carried out in 1991, after the initial operation tests, to meet with surface irrigation as well as surface drainage during rainy season. In March 1995, a survey on ground height was conducted with the purpose of understanding the status of ground slope and unevenness in each lot. The findings on the surface slope are described under a separate section.

(2) Outline of the Irrigation Facilities

1) Pump Facilities

a. Outline of the Pumps

Three units of the five(5) stage volute pumps made in Japan have been installed, to supply pressured water for the use of traveling sprinklers. The outline of the pumps are as follows.

Name of pump	: Multi-stage volute pump
Number of stage	: five(5)
Model(frame number)	: MVO 1305FA
Nominal diameter	: 5 inches
Output of electric motor	: 37 kw
Design discharge	: 1.39 m^3/min
Design total head	: 10.5 kgf/cm^2

The maximum output pressure was 13.5 kgf/cm^2, under the discharge zero(0). Since all pumps have remodeled to four(4) stage in May 1995, the maximum pressure and operation pressure at discharge of 1.39 m^3/min was decreased in 11.4 kgf/cm^2 and 8.5 kgf/cm^2 respectively.

b. Flow Meter

A propeller type flow meter for 200 mm pipe made in Japan have been installed at the terminal of the outlet pipe of pumps. The functions of the flow meter are to indicate total volume of water by digital and to indicate a momentary flow rate on the dial gauge.

2) Water Supply System

a. Water Supply Pipe

Two sizes of supply pipe, made from polyvinyl chloride with a caliber of 300 mm and 200 mm made in Turkey, were used. The length of the 300 m pipe and 200 mm pipe is 1,288 m and 300 m respectively.

b. Turnouts

In order to supply water to the rainguns and the boom sprinklers, nine(9) units of turnouts named hydrant, with the caliber of 110 mm manufactured by Bauer, Austria, were installed along the northern boundaries of the farm lots from 4A through 4C.

c. Air Vent Valves

In May 1995, five(5) sets of air vent valves with 25 mm size have been newly installed on the main pipe line through the profile section in the 300 mm pipe, with the purpose of securing more safety of the pipe line.

d. Scouring Sluice Valve

At the end of the main supply pipe, each one unit of air vent valve and scouring sluice valve have been installed, with the purpose of release air from the pipe lime and flush away the muddy materials deposited inside of the pipe.

3) Traveling Type Sprinkler Equipments

a. Raingun

The operation test of traveling sprinklers for field crop cultivations was carried out by means of three(3) sets of rain guns, manufactured by Bauer in Austria. Outline of the equipments are as follows:

Model	: Rainstar 110-350T
Caliber of nozzle	: 32 mm
Supply pressure	: 8.5 kgf/cm^2
Pressure of nozzle	: 4.5 kgf/cm^2
Amount of water sprinkling	: 83.4 m^3/hr.
Polyethylene pipe (with the dedicated reel)	
Length	: 300 m
Inner diameter	: 90 mm
Outer diameter	: 110 mm

b. Boom Sprinkler

The two units of the boom sprinkler made by Bauer, Austria were used for field crops and vegetable irrigation. The model and standard of the boom sprinkler are as follows:

Model	: Rainboom ASH50
Spray nozzle	
Installed numbers	: 23
Caliber	: 6.8 mm
Maximal irrigation width	: 58 m
Supply pressure	: 5.1 kgf/cm^2
Pressure of nozzle	: 2.3 kgf/cm^2
Amount of water sprinkling	: 50.0 m^3/hr.
Polyethylene pipe and reel (those for the rain gun are used.)	
Length	: 300 m
Inner diameter	: 90 mm
Outer diameter	: 110 mm

(3) Operation Tests of Traveling Type Sprinkler System

1) Status of Pumps in Operation

a. Status of Pumps During Operation

The pumps and motors have performed normally throughout the full operation period, without any special tune up or repair except replacement of consumable parts.

As the results of internal inspection of pumps by the time of overhauling, which have conducted in May 1995 together with the modification, none of wear nor other any disorder portion were observed, and it was confirmed that the pumps were in the almost same condition as that upon manufacture.

b. Change in the Performance after the Modification

In May 1995, all pumps had been modified from five(5) stages to four(4) stages, with the purpose of lowering the maximum output pressure. And the maximum output pressure of pumps, have been lowered to 11.4 kgf/cm^2 from 13.5 kgf/cm^2. The performances of pumps before and after modified are shown on the following table.

Table 2-2-1 Performance of sprinkler irrigation pumps before and after modified

Discharge Controlled	Output Pressure kgf/cm^2		Rate of Pressure B / A
	Original (A)	Modified (B)	
2.08 m^3/min(150%)	5.3	3.8	72 %
1.74 m^3/min(125%)	8.3	6.4	77 %
1.39 m^3/min(100%)	10.3	8.5	83 %
0.70 m^3/min(50%)	12.7	10.5	83 %
0.00 m^3/min(0%)	13.5	11.4	84 %

2) Performance Tests of the Rainguns

a. Performance of the Raingun

According to the Performance Table described in the Operation Instructions prepared by Bauer, the performance of the raingun is as follows. The performance of the equipments were confirmed by the field operation tests carried out in September 1990.

Table 2-2-2 Performance of Rainstar 110-350T with a 32 mm nozzle and a 300 m hose

Nozzle Pressure(bar)	3.5	4.0	4.5	5.0
Discharge (m^3/s)	1.23	1.31	1.39	1.47
Connection Pressure(bar)	6.6	7.4	8.1	9.0
Spray Range (m)	53.2	55.3	57.2	58.9
Width of Strip (m)	90	94	97	100

b. Total Performance of the System after Modified Pumps

i) Reduction of Discharge Rate

It is apparent that the reduction of pump pressure is resulted in the reduction of discharge through the rainguns. In this connection, total performance of the raingun system by means of modified pumps was estimated by the operation record in 1995, when operated three(3) rainguns simultaneously. Table 2-2-3 shows total operation hours of pumps and the corresponding volume of water supplied for specific farm lot, and the average discharge and the rate per a raingun, when the three units of the raingun were operated simultaneously.

Table 2-2-3 Average discharge and efficiency of Rainguns in 1995 irrigation period after the modification

Lot	Total Volume and Hours		Discharge par One Unit	
Number	m^3	Hours	m^3/min	%
3 A	11,755	48.50	1.346	96.8
4 A	20,300	83.50	1.351	97.1
4 B	19,657	81.50	1.340	96.0
3 C	15,105	64.00	1.311	94.4
4 C	18,277	76.50	1.327	95.5
Total	85,094	354.00	1.335	96.1
Design discharge			1.390	100.0

ii) Reduction of Strip Width

The reduction of the strip width is obtained theoretically from the performance of raingun shown in the Table 2-2-3 and average discharge of 1.335 m^3/min shown in the table 2-2-3, then the reduced strip width is expected to be 94 m against the planned width of 97 m.

c. Sprinkler Works and Wind Conditions

As a common characteristics on wind pattern of daily cycle in the region, the most of fine days it will blows from noon time through evening. And the southwestern wind is dominant during the irrigation period from May through September, as shown in Table 2-1-19 in the Section of Meteorological Observation.

For sprinkler operation by the rainguns, this wind direction becomes the follow wind at the lots 3A - C and the adverse wind at the lots 4A - C.

It was immediately experienced when the operation of rainguns was commenced that the strip width of rainguns were constricted by the bowing wind during day time. Consequently, operation time was shifted from daytime to night time after the wind stopped. Since the operation hours was shifted to the night time, the sprinkler operation was carried out almost on schedule.

d. Strip Width of Raingun in Windy Time

As a result of survey in strip width of raingun and wind velocity, conducted in September 1995, it was confirmed that the strip width is constricted considerably by wind when it becomes hard. The outline of the survey methods and the findings are as follows:

i) Outline of Survey Method

Place of experiment	: a part of lot 3B
Number of raingun	: one(1) unit
survey of strip width	: the maximum width for every cycle
survey of wind speed	: about 2m high, with portable wind speed meter, at the same time when strip width was measured
Operation hour	: about one(1) hour each.
Total survey time	: 13 times

ii) Findings

Major direction of wind throughout the series of survey period were from the south to southwest, the follow wind for the sprinkling direction. Since the place of survey was limited only in the lot 3B, no data on the against wind was collected. However, it is considered that the relationship between the wind speed and the strip width was studied. Table 2-2-4 shows only a relationship between a wind speed and the corresponding mean strip width by raingun without considering the direction of wind.

Table 2-2-4 Wind velocity and strip width in average

Wind Velocity (m/s)	Strip Width in Average(m)		
	Eastward	Westward	Total
0.0	40.4	42.1	82.4
1.0	39.3	42.0	81.7
2.0	41.8	38.3	80.0
3.0	38.6	36.6	75.8
4.0	35.8	34.3	70.4
5.0	35.5	31.9	67.6
6.0	32.4	28.8	63.8

3)Performance Test of Boom Sprinkler

The performance test on the boom sprinkler was conducted in September, 1990 and obtained in the following results, which was considered to be satisfied the performance the standard as shown in the above section.

Table 2-2-5 Performance of Boom sprinkler AS-50 with 23 units of 6.8 mm nozzle and a 300 m hose

Subjects	Unit	Test-1	Test-2
Supply pressure	Bar	9.0	8.0
Pressure of nozzle	Bar	2.6	3.5
Momentary discharge	l/s	22.5	25.0
Maximum strip width (mean of both width)	m	32.1	

2-2-2. Operation Tests for Orchard Irrigation System

(1) Physical Data of Irrigated Area

1) Name and Dimension of Orchard Lots

The names of orchard lots are derived from the name of fruit trees planted, and the order of lots from the western side are Kiwi, Peach, Plum and Demonstration farm. The areas subject to irrigation and the number of fruit trees planted in each lot are as shown in Table 2-2-6.

Table 2-2-6 Size and dimensions of planted area and number of trees

Name of Lot	Size and Dimensions		No. of Trees
Kiwi Field	69m X 306 m	2.75 ha	1,008
Peach Field	51m X 306 m	1.56 ha	667
Plum Field	51m X 306 m	1.56 ha	667
Demonstration Field	45m X 306 m	1.38 ha	789

2) Slope of the Ground Surface

The slope of ground surface of each lot are controlled from the northwest to the southwest in general, at the construction period, by the consideration of surface irrigation and surface drainage during rainy season. In July 1996, the slope of ground surface was surveyed, to assure the status of surface slope. The result of this survey is as shown under the separate item.

(2) The Data of the Irrigation Facilities

1) Pump Facilities

a. Outline of the Pumps

Two units of the volute pumps made in Japan was installed, to supply pressured water for the use of drip irrigation in the orchard areas. As the drip irrigation method was expanded for vegetable cultivation in the part of 3A and 3B lots in 1993, these pumps are used in common with the vegetable irrigation since after.

Name of pump	: single stage volute pump
Model(frame number)	: SV-JA52AK
Nominal diameter	: 50 mm
Output of electric motor	: 5.5 kw
Design discharge	: 0.282 m^3/min
Design Total head	: 2.5 kgf/cm^2

b. Filter System

For the use of drip irrigation, a filter system composed of one unit of screen filter and two units of sand filter tanks was installed.

2) Water Supply System

a. Main Water Supply Pipe

A polyvinyl chloride pipe(PVC) with a caliber of 100 mm and 75 mm were used from the terminal of the filter system through the last turnout points, and total length of each pipe are 495 m and 392 m respectively.

The main supply pipe is branched into two(2) lines at the middle, and two units of sluice valves with a size of 100 mm are installed at the head of each branched main pipe line. One branched pipe is placed under the peach lot along the farm road, to supply water to the kiwi and peach lots.

And the other is placed under the demonstration lot along the farm road, to supply water to the plum lot and the demonstration lot.

Eight(8) units of turnouts, each two set per lot, are provided along the two(2) main pipe lines. Each turnout consist of a sluice valve with a valve box made from concrete cast in place.

Since the drip irrigation method was expanded to the part of vegetable cultivation in 3A and 3B lots, two main supply pipelines in peach area and demonstration area were expanded about 90 m each from the terminal to the border of the 3A lot in 1993.

b. Pipe System in Orchard Lot

The pipe system in each orchard lot is consisted of two(2) sets of terminal systems with almost equal size and length, divided each lot into two(2) sections.

The pipe placed in the lot is a PVC pipe with a caliber of 37 mm and the total length of 1,176 m, accordingly a length of one(1) line is 147 m. Each turnout is located at the middle of the pipe system.

c. Terminal Drip System

A normal drip irrigation method applied to fruits trees since the Project came into operation. The terminal drip system is consisted of PVC tube per low of trees with a caliber of 13 mm, branched from the pipe system as aforesaid, and number of emitters fit on the tube.

Since May 1994, a mini sprinkler system was newly introduced in addition to the drip irrigation method, in a part of kiwi lot for a experiment.

(3) Survey and Examination of the Orchard Irrigation

1) Status of Pumps

a. Status of Pumps During Operation

The pumps and motor worked well throughout the operation period, without any particular problem. When they were overhauled and checked for internal parts during the irrigation period in 1995, no particular abnormality was observed. However, as the water-tightness of the foot valve lowered, it was replaced with a local made valves in March 1996.

b. Performance of the Pump

The performance of the pumps, based on the operation test when it was manufactured, are shown in Table 2-2-7. It is considered that the performance of pumps are not decreased even now.

Table 2-2-7 Performance of pumps for drip irrigation system

Discharge (ratio %)	Output pressure
0.35 m^3/min (124 %)	1.93 kgf/cm^2
0.28 m^3/min (124 %)	2.77 kgf/cm^2
0.21 m^3/min (124 %)	3.11 kgf/cm^2
0.10 m^3/min (124 %)	3.40 kgf/cm^2
0.00 m^3/min (124 %)	3.47 kgf/cm^2

2) Survey and Examination of the Drip Irrigation System

a. Outline of the Examination

i) Irrigation Method up to 1992

One(1) line of tube per row of trees was placed along one side of trees in a row, used for drip irrigation. A nozzle-type emitter made by Rainbird Inc., U.S.A. was fit on the tube per a tree to supply irrigation water for each trees. As to the irrigation interval, continuously drip irrigation was applied in the beginning, then it was revised to intermittent drip irrigation.

ii) Irrigation Method in 1993 - 1994

As the fruit trees growing, the number of emitter per tree was increased to twice, to fit each additional emitter on the tube, adjacent to the exist in emitter with a distance of 1.5 m. Then the tube was moved longitudinally to be covered each tree with two emitters equally. The emitters were procured normal diaphragm-type available in the country.

In addition, mini sprinkler test was newly commenced in a parts of the kiwi lot combined with a cover crop tests since 1994, by means of a rotary jet type with a revolving nozzle.

iii) The Irrigation Period in 1995

The number of emitters per tree was increased to three for the trees growing successfully. The modification was applied to the tube line system, to provide additional line, placed on the other side of trees, connected the existing tube at each both end to form a loop. And an additional emitter per tree was fit on the new line at the front of each tree.

As to mini sprinkler test, a different type of equipment was newly introduced, which is provided with a fixed nozzle to spray water in 360 degree around forming a mist.

New irrigation system for poplar planted around the orchard area to forming a shelter belt, and nursery bed for cutting of kiwi were provided and put into irrigation. The former system is normal drip system, and the latter is mini sprinkler system.

iv) The Irrigation Period in 1996

In response to the operation plan of the counterpart Agency which is to succeed the Project operation and management after October 1996, the Farm level irrigation system, both pipe line system and drip system in the most part of kiwi area, was modified to meet with proposed grape cultivation. And the farm level irrigation system for the remained kiwi area was also modified to meet the mini sprinkler irrigation methods.

b. The Performance of the Emitter

i) The Nozzle-type Emitter

In September 1990, the relationship of the terminal pressure and the flow rate was examined, by means of a nozzle-type emitter made by Rainbird Inc.. Table 2-2-8 shows the results of measurement carried out at the Project site.

In consideration of this result of measurement and the overall performance on the drip system observed pressure drop at the terminal, the flow rate per nozzle-type emitter was assumed to be 8 l/hr.

Table 2-2-8 Performance of nozzle-type emitter made by Rainbird

Pressure (kgf/cm^2)	0.5	1.0	1.5
Discharge (L/hr)	5.4	7.2	9.4

ii) Diaphragm-type Emitter

The mechanism of diaphragm-type emitter used for the operation test since 1993, is provided with a disk at the inside of case to control flow and a screw-type cover with a dripping hole on top it. During the dripping operation, it is observed that the type of emitter is possible to increase its flow rate as required by unscrew the cap.

In the irrigation practice in 1995, the rotation block for the orchard inclusive of poplar and nursery bed was made up, taking the performance of pumps and number of emitter and mini sprinklers into consideration. And estimated mean discharge of the diaphragm-type emitter to be 15 l/h.

iii) Mini Sprinkler and Sprayer

The performance of mini sprinklers mentioned in the above, is shown in the following Table 2-2-9.

Table 2-2-9 Performance of the mini sprinkler

Pressure bar	Rotation Type Rondo Class:Red		Fixed Spray Type	
	Flow Rate L/ha	Radius m	Flow Rate L/ha	Radius m
1.5	90	4.0		
2.0	100	4.4	31	1.7
2.5	115	4.7	35	1.8
3.0			38	1.9
3.5			41	2.0

As shown in the above table, the performance of the rotation type is not only lager than that of new emitter, but also water sprinkling radius, even in the lowest pressure on the table. Accordingly the flow rate and the radius at practical irrigation application are controlled, by manipulating the stop valve installed at the head of each dripping tube, to be about 50 to 60 % in both flow rate and the radius of sprinkling. The objective flow rate and the radius were obtained by measurements in March 1995.

iv) Unit Flow Rate by Each Supply Method in 1995 Operation

The target flow rate of the drip method in standard was set to 38l/hr, with a total of three emitters; one nozzle-type and two diaphragm-type emitters per fruit tree. On the other hand, the target flow rate of mini sprinkler per rotary type is assumed to be 50 l/hr and the spraying radius will be approximately 2.0 m, and the flow rate of fixed type mini sprinkler is counted to 38 l/hr by adjusting the screw head slightly to increase the flow rate.

v) Operation for 1996

The operation program is referred in the operation manual, in connection with the operation in future.

2-2-3. Operation Tests for Vegetable Irrigation Method

(1) Outline of the Irrigation Tests

1) Area for Vegetable Cultivation

a. Vegetable Cultivation in the Field Crops Areas

A vegetable cultivation at the outdoor with sprinkler irrigation method is selected annually among the field lots of 3A, 3B, 4A and 4B. On the other hand, a vegetable cultivation with drip irrigation method is carried out between the field lots of 3A and 3B.

A vegetable cultivation in the field lots with drip irrigation method is continued in the part of lot 3A or 3B annually most for spring raising varieties, shifted cultivation area for every cultivation season.

The cultivation in the greenhouse is carried out in the northwest corner of lot 3A where stationary greenhouses and appurtenant facilities are provided.

2) Sort of Irrigation Methods and Results of Experiments

a. Traveling Sprinkler Method

The traveling irrigation method applied to daikon, Japanese variety of radish, cultivation since the autumn of 1991, by means of two(2) units of rain booms, and the following spring of 1992 for broccoli, tomato and melon cultivation.

As to the results of the initial experiment, it is cleared that the sprinkler irrigation method by means of boom sprinkler is quite successful for daikon and broccoli. On the contrary, the sprinkler irrigation itself is not so successful for fruits vegetables irrigation, such as tomato and melon, due to water sprayed on the plant body which induced blight and resulted in deteriorated fruits production.

b. Surface Irrigation Method

The surface irrigation method was tested for tomato and melon irrigation in 1992 and 1993 in the small scale of area with the purpose of only comparative experiments with other irrigation methods.

c. Drip Irrigation Method

The drip irrigation method by means of a drip tube was commenced since the spring of 1993 for tomato and melon, combined with vinyl mulching method, after the experiments of sprinkler and surface irrigation practice.

As the drip irrigation method by means of common drip tube, combined with vinyl mulching method were quite successful since the first experiments, the drip irrigation method have been used as the standard irrigation method for the same sort of vegetable cultivation.

(2) Irrigation Facilities

1) Water Supply System

a. Traveling Sprinkler

The sprinkler irrigation system for the field crop areas is used in common for the vegetable cultivation, without any special modification.

b. Supply System for Drip Irrigation

The suppl system for orchard area is used in common for that of vegetable, by extending two(2) pipelines with a caliber of 59 mm up to the northern border of 3A lot, where two sets of sluice valves, strainers, water meters and extension hoses with a caliber of 50 mm were provided.

c. Surface Irrigation

As the surface irrigation test was practiced only a comparative with other irrigation method, no special irrigation system was provided.

d. Greenhouse Cultivation

As to drip irrigation method in the greenhouse, the extended system is used by switching as required. On the other hand, miscellaneous water use for the greenhouse cultivation, domestic water system for the Project office is used in common, by extending supply pipeline and a receiver tank and faucets at the house side.

2) Structure of Terminal Irrigation Facilities

a. Boom Sprinkler

Two(2) units of boom sprinkler made in Austria are was used in common with the field crop irrigation. with regard to the outline and performance of equipment etc. please refer in the above section 2-2-1.

b. Drip Irrigation Method

Since initial operation in 1993, the following drip irrigation system have been used, which is consisted of a main supply pipe, lateral pipelines and terminal drip tubes.

Main supply pipe: PVC pipe with a 63 mm outer diameter, extended from orchard irrigation pipe.It is provided with each one(1) unit of sluice valve, filter and water meter.

Lateral pipe : PVC pipe with a 35 mm outer diameter and 50 m length as a standard length are branched from the main supply pipeline, drip tubes are branched from the pipe.

Drip tube : PVC tube with a 16 mm outer diameter and 40 m length as a standard, which is provided with number of fine holes for dripping water.

(3) Design of Drip Irrigation System

1) Formation of Farm Level

For better understanding, a dimension of a cultivation unit is assumed to be one(1) ha, which is formed the following figure.

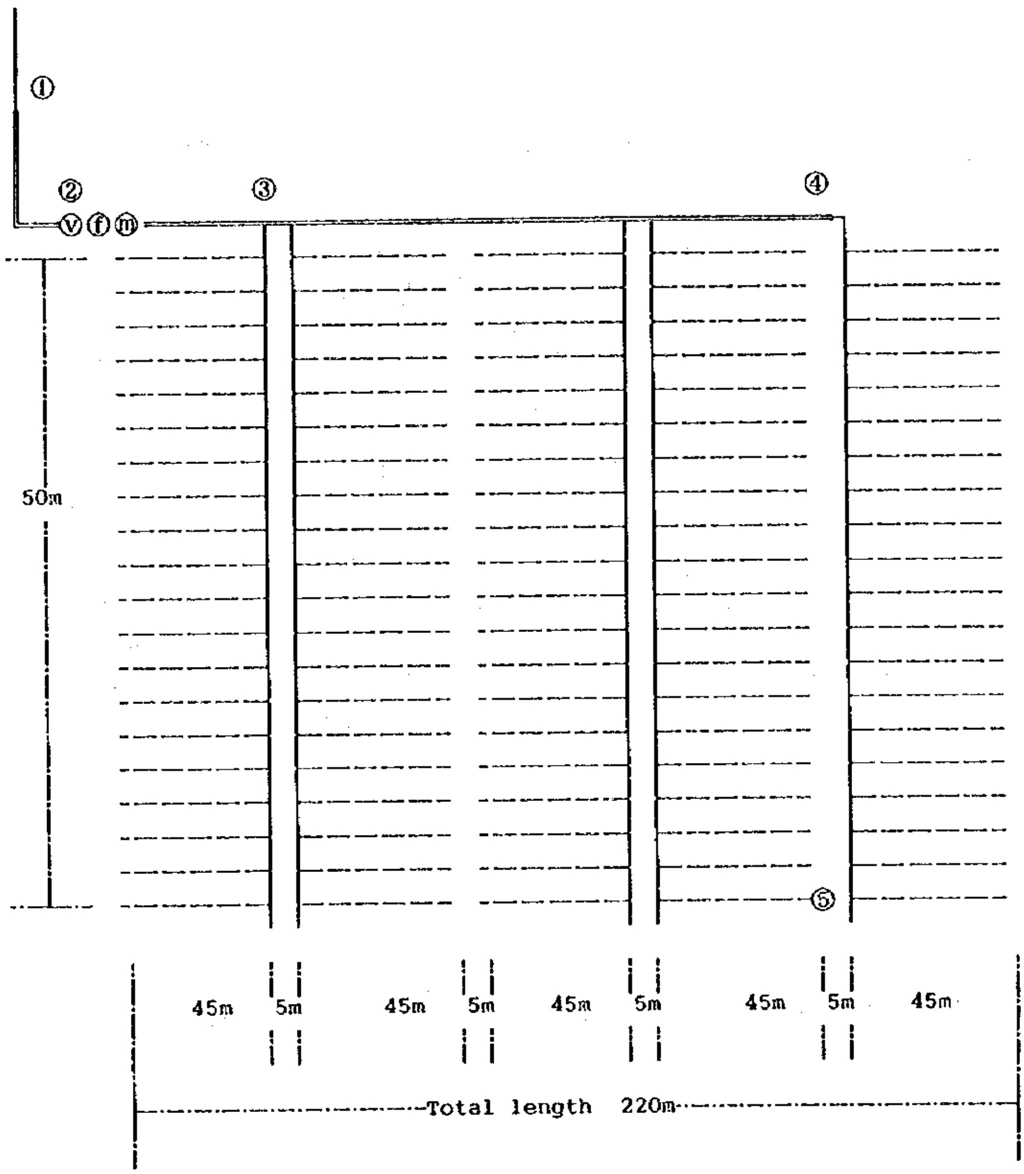

Fig. 2-2-2 Schematic plan of drip tube terminal irrigation system
In case of one(1) ha

Legend:

———	: supply line of orchard irrigation system		
═══	: 63 mm pipe	ⓥ	: sluice valve
———	: 35 mm pipe	ⓕ	: filter
- - - -	: 16 mm drip tube	ⓜ	: water meter

Note : The number of tubes or furrows per lateral pipe are; 20 lines for melons and 31 lines for tomatoes.

2) Irrigation Requirement

a. Performance of Drip Tube

The performance of drip tube prepared by the manufacturer is shown in the following table.

Table 2-2-10 Performance of drip tube

Pressure	Discharge	Max.length	Note: The unit of discharge is per meter length.
0.5 bar	1.4	80 m	
1.0 bar	2.4 l/hr	70 m	
1.5 bar	2.7 l/hr	65 m	

b. Total Length of Drip Tube and Irrigation Requirement

Melon cultivation:

Drip tube length: 20unit X 5set X 40m = 4,000 m

Water requirement: 4,000 m X 2.7 l/hr + 1/1,000 m^3/l = 10.8 m^3/hr
= 3.0 l/s

Tomato cultivation:

Drip tube length: 31unit X 5set X 40m - 6,200 m

Water requirement: 6,200 m X 2.7 l/hr + 1/1,000 m^3/l = 16.7 m^3/hr
= 4.64 l/s

3) Hydraulic Analysis on the Drip Irrigation System

a. Dimension of Discharge

The design discharge for one(1) ha of melon irrigation assumes to 3.0 l/s and the dimension of the terminal drip tube irrigation system mentioned the above is used.

b. Friction Loss Between Major Control Points

The control points is selected as follows, which is also plotted by the corresponding numbers on the above schematic plan.

①: Beginning Point which is the outlet of terminal valve of orchard.
②: Lot 3A(sluice valve), located at the north border of lot 3A where a sluice valve for the system is provided.
③: Branch point for a Lot, which is start point of farm level system
④: Branch point of terminal lateral
⑤: Branch point of terminal tube

c. Water Pressure at Major Control Points

The following table shows the water pressure for a melon irrigation system. In the table the lowest pressure 13.40 m (1.34 bar) was observed at the terminal branch of ⑤. Though this pressure is about 10 % lower against objective pressure of 1.5 bars, the possible decrease rate of discharge is estimated to be only four(4) % and for all system level will be one(1) % level.

Table 2-2-11 Water pressure in one(1) ha of melon drip tube irrigation system

No	Pressure Control Points	Flow l/s	Length m	Loss	Pressure
①	Beginning Point	3.00	0 m		20.00 m
②	Lot 3A(sluice valve)	3.00	90 m	2.36 m	17.64 m
③	Branch of No. 1 Lateral	3.00	100 m	2.61 m	15.03 m
	No. 2 Lateral	2.40	5 m	0.09 m	14.94 m
	No. 3 Lateral	1.80	95 m	0.97 m	13.97 m
	No. 4 Lateral	1.20	5 m	0.02 m	13.95 m
	No. 5 Lateral	0.60	45 m	0.06 m	13.89 m
⑥	Terminal branched tube		45 m	0.49 m	13.40 m

d. Possibility of Extension

When drip irrigation area is extended to father by mean of the system from orchard irrigation system, such as lot 4A and 4B, it will be possible by the replacement of the supply pipeline with over size pipe.

For example when a caliber of 75 mm PVC is used for the supply pipe line instead of 59 mm pipe, the allowable distance for five(5) drop in pressure between ① to ③ is expanded to 610m from 190 m.

2-2-4. Drainage Problems in the Rainy Season

(1) Study on Drainage and Improvement

1) The Need of Drainage Measures

a. Background

Because of the successive rains with about 240mm in the total depth, which attacked the area from November 18 through 22, 1994, a huge damages was incurred by the whole area including the Cukurova Farm. This project was not exceptional, and the Daikon nearing the harvest season and the wheat for the autumn seeding were seriously damaged by flooding. In addition, as the soil of farms became soft due to the poor drainage, tractors for farming works were not able to use in the most of the field until the following spring.

After the experience of heavy rains and the damages caused by the poor drainage in the Project field, it is strongly felt that function of drainage in the cultivated field during rainy season must be studied to improve it. In this connection, investigation and study on drainage problems, in the cause and the results, was carried out, in order to make up the necessary countermeasures to improved it, although which was not included in the original scope of works.

b. Study on Soil Moisture

Almost all of the Project field is consisted of clayey soil which has a characteristics of very slow speed in permeation toward vertical and horizontal directions by the gravity when it is moistened. And evaporation from the ground surface and transpiration through plants, supported by the capillary action between soil particle, are principal measure to decrease the moisture content in the soil.

However during rainy season or winter time, as it is low temperature, weak solar radiation and high humidity, the transpiration rate becomes quite low, and the moisture in the soil will not decrease easily once the soil is saturated by the rainfall.

As the results of study on the groundwater level and rainfall, it was observed that the groundwater level was increasing by several times more than the rainfall depth after the rainfall.

c. Effective Way to Minimize Drainage Problems

It is concluded that an effective way to minimize the drainage problems in the farm lot is to exclude surplus rainfall from the field as soon as possible, in order to minimize the volume of water sinking through soil as small as possible.

2) Drainage Function in the Field

a. Problems on Drainage in a Farm Lot

At the standpoints mentioned the above, the following problems have been identified as the results of the field investigation:

i) Maximum Length of Drain Water

In many case of the winter cultivation, no drainage ditches are provided within the field, and surplus rainfall will flowing down on the surface of field toward the lower direction. Since the fields in the Project was provided with the maximum slope toward diagonal direction in general, the water tends to flow to the diagonal directions, when no ridge have been provided. Consequently, drainage distance amounts more than 400 m at the longest. When the ridge is made, the water flows to the direction of ridge, and the longest distance is reduced to 300 m, as it is quite long one.

ii) Flooding of Water Due to Uneven of the Field Surface

In a larger size of field, it is relatively difficult to control its ground slope evenly throughout full area by the cultivation works. When local lower place was remained, surplus water around the place will be gathering to make a puddle and does not dry up easily. When the flooded range becomes wider, it will be formed high moisture place with problem where a tractor is not able to use.

iii) Few Drainage System

While one line of collection ditch and two(2) drainage culverts are provided for each farm lot, to collect and drain the surface runoff from the field, along the lower edge of the lot and both terminals of the ditch respectively, the density of drain and number of drainage culvert is not so enough as to drain the surplus runoff efficiently from the field.

Especially in case of the lot 3C, where the ground slope is the minimum among the farm lots, have been suffered from standing water throughout the rainy season in a part of area where it is located in the lowest elevation.

b. Project Drainage System

i) Function of Main Drain

The main drain was constructed together with the development of the other Project facilities, as shown in Fig. 2-2-3. According to the initial

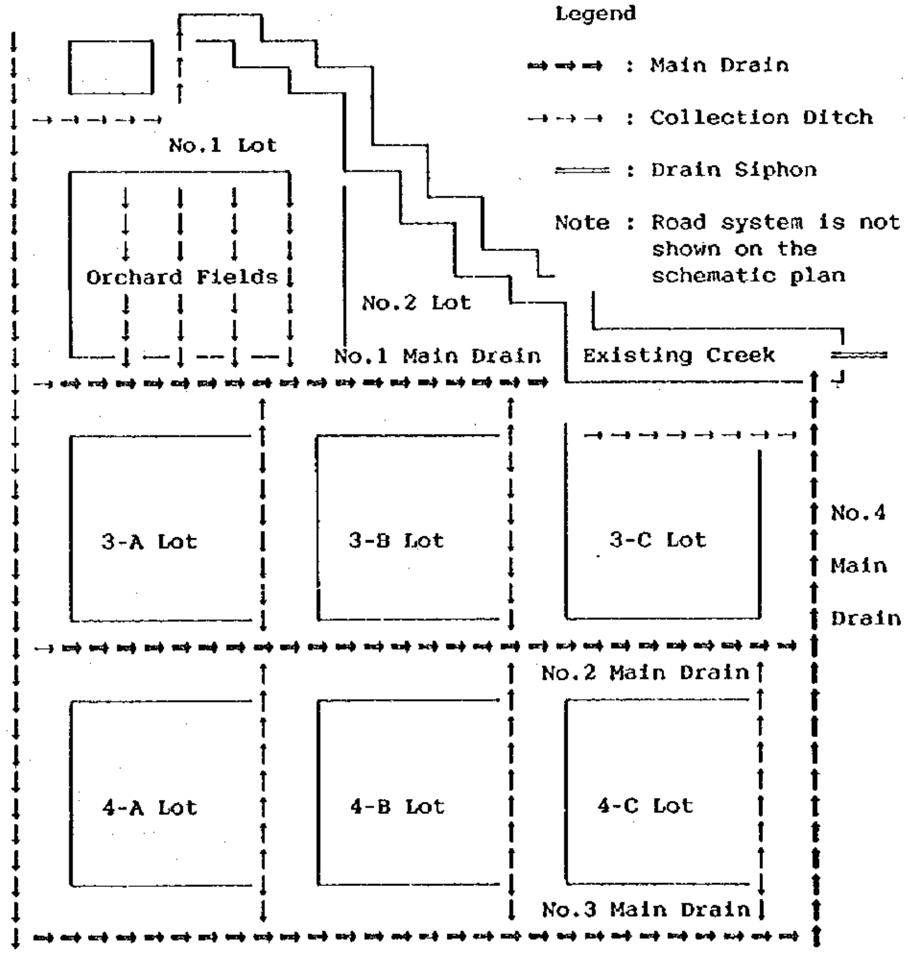

Fig. 2-2-3 Schematic plan of the project drainage system

plan, the drainage capacity was designed based on the probable intensity of rainfall, and provided with sufficient drain capability at every sections.

ii) Drainage Siphon

The drainage siphon made of steel pipe have been provided at the terminal of the Project drain system across the public road out of the Project area, in order to lower the water level in the Project drain during rainy season as required.

(2) Study and Improvement on Drainage for Field Crop Areas

1) Survey on Ground Height and the Slope

a. Survey Points of Ground Height

The ground height for each farm lot is surveyed on the grid point with each 50 m spacing, previously provided for each lot. The base point of each grid was placed on the road at the Northwest corner of each lot, and two(2) base lines with 50 m grid point was extended on the inside of road toward the East and the South along the farm lot respectively. The survey points are; at each grid point, inside ridge adjacent to the grid on the baseline, and center of the road on the grid line.

b. Bench Mark for Project Facilities

A bench mark which means a datum point on ground height, presented by above mean sea level, used for hydraulic structures or civil worked as a common standard on the height.

The bench mark for the Project facilities was set at the northeast corner on the wall of storage pool of the intake structure, and the elevation (El.) was assumed to El. 33.25 m based on the plan at the construction stage.

c. Arrangement of Data Collected

In order to grasp a status of ground height within a farm lot, the relative difference of ground height presented by numerical number will be more easier than the value presented by elevation. In this connection, the surveyed data on the ground was arranged by the difference of height from the lowest grid point, which is given by zero(0) cm, at each farm lot basis. The Fig. 2-2-4 is shown the relative difference of ground height on the grid point at each 50 m interval on each farm lot basis, as of March 1995. The following Table 2-2-12 is shown average ground slope, obtained from the survey.

Notes: Numbers in the Figure show difference of ground height in cm on the grid of each 50 m interval, from the lowest grid height shown by zero(0).

Legend

- (thick line) : Main base lines of a grid
- (thin line) : Sub base lines of a grid
- □ : Base point of a grid
- * : Grid point on the base line
- (double line) : Main drain and flow direction
- R23 & +16 : Center of road and difference height based on the adjacent farm lot

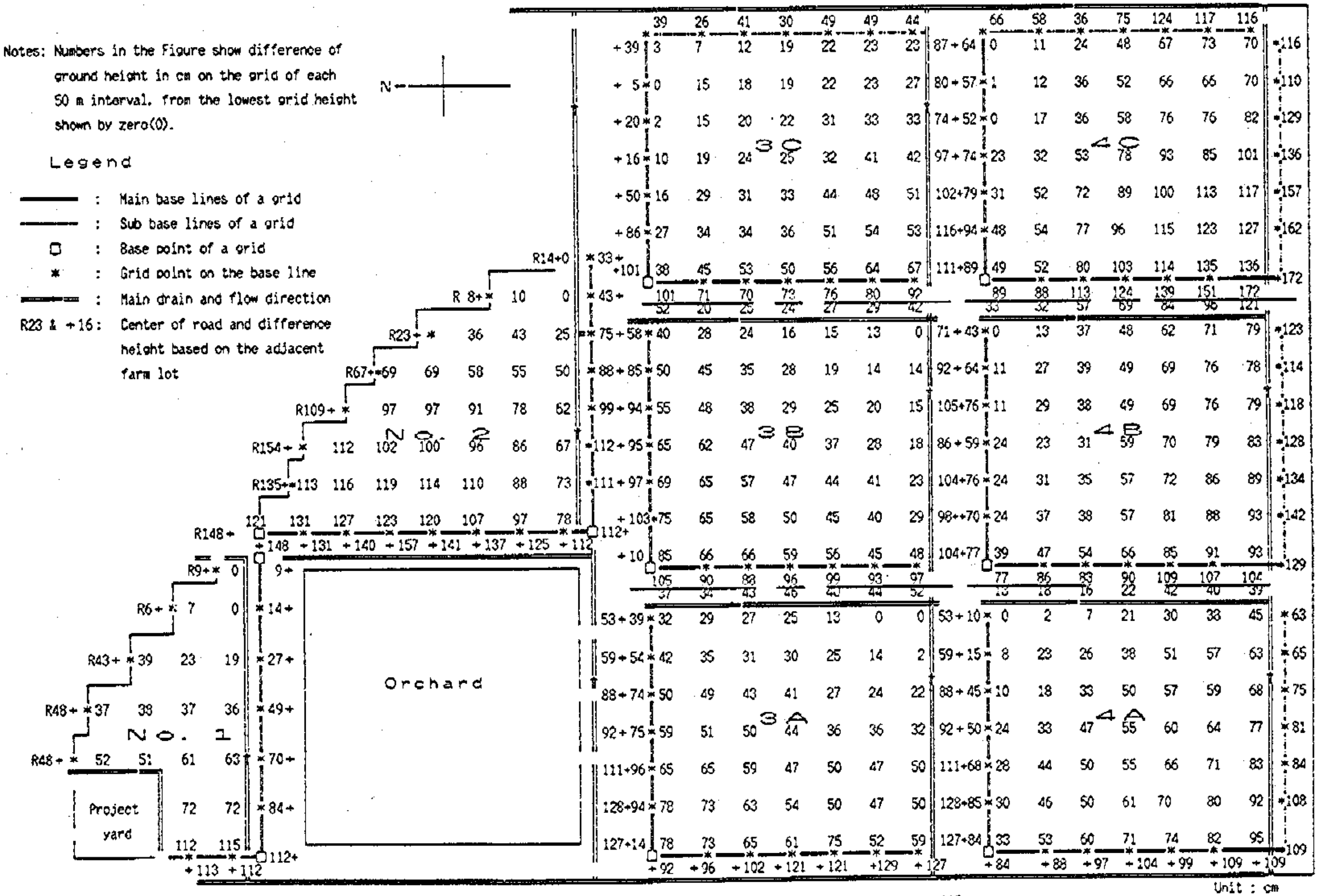

Fig. 2-2-4 Relative difference of height each farm lot basis as of March 1995

Table 2-2-12 Average slope and the direction of field crop lot

Lot	West to East		South to North		Diagonal Slope	
No.	Height	Slope	Height	Slope	Height	Slope
1	-0.63	-1/ 320	+0.11	+1/1800		
2	-0.78	-1/ 380	-0.46	-1/ 430		
3-A	-0.27	-1/1100	+0.48	+1/ 630	-0.78	-1/ 540
3-B	-0.42	-1/ 710	+0.41	+1/730	-0.85	-1/ 490
3-C	-0.29	-1/1030	+0.38	-1/1250	-0.64	-1/ 660
4-A	-0.46	-1/ 650	+0.56	-1/ 540	+0.95	-1/ 440
4-B	-0.66	-1/ 450	+0.24	-1/1250	+0.93	-1/ 450
4-C	-0.79	-1/ 380	+0.54	-1/ 560	+1.36	-1/ 310

2) Improvement of Drainage System

a. Drainage Facilities to be Provided in the Farm Lot

In order to drain surplus surface water from the farm lot effectively, the following facilities will be requisite to provided at each farm lot basis. Without any one of them, effective drainage for a farm lot will be never expected.

Farm drain : to collect surface water in the farm evenly,
Main farm drain : to collect water through the farm drains and convey to the cross drain culvert,
Cross drain culvert : to exclude water collected by the drains out of the farm lot.

b. Excavation of Farm Drain

The farm drain was provided in autumn 1995 in the area of wheat cultivated based on the drainage improvement scheme. The farm drain was made along the rows of seeded wheat about each 25 m interval by means of a canal plow pulled by a tractor. and the same sort of drain was made beside of the farm road, and it is connected to the farm drain or Main farm drain at the both terminals.

The drains work not only as a farm drain but also serves a side drain of the road to receive water from the road section and keep off the road section from standing water.

The farm drain and the side drain of road must be newly provided for winter cropping, following to the seeding as required, and it is preferable to provide them as the part of cultivation works.

c. Main Farm Drain

The main farm drains, which is located at the terminal point of the farm drain along the boundary of the lot, have a role to carry the drainage water collected by the farm drains to the cross drain culvert, to be described in the following section.

The main drain will be used for the surface irrigation area for collecting surplus water through the field, accordingly it is recommended to provide even for a summer crop cultivation as a permanent facilities.

d. Cross Drain Culverts

The cross drain culverts were provided for all farm lot from two(2) to four(4) units each, with the purpose of exclude the drainage water from the farm lot to the main drain canal through them.

The body of culvert was made by normal concrete pipes in factory made with the diameter of 30 cm, and a concrete box cast in place was provided at the entrance side, to secure effective drainage and protect the ditch sections connected to the box from erosion by the water.

e. Effects of the Drainage Facilities

In the autumn cultivation of wheat, as it was delayed in the cultivation schedule in a part of lots due to more rains than usual, most part of the wheat was grown successfully by the improvement of drainage system.

On the contrary, the corn cultivation in the Lot 3A, which was transferred surface irrigation from the traveling sprinkler method since the late irrigation period, was postponed greatly, due to the delay of dry in of soil due to the rains.

3) Recommendation

a. Optimum Space of Farm Drain

As the role of the ditch is quite important for the effective drainage, it must be provided with adequate density, just same as the irrigation ditches for border irrigation.

With regard to the optimum spacing between farm ditches, it is necessary to determined based on the annual experiments. It is preferable to provide about 10 m spacing, because the drainage area of one(1) farm drain with a length of 300 m is 6,000 m^2 or 0.6 ha, and it is certainly quite large dimension. And distance to gather surface water will be zero(0) to five(5) m in average from both sides of the drain. When this space between the two farm drains will set more, the gathering distance becomes longer as well and the drainage functions will be decreased.

b. Construction of Main Farm Drain

With regard to the construction of main farm drain, it is preferable to make by means of a grader, with sufficient cross sectional area and collect profile slope, not only for well drainage of the farm lot, but also for the maintenance of the road section concerned.

(3) Study and Improvement on Drainage for Orchard Areas

1) History of Drainage Improvement

a. Improvement of Lateral Drains

In the orchard area, four(4) lines of the lateral drains with 0.6 m in depth were excavated at the eastern side of each lot to collect the surface water from the lot, as the Project facilities at the construction stage.

In 1993, these lateral drains were excavated about 0.5 m deeper, in order to lower the groundwater level in the orchard lot during the rainy season.

b. Drainage Improvement after 1995

Due to the rains from November 18 through 22 ,1994, many part of the orchard lots were inundated with water, resulting in a large delay of farming schedule, such as the application of organic manure scheduled to finish within the end of 1994 was delayed until February the following year. In addition, some of peach trees grown fairly well was died due to the water stress by waterlogged caused by the heavy rains. Since January 1995, improvement for drainage system was planned and carried out one and another,as described in another section.

c. Drainage Problems

i) Cultivation During Winter Season

Due to the winter cultivation for fruits trees, such as trench excavation around trees for organic manure and chemicals application, the cross section of farm drain were destroyed at many portions.

2) Improvement of Drainage Function

a. Outline of the Improvement Scheme

In principle, proposed drainage system for the orchard lot is as same as the field crop areas. It is consisted of farm drains, main farm drains and drain culverts.

Out of these facilities, main farm drains and drain culverts were provided until January 1995. However the drainage function in each orchard lot remained only partial improvement, due to incomplete farm drains. Excavating of farm drains were delayed until the late of rainy season.

b. Drain Culverts

The drain culverts were installed across the traffic space for farm machine between the existing lateral drain. The number of the culverts installed were 12 in the kiwi lot, and eight(8) in the other orchards lots. A polyethylene pipe with a diameter of 15 cm was used for the culvert. No inlet box is provided and the main farm drains are connected directly to the entrance of the culvert pipes.

c. Main Farm Drains

The main farm drains were excavated parallel with the drainage canal between the planted area and the traffic space along the drainage canal. Since the main farm drains were collapsed by the farming works during dry season, it was re-excavated manually before rainy season.

d. Construction of Farm Drains

The farm drains were excavated between the rows of trees by means of a canal plow pulled by a tractor. The farm ditches were excavated again before the following rainy season by a tractor in autumn 1995.

3) Survey on Ground Height and the Slope

a. Survey of Ground Height

The survey of ground height for whole field crop area is carried out to get a basic data on the ground slope necessary for drainage study, by making grids points to be surveyed on each field lot basis.

b. Survey Points of Ground Height

The ground height for each crop lot is surveyed along the both boundary of planted area, on both Southward and Eastward, with about each 50m spacing.

c. Arrangement of Data Surveyed

In order to grasp a status of ground height within a farm lot, the surveyed data were arranged to the relative difference of ground height from the turnout box, the height of which presents as zero(0).

The following Fig. 2-2-5 is shown average ground slope, obtained from the survey.

4) Recommendation on the Drainage Improvement

a. Improvement of Ground Surface

In the Most of all sections of orchard lots except for the grape lot, fruits trees were planted on the flat surface or on hollowed, which make it difficult for effective surface drainage during rainy season. In this connection it is recommended to shape the ground surface to be projected at the foot of trees by gathering soil. At the same time, the space between the row of trees must be shaped to be hollowed at the middle in the crosss section. If available, it must be carried out by the grader at the first time. And the ground surface and profile slope must be arranged as even as possible.

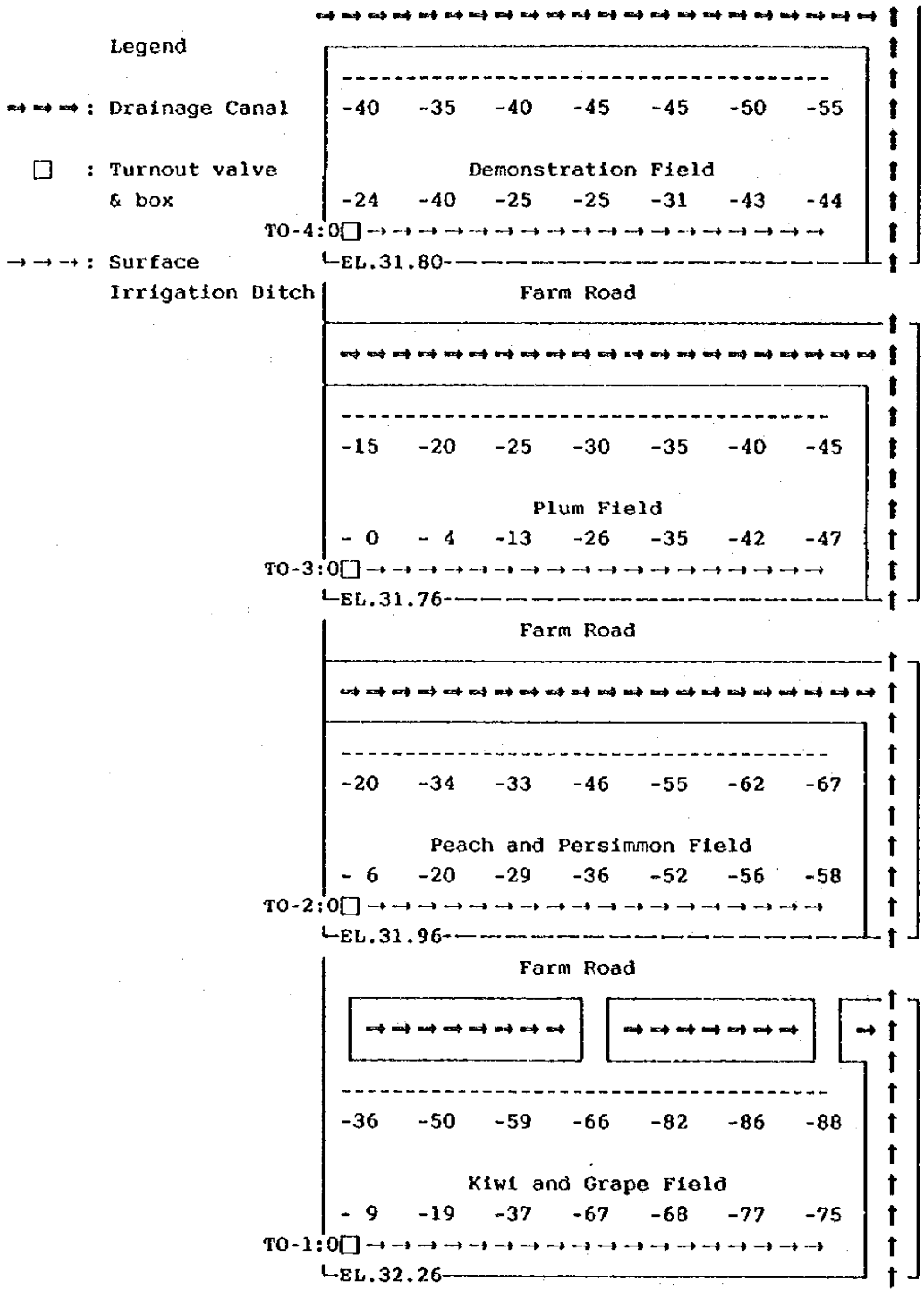

Fig. 2-2-5 Relative difference of height in each orchard lot basis as of July 1996

b. Maintenance of Drains

Before rainy season the farm drains and main farm drains must be restored completely.

(4) Study and Improvement on Drainage for Vegetable Cultivated Area

1) Drainage Problem in Vegetable Cultivated Area

a. Drainage Problem in the Field Cultivation During Rainy Season

The drainage problem in rainy season are mostly concentrated in the Daikon cultivation. And the sort of problem is divided into the following two categories, one is water stress directly affected plant growing and the other is farming works by tractors mainly for harvest season, which damage the drainage system previously provided in the cropping area.

As characteristics of daikon it is quite weak against waterlogged soil which will decay root of daikon easily and resulted in valueless products. Accordingly adequate drainage system will be requisite for the daikon cultivation.

On the other hand, broccoli is not so affected from the drainage problems, due to the characteristics of the plant and the difference of cultivation method from daikon, in use of tractors.

b. Drainage Problem in Greenhouse Cultivation During Rainy Season

On the other hand, drainage problem for greenhouse cultivation during rainy season is caused by inundation around the greenhouse, to induce the high moisture of soil in the greenhouse.

2) Drainage Improvement in Field Cultivation

a. Temporary Drain Excavation in 1994

The daikon area before harvest season was seriously damaged by the rains from November 18 through 22, 1994, due to inundation almost over the planted area. Just after the rains, a temporary main farm drains was excavated by manual works to relieve the plants, however it was results in vain.

b. Drainage Improvement for Field Cultivation in 1995

A grid of drain system about 45 m spacing along the traffic road was planned for the daikon and broccoli growing area in the 3B lot, which were cultivated within the same lot divided by the experimental sections each other.

As the experimental farm was consisted of each 40 m square dimension for one test, surrounded by traffic space of about five(5) meters, the grid of drain system was made in associated with that allotment, between the traffic space and the growing area. In the drain system, the main drains are excavated from the north to south, followed to the route of rainboom, and the surface water collected the transverse drain is carried through the main drain to empty into the No. 2 main drain canal through the drain culverts.

c. Drainage Improvement for Greenhouse

The drainage conditions surrounded the greenhouse was improved by excavating a drain along the south through the eastern border of the division in the lot 3A where the greenhouses and farming facilities were provided. And at the terminal of the drain, a drain culvert with a inlet box is newly constructed.

3) Findings for 1995 Operation

During the rainy season, major works in the field becomes harvest of the daikon by manual works and the transportation works of the product by means of a tractor. As a tractor enters into the field and moves along the traffic space, the drain provided across the traffic space is disconnected by the trail of the tractor, and farther more the depth of trail becomes deeper and wider by the frequent transportation which makes worsen the field conditions.

As the results, vast inundated area was remained as it is after the harvest of the daikon, which refused tractor to admit the area until the following dry season.

4) Recommendation

a. Drainage for Daikon Cultivation

As explained in the above section, drainage improvement in the field of daikon cultivation must be studied thoroughly, not only for drain system but also for planting order in the lot, and for equipment used for the harvest etc., in order to establish some successful cultivation technology in the clayey soil.

As we have no opportunity to experiment with the counterpart staff, only a possible measures, studied theoretical approach by a common sense, is recommended as follows:

Review of seeding order: considering the drainage condition, until the harvest, the early seeding section must be allocated in the highest portion where the surface drain is initiated, in order to leave drain system located the lower area without destroy by the harvest works.

Entrance area of tractor for harvest: when a tractor is used for the harvest work, the traffic portion for the harvest must be selected higher portion so as not to interrupt the drain system for the lower planted area.

Temporary drain culvert for tractor crossing: the temporary drain culverts of with a caliber of 300 mm PVC pipe is set previously at cross point of the main drain to secure the function of drain.

2-3. Study and Verification of Field Crop Production Technology

2-3-1. Improvement of Plowing Method and Working System

(1) Plowing Machinery

Tests were carried out on the differences in germination and incipient growth of wheat and rapeseed due to the difference of plowing machines (Chiselplow, Rototiller, Aysan, Bottomplow and Chiseltiller).

1) Tests Using Rapeseed (October 1991 - June 1992)

Tests of tilling methods:

Tests were carried out using rapeseed to find out if a working system without plowing was possible. The types of tilling methods were as follows.

Bottomplow + Chiseltiller
Bottomplow + Rototiller
Aysan
Rototiller
Chiselplow + Rototiller

As a result of the tests, it was found that the clod crushing condition was best with Rototiller but plowing-in of soybean haulms was not good. Especially,it was not good in the section where only Rototiller was used. Aysan showed a good clod c rushing condition but plowing-in was the worst next to Rototiller.

The clod crushing condition with Bottomplow + Rototiller was the best. Plowing-in was also perfect.

The clod crushing condition with Bottomplow + Chiseltiller was found to have rough clods remaining. Plowing-in was perfect.

Survey on Rapeseed Germination

	1	2	3	Average	Rate of Germination
① Bottomplow + Chiseltiller	85	64	57	68	97
② Bottomplow + Rototiller	49	58	73	60	86
③ Aysan	61	68	48	59	84
④ Rototiller	60	65	67	64	91
⑤ Chiselplow + Rototiller	71	57	78	69	98

Note: Surveyed on November 11, 1991.
Number of buds per 50x50cm, repeated three times.

No difference was found in the number of rapeseed sprouts by the type of farm working machinery used.

A difference due to farm working machinery was found and the number of weeds was very few in the Aysan section although the reason is not clear.

Survey on Weeds in Rapeseed Section

	1	2	3	Average
① Bottomplow + Chiseltiller	26	58	34	39
② Bottomplow + Rototiller	70	48	54	57
③ Aysan	07	13	07	09
④ Rototiller	54	32	30	39
⑤ Chiselplow + Rototiller	28	22	36	29

Note: Surveyed on November 26, 1991.
Number of weeds per 50x50cm, repeated three times.

2) Tests Using Wheat (October 1992 - June 1993)

Tests of tilling methods:

Tests were carried out using wheat to find out if a working system without plowing was possible. The types of tilling methods were as follows.

Bottomplow + Chiseltiller
Bottomplow + Rototiller
Aysan
Rototiller
Chiselplow + Rototiller

As a result of the tests, it was found that there was no difference in the plowing-in condition of soybean haulms among sections. The condition of crushed clods was the same in all sections because the moisture condition was good at the time of clod crushing.

Survey on Wheat Germination

	1	2	3	Average	Rate of Germination
① Bottomplow + Chiseltiller	71	68	61	66	52
② Bottomplow + Rototiller	70	71	74	71	56
③ Aysan	61	79	81	73	58
④ Rototiller	61	62	79	67	53
⑤ Chiselplow + Rototiller	73	62	74	69	55

Note: Surveyed on November 26, 1992.
Number of sprouts per 50x50cm, repeated three times.

No difference was found in the rate of wheat germination by the type of farm working machinery.

Survey on Weeds in Wheat Section

	1	2	3	Average
① Bottomplow + Chiseltiller	0	0	0	0
② Bottomplow + Rototiller	0	0	0	0
③ Aysan	0	0	0	0
④ Rototiller	0	0	0	0
⑤ Chiselplow + Rototiller	0	0	0	0

Note: Surveyed on November 26, 1992.
Number of sprouts per 50x50cm, repeated three times.

Survey on Wheat Germination

	1	2	3	Average	Rate of Germination
① Bottomplow + Chiseltiller	83	80	108	90	71
② Bottomplow + Rototiller	113	85	108	102	81
③ Aysan	118	105	99	107	85
④ Rototiller	101	103	118	107	85
⑤ Chiselplow + Rototiller	108	113	101	107	85

Note: Surveyed on December 11, 1992.
Number of sprouts per 50x50cm, repeated three times.

No difference was found in the number of wheat sprouts by the type of farm working machinery.

Survey on Weeds in Wheat Section

	1	2	3	Average
① Bottomplow + Chiseltiller	0	7	3	3
② Bottomplow + Rototiller	7	14	9	10
③ Aysan	7	13	8	9
④ Rototiller	13	4	6	8
⑤ Chiselplow + Rototiller	5	6	7	6

Note: Surveyed on December 11, 1992.
Number of sprouts per 50x50cm, repeated three times.

There was a fluctuation but no difference was found among sections.

Although there is a hesitancy to draw a conclusion since the tests were only for a year for both wheat and rapeseed, there are no problems, as far as tests show, about germination and incipient growth of wheat and rapeseed in the fields which were prepared by crushing clods with only a harrow without plowing, and there was no difference in yield.

Preparation for the seeding of wheat using only a disk harrow for clod crushing and soil preparation by farmers can be seen around the experimental station.

(2) Improvement of Working System

Establishment of a working system during the period from the harvest of the double cropping of soybean and corn to the seeding of wheat.

A survey was conducted on working technology during the period from the harvest of the second crop of soybean and corn to the seeding of wheat in the project field,and it became clear that the following working system could be set up.

1) Harvest of Double cropped Soybean and Corn

Using a 143 horsepower tractor and a harvest transport truck, the conventional working efficiency of the harvest of the second crop of soybean was 0.59hr/ha and the working efficiency of the harvest of the second crop of corn was 1.54hr/ha. However, soybean (sowed on July 5) suffered as much as about 21% of field loss since the lowest pod setting position was extremely low at 6cm on the average. In the case of the second crop of soybean, a variety and a cultivation method to make pod setting position higher are necessary.

Table 2-3-1 Combine harvesting of soybean and corn

Work Name	Soybean Harvest	Corn Harvest
Machine used	Conventional combine (swath 4.3m), Truck	Conventional combine (four-rows corn attachment),Truck
Travel speed (m/s)	1.61	0.91 (0.83-1.17)
Working efficiency (%)	(70)	72.00
Field working (h/ha)	0.59	1.54
Capacity (ha/h)	1.70	0.65
Fuel consumption (/ha)	9.10	13.70
Volume (/hr)	15.40	15.40

Remarks: Soybean Harvest
1) Field working efficiency is estimated at 70%.
2) Fuel consumption is estimated from domestic data.
3) Yield from a selected 3.3m2 plot: 2,680kg/ha (Water content 8.6%).

Corn Harvest
1) Fuel consumption is estimated from domestic data.
2) Yield from a selected 3.3m2 plot: 7,450kg/ha (Water content 16.2%).

2) Working System for Field Preparation by Tillage and Seeding

Burning is the most suitable method in the field after corn harvest (harvesting of ears) utilizing the dry condition of this area since there is plenty of residual. Even in a field which was not burned for the purpose of the reduction of organic matters, the condition of the field was made somehow possible for seeding if a disk harrow was used up to about four times, but the field was not thought to be suitable for seeding, considering the points of covering soil, germination and emergence, since there was a considerably large amount of residual on the field surface. However, the survey of emergence after seeding showed it was normal. Also, efforts were directed to the promotion of the draining of surface water. The working system from the burning of corn residual to the digging of furrow-drains was set up as shown in Table 2-3-2,3. Table 2-3-4,5 shows the standard working system in the TIGEM Cukurova Farm for comparison.

After all, A system, which is based on tillage by Chiselplow and clod crushing by a disk harrow, is the best in fuel consumption per unit area and it is the same, even in field working capacity, as the working system based on plowing work by Bottomplow (between C1 and C2) which is reported on in the basic data of TIGEM Cukurova Farm, if it is compared by truck size.

On the contrary, the working system based on soil crushing by a rotary harrow (B system) is not so inferior in field working capacity but is obviously inferior in the point of fuel consumption per unit area.

However, it is thought that the working system based on plowing by Chiselplow and soil crushing by a disk harrow (A system) is obviously

Table 2-3-2 Operational system A(burning off, tillage, fertilizer application, sawing and drainage canal construction)

Operation	Shredd-ing	Burn off	Plowing	Harrowing	Fertilizing	Harrowing	levelling	Sowing	Soil Packing * 1)	Drainage canal construction	Total
Machinery	Tractor 105PS Shredder (1.3m)	Tractor 105PS	Tractor 105PS (Four-wheel) Chiselplow	Tractor 105PS Disk harrow	Tractor 105PS Broadcaster	Tractor 105PS Disk harrow	Tractor 105PS Land leveler	Tractor 105PS Drill seeder	Tractor 105PS (Cultipacker)	Tractor 105PS (Four-wheel) Ridger	
Field working capacity: hr/ha	0.70	(0.35)	0.88	0.53	0.21	0.47	0.21	0.51	(0.21)	0.06	3.48
ha/hr	1.42	(2.83)	1.14	1.72	4.70	2.12	4.70	1.96	(4.70)	17.50	
Travel speed: m/s	3.15										
working efficiency: %	91.0										
Fuel consumption: l/ha	(2.50)	(1.40)	16.10	7.90	0.70	6.40	(2.10)	4.00	(2.10)	(1.10)	41.80
l/hr	(3.50)	(3.50)	18.40	13.60	3.50	13.60	(10.00)	7.90	(10.00)	(18.40)	
Remarks	* 2)	* 3)	* 4)		Compound fertilizer 20-20-0 24kg/10a Two-man job		* 5)	Wheat grain: 25kg/10a. Two-man loading job	* 6)	Digging depth: 17cm Width of upper side of furrows 130cm	* 7)

Note: * 1) It would have been desirable to use Cultipacker which can perform clod crushing, soil covering and compacting as well as causing seeds to adhere to soil.
2) Fuel consumption was estimated from fertilizing work.
3) Set fire to old tires and drag them.
4) Plowing depth: about 20cm (after field preparation work)
5) Fuel consumption was estimated from seeding work.
6) Estimated from field preparation work.
7) Depth of crushed clod layer: about 10cm, 2cm, Rate of crushed clod: 67.6%, Rate of 1cm crushed clod: 53%.

Table 2-3-3 Working system for field preparation by tillage, fertilizing and sowing (system B)

Operation	Plowing	Plowing	Fertilizing	Harrowing	Sowing	Soil Covering	Soil Packing * 1)	Total
Machinery	Tractor 105PS. 78PS. (Two-wheel). Chiselplow	Tractor 105PS. 78PS. (Two-wheel). Chiselplow	Tractor 78PS Broadcaster	Tractor 105PS Rotary harrow: Operating width 190cm	Tractor 78PS Broadcaster	Tractor 105PS Rotary harrow	Tractor 105PS (Cultipacker)	
Field working capacity: hr/ha ha/hr	0.85 1.17	0.80 1.25	0.18 5.59	0.64 1.57	(0.18) (5.59)	(0.64) (1.57)	(0.21) (4.70)	3.50 (+ 0.41)
Fuel consumption: l/ha l/hr	12.40 16.80 12.40	13.00 18.50 13.30	(0.60) (3.50)	11.40 17.90	(0.60) (3.50)	(11.40) (17.90)	(2.10) (10.00)	51.50 (+ 4.00)
Remarks	* 2)	* 3)	* 4) Two-man job	* 5)	* 6)	* 7)	* 8)	* 9)

Note: * 1) It would have been desirable to use Cultipacker which can perform clod crushing, soil covering and compacting as well as causing seeds to adhere to soil.
2) Collection of residual, shallow plowing, work for surface layer breaking.
3) Plowing depth: about 20cm. (measured after clod crushing work).
4) Fuel consumption was estimated from a 105PS tractor.
5) Plowing depth: 10cm, 2cm, Rate of crushed clod: 67%. Rate of 1cm crushed clod: 48%.
6) Estimated by a broadcaster although actually a drill seeder was used for seeding.
7) Estimated from clod crushing work.
8) Estimated from field preparation work.
9) It is necessary to add those of burning and digging furrow-drains.

Table 2-3-4 TIGEM Cukurova Farm's operational system(C-1) of plowing, harrowing, fertilizing and sowing

Operation	Plowing	Harrowing	Levelling	Fertilizing and Sowing	Total
Machinery	Tractor 78PS, three-bottomplow, working width: 100 cm	Tractor 78PS, cultivator, working width: 220 cm	Tractor 78PS, combination harrow, working width: 250 cm	Tractor 78PS, working width: 380 cm	
Field working capacity: hr/ha ha/hr	2.00 0.50	1.10 0.88	0.60 1.80	0.60 1.80	4.30 (+ 0.40)
Fuel consumption: l/ha l/hr	18.20 9.10	12.00 10.60	5.50 9.90	5.20 9.40	40.90 (+ 4.60)

Table 2-3-5 TIGEM Cukurova Farm's operational system(C-2) of plowing, harrowing, fertilizing and sowing

Operation	Plowing	Harrowing	Levelling	Fertilizing and Sowing	Total
Machinery	Tractor 143PS, six-bottomplow, working width: 240 cm	Tractor 143PS, cultivator, working width: 300 cm	Tractor 143PS, combination harrow, working width: 500 cm	Tractor 143PS, suction seeder working width: 420 cm	
Field working capacity: hr/ha ha/hr	0.85 1.18	0.47 2.11	0.18 5.60	0.30 3.33	1.80 (+ 0.40)
Fuel consumption: l/ha l/hr	18.00 21.20	11.00 23.20	4.80 26.90	5.10 17.00	38.90 (+ 4.60)

inferior to the working system based on plowing by Bottomplow in the accuracy of seeding work. Also, it had been thought that there was a point needing improvement even in the working system based on plowing by Chiselplow and soil crushing by a rotary harrow (B system) since a large amount of corn residual was exposed on the field surface, but the rate of germination was as high as 90% and no difference was observed in the rate of germination for both systems in the survey of the rate of wheat germination carried out in early December.

3) Improvement of the Working System for Field Preparation by Tillage, Fertilization and Sowing

Table 2-3-6 shows the results of a study on the improvement measures of the working system for field preparation by tillage, fertilization and sowing by introduced Japanese-style technology. Synchronization of work by the introduction of a rotary seeder.

Although the field working capacity of this system is similar to that of A system, it is forecasted that the fuel consumption is far inferior. However, the extreme shortening of the working process may produce the shortening of the interruption period of seeding work due to rain and so on. In addition, it is presumed that a rotary seeder may bring about many advantages such as improvement of the plowing-in of the preceding crop residual, uniformalization of seeding depth, improvement of soil covering and compacting effect, etc. However, it is feared that the necessity for changing worn-out straight blades of a rotary seeder may push up costs. Damage to straight blades by stones and pebbles is also a concern, but the problem is not so serious, it seems, because reasonable efforts are being made to remove them since this is a project field. It is thought, therefore, that it is necessary to evaluate comprehensively the advantages of being able to limit the number of working processes in order to cope with the high frequency of rain in November and to improve seeding accuracy by increasing the burying amount of previous crop residual, and disadvantages of working speed being kept slow, cost increase due to blade changes, etc.

4) Daily Working Time and Annual Working Schedule

a. Daily Working Time

In the project field, daily working time could be set up as follows.

Daily working time : 8.0h (AM 4.5h, PM 3.5h)
Working hours in the field : 5.6h
Rate of actual work : 70%

This daily working time includes breaks in the morning and in the afternoon, repair of breakdowns and movement between fields, and is thought to be applicable in the case of even considerably large-scale farm management. However, if it is large-scale management, various systematic measures such as appropriate arrangement of places to keep machinery, cars to take breaks in, control of fuel supply cars, a wireless communication

Table 2-3-6 The prospect of improved operational system D with rotary seeder

Operation	Burn off	Plowing	Harrow. Levelling. Fertilizing. Sowing and Soil packing	Drainage canal Construction	Total
Machinery	Tractor	Tractor 105PS. Chiselplow. working width: 236 cm	Tractor 105PS (Four-wheel). rotary seeder. working width: 240 cm	Tractor 105PS. ridger(canal plow)	
Field working capacity: hr/ha ha/hr	(0.35) (2.83)	0.88 1.14	(2.23) (0.45)	0.06 17.50	(3.52)
Fuel consumption: l/ha l/hr	(1.40) (3.50)	16.10 18.40	(41.30) (18.50)	(1.10) (18.40)	(59.90)

Note: The field working capacity was estimated based on a rotary seeder working speed of 0.8m/s and field working efficiency of 65%. but a working speed of 1.0m/s seems to be possible if a 105PS tractor could be used.
Fuel consumption was estimated this time using the maximum value measured with a 105PS tractor.