The leaching efficiency (Le) has been shown to vary with the soil type, and particularly with the internal drainage properties of the soil and the field. In the Study area, because of sandy soils, "Le" is assumed to be 100% Since is 100%, water needed to satisfy both ETcrop and LR is equal to (ETcrop - Pe)/(1-LR).

In the left column of Table F.2.1.1, the leaching requirements for principal crops including dates palm, olive, fruit trees, alfalfa and tomato are calculated for the eight oases based on the water quality test results. It is seen in table that leaching requirements range between 20% and 40%. Generally, guidelines for estimating irrigation requirements recommend to include these drainage requirements into gross application of water.

F.2.2 Effective Percolation

In the foregoing paragraphs, all irrigation water including percolation and rainfall, which is not directly taken up by the plants, was considered as losses. This might not be correct because field percolation losses are considered as effective for leaching. The difficulty that percolation losses are unevenly distributed over the field can be substantially overcome by employing an irrigation technique which is adjusted in such a way that the differences in leaching over the field are offset over a number of years by shifts in irrigation units, changes in the size of basin, etc.

In order to examine the above, ratios between the water losses and the net water requirements are calculated as shown in the rightest column of Table F.2.1.1. It is seen in the column that the water loss rate ranges between 23% and 34% in the case that canalization is practised up to last 50m. In any of the eight oases, water loss exceeds leaching requirements. Therefore, normal field percolation losses may be sufficient for leaching, so that no additional leaching is necessary provided that proper artificial drainage is practised.

F.2.3 Subsurface Drainage

It seems that the groundwater table is the most important factor for plant development restricted by lack of oxygen in the root zone and for evapotranspiration effecting upon salt accumulation in the top soil layer by capillary movement. Therefore, the groundwater table should by maintained within certain ranges depending on crops and soils in respect to the aeration and root development.

Irrigation losses generally form the main source to be drained. The subsoil (percolation losses) include canal seepage and infiltration losses in the field as well as rainfall as discussed in the proceeding paragraphs. The study results indicate that the large percolation takes place during summer in July and August when the irrigation frequency is mist high, whereas it decreases in winter from January to March when the irrigation frequency is low.

Table 2.3.1 shows the balance of water under irrigated condition of the surface in July or August. The drainage requirements can be given in the difference between the amounts of recharging requirements are calculated as the sum of rainfall and gross water requirements minus evapotranspiration (or net water requirements).

The highest groundwater table should by determined in terms of necessities for aeration of soil and limits of salt accumulation. For tree crop on sandy loam and loamy sand, it is widely reported that the average depth of 80cm to 120cm can be tolerated. In view of effect, which is caused by extraordinary high evapotranspiration, on waterlogging prevailing during summer, the design groundwater depth can be fixed at 100cm for the project area.

F.2.4 Optimization of Drain Interval

In view of the importance of soil permeability in the consideration of the design and layout of deep drains, a survey of the permeability was carried out in the areas where it is considered that deep drainage nay eventually be necessary. Location and procedure are detailed in attachment-9. The values obtained range between 350 cm/day and 8.600 cm/day as shown in Table F.2.4.1.

In the calculation of the design depth and interval of the field drains, monographic solution of the Hooghouds formula is employed, because it is commonly used in this country. Rightest column of Table F.2.4.1 shows the required interval of drains on the condition that the depth of the drainage pipeline is located 2.0 m below the ground surface. It is seen in the table that the interval ranges from 107 m to 590m. Since the layout of the field is in principle 100m x 100mn it is recommended that the drainage space should be 100m.

Table F.1.2.1 Evapotranspiration estimated by four methods

Gafsa Governorate

(UNIT:mm/day)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL(mm)
PAN CLAS-A	2.3	3.3	5.2	6.6	9.8	12.6	12.7	11.9	8.3	5.5	3.5	2.3	2558
PENMAN	2.2	3	4.5	6.3	8	9.6	9.8	8.8	6.6	4.3	2.7	1.9	2065
BLANEY CRD	2.3	3	3.8	4.5	6.1	7.5	7.8	7.4	6	4.3	2.8	2.3	1762
ESPINAR	1.2	1.8	2.7	3.9	5.2	5.9	5.8	5.3	4.2	2.7	1.7	1.1	1265

Tozeur Governorate

(UNIT:mm/day)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL(mm)
PAN CLAS-A	2.8	4.5	6.8	8.8	12.0	15.3	15.2	14.7	10.8	7.3	4.5	3.0	3220
PENMAN	2.2	3.1	4.7	6.8	8.1	9.4	10.1	9.6	7	4.6	2.6	2.2	2147
BLANEY CRD	2.4	3.2	4.1	5.3	6.6	7.9	8.5	7.8	6.5	4.6	3.3	2.4	1908
ESPINAR	1.4	2	2.9	4.1	5.3	6.3	6.3	5.7	4.4	2.9	1.8	1.2	1351

Kebili Governorate

(UNIT:mm/day)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL(mm)
PAN CLAS-A	2.3	3.8	6.2	8.0	11.2	14.0	13.9	12.9	10.1	6.9	4.1	2.3	2918
PENMAN	1.9	2.9	4.8	6.4	7.8	8.7	9.5	9.1	9.5	4.7	2.8	1.5	2122
BLANEY CRD	2.4	3.3	5	6	7.5	8.8	9.5	8.7	7.4	5.3	3.3	2.4	2122
ESPINAR	1.4	2.2	3.4	5.2	7.5	9.1	9.6	8.1	5.5	3.6	2.1	1.2	1797

Gabes Governorate

(UNIT:mm/day)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL(mm)
PAN CLAS-A	2.7	3.5	4.3	5.4	5.8	6.6	7.4	7.1	6.2	4.8	3.9	3.2	1854
PENMAN	2.3	3	3.9	5.4	6.3	7.5	8	7.5	6	3.9	2.5	2	1777
BLANEY CRD	2.5	3.3	3.8	4.8	5.8	6.7	7.5	6.8	6	4.5	3.3	2.5	1752
ESPINAR	1.5	2	2.6	3.7	4.9	6	6.3	5.5	4.1	2.8	1.9	1.4	1302

Table F.1.3.1 Crop coeficients (Kc)

(Unit:mm/day)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
Dates	0.75	0.75	0.75	0.75	0.74	0.79	0.78	1.00	0.90	0.90	0.75	0.75	0.80
Olive	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Fruit Trees			0.25	0.30	0.40	0.60	0.80	0.80	0.60	0.40	0.30		0.37
Annual Crops		0.40	0.80	1.10	0.90	0.80	0.75	0.90	0.50	0.50	0.30		0.58

Table F.1.3.2 Cropping patern and intensity

(Unit:%)

	0 - 1	0 - 2	D - 1	D - 2	D - 3	D - 4	DF- 1	DF- 2	F - 1	F - 2	FD- 1	FD- 2	A - 1
Dates			100	80	80	80	60	50			40	30	
Olive	100	50							40	30			
Fruit Trees		30		20		10	40	30	60	50	60	50	
Annual Crops		20			20	10		20		20		20	100

Table F.1.3.3 Weighted average crop coefficients (Kc)

(Unit:mm/day)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
0 - 1	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
0 - 2	0.35	0.43	0.59	0.66	0.65	0.69	0.74	0.77	0.63	0.57	0.50	0.35	0.58
D - 1	0.75	0.75	0.75	0.75	0.74	0.79	0.78	1.00	0.90	0.90	0.75	0.75	0.80
D - 2	0.60	0.60	0.65	0.66	0.67	0.75	0.78	0.96	0.84	0.80	0.66	0.60	0.71
D - 3	0.60	0.68	0.76	0.82	0.77	0.79	0.77	0.98	0.82	0.82	0.66	0.60	0.76
D - 4	0.60	0.64	0.71	0.74	0.72	0.77	0.78	0.97	0.83	0.81	0.66	0.60	0.74
DF- 1	0.45	0.45	0.55	0.57	0.60	0.71	0.79	0.92	0.78	0.70	0.57	0.45	0.63
DF- 2	0.38	0.46	0.61	0.69	0.67	0.74	0.78	0.92	0.73	0.67	0.53	0.38	0.63
F - 1	0.28	0.28	0.43	0.46	0.52	0.64	0.76	0.76	0.64	0.52	0.46	0.28	0.50
F - 2	0.21	0.29	0.50	0.58	0.59	0.67	0.76	0.79	0.61	0.51	0.42	0.21	0.51
FD- 1	0.30	0.30	0.45	0.48	0.54	0.68	0.79	0.88	0.72	0.60	0.48	0.30	0.54
FD- 2	0.23	0.31	0.51	0.60	0.60	0.70	0.78	0.88	0.67	0.57	0.44	0.23	0.54
A - 1	0.00	0.40	0.80	1.10	0.90	0.80	0.75	0.90	0.50	0.50	0.30	0.00	0.58

Table F.1.3.4(1) Net water requirements in Gafsa governorate

(Unit:mm/day)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL(mm)
O - 1	1.54	2.10	3.15	4.41	5.60	6.72	6.86	6.16	4.62	3.01	1.89	1.33	1445
O - 2	0.77	1.29	2.63	4.16	5.20	6.62	7.25	6.78	4.16	2.45	1.35	0.67	1323
D - 1	1.65	2.25	3.38	4.73	5.92	7.58	7.64	8.80	5.94	3.87	2.03	1.43	1684
D - 2	1.32	1.80	2.93	4.16	5.38	7.22	7.68	8.45	5.54	3.44	1.78	1.14	1552
D - 3	1.32	2.04	3.42	5.17	6.18	7.60	7.59	8.62	5.41	3.53	1.78	1.14	1642
D - 4	1.32	1.92	3.17	4.66	5.78	7.41	7.63	8.54	5.48	3.48	1.78	1.14	1597
DF- 1	0.99	1.35	2.48	3.59	4.83	6.85	7.72	8.10	5.15	3.01	1.54	0.86	1419
DF- 2	0.83	1.37	2.75	4.32	5.36	7.06	7.64	8.10	4.82	2.88	1.42	0.71	1443
F - 1	0.62	0.84	1.94	2.90	4.16	6.14	7.45	6.69	4.22	2.24	1.24	0.53	1191
F - 2	0.46	0.87	2.23	3.65	4.72	6.43	7.45	6.95	4.03	2.19	1.13	0.40	1238
FD- 1	0.66	0.90	2.03	3.02	4.29	6.49	7.76	7.74	4.75	2.58	1.30	0.57	1287
FD- 2	0.50	0.92	2.30	3.75	4.82	6.69	7.68	7.74	4.42	2.45	1.17	0.43	1310
A - 1	0.00	1.20	3.60	6.93	7.20	7.68	7.35	7.92	3.30	2.15	0.81	0.00	1470

Table F.1.3.4(2) Net water requirements in Tozeur governorate

(Unit:mm/day)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL(mm)
O - 1	1.54	2.17	3.29	4.76	5.67	6.58	7.07	6.72	4.90	3.22	1.82	1.54	1503
O - 2	0.77	1.33	2.75	4.49	5.27	6.49	7.47	7.39	4.41	2.62	1.30	0.77	1376
D - 1	1.65	2.33	3.53	5.10	5.99	7.43	7.88	9.60	6.30	4.14	1.95	1.65	1756
D - 2	1.32	1.86	3.06	4.49	5.44	7.07	7.92	9.22	5.88	3.68	1.72	1.32	1617
D - 3	1.32	2.11	3.57	5.58	6.25	7.44	7.82	9.41	5.74	3.77	1.72	1.32	1711
D - 4	1.32	1.98	3.31	5.03	5.85	7.26	7.87	9.31	5.81	3.73	1.72	1.32	1664
DF- 1	0.99	1.40	2.59	3.88	4.89	6.71	7.96	8.83	5.46	3.22	1.48	0.99	1478
DF- 2	0.83	1.41	2.87	4.66	5.43	6.91	7.88	8.83	5.11	3.08	1.37	0.83	1503
F - 1	0.62	0.87	2.02	3.13	4.21	6.02	7.68	7.30	4.48	2.39	1.20	0.62	1239
F - 2	0.46	0.90	2.33	3.94	4.78	6.30	7.68	7.58	4.27	2.35	1.09	0.46	1288
FD- 1	0.66	0.93	2.12	3.26	4.34	6.35	8.00	8.45	5.04	2.76	1.25	0.66	1340
FD- 2	0.50	0.95	2.40	4.05	4.88	6.55	7.92	8.45	4.69	2.62	1.13	0.50	1364
A - 1	0.00	1.24	3.76	7.48	7.29	7.52	7.58	8.64	3.50	2.30	0.78	0.00	1530

Table F.1.3.4(3) Net water requirements in Kebili governorate

(Unit:mm/day)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL(mm)
O - 1	1.33	2.03	3.36	4.48	5.46	6.09	6.65	6.37	5.65	3.29	1.96	1.05	1485
O - 2	0.67	1.25	2.81	4.22	5.07	6.00	7.03	7.01	5.99	2.68	1.40	0.53	1363
D - 1	1.43	2.18	3.60	4.80	5.77	6.87	7.41	9.10	8.55	4.23	2.10	1.13	1743
D - 2	1.14	1.74	3.12	4.22	5.24	6.54	7.45	8.74	7.98	3.76	1.85	0.90	1607
D - 3	1.14	1.97	3.65	5.25	6.02	6.89	7.35	8.92	7.79	3.85	1.85	0.90	1695
D - 4	1.14	1.86	3.38	4.74	5.63	6.72	7.40	8.83	7.89	3.81	1.85	0.90	1651
DF- 1	0.86	1.31	2.64	3.65	4.71	6.21	7.49	8.37	7.41	3.29	1.60	0.68	1471
DF- 2	0.71	1.32	2.93	4.38	5.23	6.39	7.41	8.37	6.94	3.15	1.47	0.56	1492
F - 1	0.53	0.81	2.06	2.94	4.06	5.57	7.22	6.92	6.08	2.44	1.29	0.42	1232
F - 2	0.40	0.84	2.38	3.71	4.60	5.83	7.22	7.19	5.80	2.40	1.18	0.32	1278
FD- 1	0.57	0.87	2.16	3.07	4.18	5.88	7.52	8.01	6.84	2.82	1.34	0.45	1336
FD- 2	0.43	0.88	2.45	3.81	4.70	6.06	7.45	8.01	6.37	2.68	1.22	0.34	1356
A - 1	0.00	1.16	3.84	7.04	7.02	6.96	7.13	8.19	4.75	2.35	0.84	0.00	1504

Table F.1.3.4(4) Net water requirements in Gabes governorate

(Unit:mm/day)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL(mm)
O - 1	1.61	2.10	2.73	3.78	4.41	5.25	5.60	5.25	4.20	2.73	1.75	1.40	1244
O - 2	0.81	1.29	2.28	3.56	4.10	5.18	5.92	5.78	3.78	2.22	1.25	0.70	1125
D - 1	1.73	2.25	2.93	4.05	4.66	5.93	6.24	7.50	5.40	3.51	1.88	1.50	1450
D - 2	1.38	1.80	2.54	3.56	4.23	5.64	6.27	7.20	5.04	3.12	1.65	1.20	1331
D - 3	1.38	2.04	2.96	4.43	4.86	5.94	6.19	7.35	4.92	3.20	1.65	1.20	1407
D - 4	1.38	1.92	2.75	4.00	4.55	5.79	6.23	7.28	4.98	3.16	1.65	1.20	1369
DF- 1	1.04	1.35	2.15	3.08	3.81	5.36	6.30	6.90	4.68	2.73	1.43	0.90	1212
DF- 2	0.86	1.37	2.38	3.70	4.22	5.51	6.24	6.90	4.38	2.61	1.31	0.75	1228
F - 1	0.64	0.84	1.68	2.48	3.28	4.80	6.08	5.70	3.84	2.03	1.15	0.56	1011
F - 2	0.48	0.87	1.93	3.13	3.72	5.03	6.08	5.93	3.66	1.99	1.05	0.42	1047
FD- 1	0.69	0.90	1.76	2.59	3.38	5.07	6.34	6.60	4.32	2.34	1.20	0.60	1093
FD- 2	0.52	0.92	1.99	3.21	3.79	5.23	6.27	6.60	4.02	2.22	1.09	0.45	1109
A - 1	0.00	1.20	3.12	5.94	5.67	6.00	6.00	6.75	3.00	1.95	0.75	0.00	1232

Table F.1.4.1(1) Irrigation interval in Gafsa governorate

	ETcrop (mm/day)	kc	(p)	Depth (m)	Sa=120mm/m		Sa=80mm/m	
					(p*Sa)*D	Int(Day)	(p*Sa)*D	Int(Day)
O - 1	6.86	0.70	0.65	1.50	117.00	17	78	11
O - 2	7.25	0.74	0.65	1.50	117.00	16	78	11
D - 1	8.80	1.00	0.50	2.00	120.00	14	80	9
D - 2	8.45	0.96	0.50	2.00	120.00	14	80	9
D - 3	8.62	0.98	0.50	2.00	120.00	14	80	9
D - 4	8.54	0.97	0.50	2.00	120.00	14	80	9
DF- 1	8.10	0.92	0.50	2.00	120.00	15	80	10
DF- 2	8.10	0.92	0.50	2.00	120.00	15	80	10
F - 1	7.45	0.76	0.50	1.50	90.00	12	60	8
F - 2	7.45	0.79	0.50	1.50	90.00	12	60	8
FD- 1	7.76	0.79	0.50	1.50	90.00	12	60	8
FD- 2	7.74	0.88	0.50	1.50	90.00	12	60	8
A - 1	7.92	0.90	0.45	1.00	54.00	7	36	5

Table F.1.4.1(2) Irrigation interval in Tozeur governorate

	ETcrop (mm/day)	kc	(p)	Depth (m)	Sa=120mm/m		Sa=80mm/m	
					(p*Sa)*D	Int(Day)	(p*Sa)*D	Int(Day)
O - 1	7.07	0.70	0.65	1.50	117.00	17	78	11
O - 2	7.47	0.74	0.65	1.50	117.00	16	78	10
D - 1	9.60	1.00	0.50	2.00	120.00	13	80	8
D - 2	9.22	0.96	0.50	2.00	120.00	13	80	9
D - 3	9.41	0.98	0.50	2.00	120.00	13	80	9
D - 4	9.31	0.97	0.50	2.00	120.00	13	80	9
DF- 1	8.83	0.92	0.50	2.00	120.00	14	80	9
DF- 2	8.83	0.92	0.50	2.00	120.00	14	80	9
F - 1	7.68	0.76	0.50	1.50	90.00	12	60	8
F - 2	7.68	0.76	0.50	1.50	90.00	12	60	8
FD- 1	8.45	0.88	0.50	1.50	90.00	11	60	7
FD- 2	8.45	0.88	0.50	1.50	90.00	11	60	7
A - 1	8.64	0.90	0.45	1.00	54.00	6	36	4

Table F.1.4.1(3) Irrigation Interval in Kebili Governorate

	ETcrop (mm/day)	kc	(p)	Depth (m)	Sa=120mm/m		Sa=80mm/m	
					(p*Sa)*D	Int(Day)	(p*Sa)*D	Int(Day)
O - 1	6.65	0.70	0.65	1.50	117.00	18	78	12
O - 2	7.03	0.74	0.65	1.50	117.00	17	78	11
D - 1	9.10	1.00	0.50	2.00	120.00	13	80	9
D - 2	8.74	0.96	0.50	2.00	120.00	14	80	9
D - 3	8.92	0.98	0.50	2.00	120.00	13	80	9
D - 4	8.83	0.97	0.50	2.00	120.00	14	80	9
DF- 1	8.37	0.92	0.50	2.00	120.00	14	80	10
DF- 2	8.37	0.92	0.50	2.00	120.00	14	80	10
F - 1	7.22	0.76	0.50	1.50	90.00	12	60	8
F - 2	7.22	0.76	0.50	1.50	90.00	12	60	8
FD- 1	8.01	0.88	0.50	1.50	90.00	11	60	7
FD- 2	8.01	0.88	0.50	1.50	90.00	11	60	7
A - 1	8.19	0.90	0.45	1.00	54.00	7	36	4

Table F.1.4.1(4) Irrigation Interval in Gabes Governorate

	ETcrop (mm/day)	kc	(p)	Depth (m)	Sa=120mm/m		Sa=80mm/m	
					(p*Sa)*D	Int(Day)	(p*Sa)*D	Int(Day)
O - 1	6.65	0.70	0.65	1.50	117.00	18	78	12
O - 2	7.03	0.74	0.65	1.50	117.00	17	78	11
D - 1	9.10	1.00	0.50	2.00	120.00	13	80	9
D - 2	8.74	0.96	0.50	2.00	120.00	14	80	9
D - 3	8.92	0.98	0.50	2.00	120.00	13	80	9
D - 4	8.83	0.97	0.50	2.00	120.00	14	80	9
DF- 1	8.37	0.92	0.50	2.00	120.00	14	80	10
DF- 2	8.37	0.92	0.50	2.00	120.00	14	80	10
F - 1	7.22	0.76	0.50	1.50	90.00	12	60	8
F - 2	7.22	0.76	0.50	1.50	90.00	12	60	8
FD- 1	8.01	0.88	0.50	1.50	90.00	11	60	7
FD- 2	8.01	0.88	0.50	1.50	90.00	11	60	7
A - 1	8.19	0.90	0.45	1.00	54.00	7	36	4

Table F.1.5.1 Monthly average rainfall

(Unit:mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
GAFSA	12.70	18.90	24.60	12.00	11.50	8.00	1.10	8.70	16.60	21.20	15.50	23.50	174
TOZEUR	8.30	9.30	9.60	8.30	8.50	2.50	0.10	1.30	9.90	7.80	10.60	10.70	87
KEBILI	7.30	0.00	3.60	0.10	3.40	6.40	0.00	1.50	4.40	0.30	19.30	27.30	74
GABES	16.40	21.50	23.70	12.00	6.20	3.70	1.00	0.70	17.60	42.10	29.50	38.40	213

Table F.1.5.2(1) Net irrigation requirement in Gafsa governorate

(Unit:mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
O - 1	35.04	39.90	73.05	120.30	162.10	193.60	211.56	182.26	122.00	72.11	41.20	17.73	1271
O - 2	11.17	17.22	57.01	112.74	149.70	190.72	223.71	201.36	108.14	54.78	25.00	0.00	1152
D - 1	38.45	44.10	80.03	129.75	172.02	219.52	235.86	264.10	161.60	98.77	45.25	20.68	1510
D - 2	28.22	31.50	66.08	112.74	155.16	208.58	237.08	253.19	149.72	85.44	37.96	11.84	1377
D - 3	28.22	38.22	81.42	142.98	179.96	220.10	234.04	258.64	145.76	88.11	37.96	11.84	1467
D - 4	28.22	34.86	73.75	127.86	167.56	214.34	235.56	255.92	147.74	86.77	37.96	11.84	1422
DF- 1	17.99	18.90	52.13	95.73	138.29	197.63	238.29	242.28	137.84	72.11	30.67	3.00	1245
DF- 2	12.88	19.32	60.50	117.47	154.66	203.68	235.86	242.28	127.94	68.11	27.03	0.00	1270
F - 1	6.40	4.62	35.39	74.94	117.46	176.32	229.79	198.63	110.12	48.12	21.76	0.00	1024
F - 2	1.62	5.46	44.45	97.62	134.82	184.96	229.79	206.81	104.18	46.78	18.52	0.00	1075
FD- 1	7.76	6.30	38.18	78.72	121.43	186.69	239.51	231.36	125.96	58.78	23.38	0.00	1118
FD- 2	2.65	6.72	46.55	100.46	137.80	192.74	237.08	231.36	116.06	54.78	19.74	0.00	1146
A - 1	0.00	14.70	87.00	195.90	211.70	222.40	226.75	236.82	82.40	45.45	8.80	0.00	1332

Table F.1.5.2(2) Net irrigation requirement in Tozeur governorate

(Unit:mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
O - 1	39.44	51.46	92.39	134.50	167.27	194.90	219.07	207.02	137.10	92.02	44.00	37.04	1416
O - 2	15.57	28.02	75.63	126.34	154.72	192.08	231.59	227.85	122.40	73.48	28.40	13.17	1289
D - 1	42.85	55.80	99.68	144.70	177.31	220.28	244.12	296.30	179.10	120.54	47.90	40.45	1669
D - 2	32.62	42.78	85.11	126.34	160.24	209.56	245.37	284.40	166.50	106.28	40.88	30.22	1530
D - 3	32.62	49.72	101.13	158.98	185.35	220.84	242.24	290.35	162.30	109.13	40.88	30.22	1624
D - 4	32.62	46.25	93.12	142.66	172.79	215.20	243.80	287.37	164.40	107.71	40.88	30.22	1577
DF- 1	22.39	29.76	70.54	107.98	143.16	198.85	246.62	272.49	153.90	92.02	33.86	19.99	1392
DF- 2	17.28	30.19	79.28	131.44	159.74	204.77	244.12	272.49	143.40	87.74	30.35	14.88	1416
F - 1	10.80	15.00	53.05	85.54	122.07	177.98	237.86	224.88	124.50	66.35	25.28	8.40	1152
F - 2	6.02	15.87	62.52	110.02	139.65	186.44	237.86	233.80	118.20	64.93	22.16	3.62	1201
FD- 1	12.16	16.74	55.97	89.62	126.09	188.13	247.88	260.59	141.30	77.76	26.84	9.76	1253
FD- 2	7.05	17.17	64.71	113.08	142.66	194.05	245.37	260.59	130.80	73.48	23.33	4.65	1277
A - 1	0.00	25.42	106.96	216.10	217.49	223.10	234.73	266.54	95.10	63.50	12.80	0.00	1462

Table F.1.5.2(3) Net irrigation requirement in Kebili governorate

(Unit:mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
O - 1	33.93	56.84	100.56	134.30	165.86	176.30	206.15	195.97	195.10	101.69	39.50	5.25	1411
O - 2	13.32	34.92	83.45	126.62	153.77	173.69	217.93	215.72	175.15	82.75	22.70	0.00	1300
D - 1	36.88	60.90	108.00	143.90	175.53	199.79	229.71	280.60	252.10	130.83	43.70	7.58	1670
D - 2	28.04	48.72	93.12	126.62	159.09	189.87	230.89	269.32	235.00	116.26	36.14	0.60	1534
D - 3	28.04	55.22	109.49	157.34	183.27	200.31	227.94	274.96	229.30	119.17	36.14	0.60	1622
D - 4	28.04	51.97	101.30	141.98	171.18	195.09	229.42	272.14	232.15	117.72	36.14	0.60	1578
DF- 1	19.21	36.54	78.24	109.34	142.65	179.95	232.07	258.03	217.90	101.69	28.58	0.00	1404
DF- 2	14.79	36.95	87.17	131.42	158.61	185.43	229.71	258.03	203.65	97.32	24.80	0.00	1428
F - 1	9.19	22.74	60.38	88.22	122.34	160.64	223.82	212.90	178.00	75.46	19.34	0.00	1173
F - 2	5.07	23.55	70.06	111.26	139.26	168.47	223.82	221.36	169.45	74.01	15.98	0.00	1222
FD- 1	10.37	24.36	63.36	92.06	126.20	170.04	233.24	246.75	200.80	87.12	21.02	0.00	1275
FD- 2	5.95	24.77	72.29	114.14	142.16	175.52	230.89	246.75	186.55	82.75	17.24	0.00	1299
A - 1	0.00	32.48	115.44	211.10	214.22	202.40	220.88	252.39	138.10	72.55	5.90	0.00	1465

Table F.1.5.2(4) Net irrigation requirement in Gabes governorate

(Unit:mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
O - 1	33.51	37.30	60.93	101.40	130.51	153.80	172.60	162.05	108.40	42.53	23.00	5.00	1031
O - 2	8.55	14.62	47.03	94.92	120.75	151.55	182.52	178.33	95.80	26.81	8.00	0.00	929
D - 1	37.08	41.50	66.98	109.50	138.32	174.05	192.44	231.80	144.40	66.71	26.75	8.10	1238
D - 2	26.38	28.90	54.89	94.92	125.04	165.50	193.43	222.50	133.60	54.62	20.00	0.00	1120
D - 3	26.38	35.62	68.18	120.84	144.57	174.50	190.95	227.15	130.00	57.04	20.00	0.00	1195
D - 4	26.38	32.26	61.53	107.88	134.81	170.00	192.19	224.83	131.80	55.83	20.00	0.00	1158
DF- 1	15.69	16.30	42.80	80.34	111.76	156.95	194.42	213.20	122.80	42.53	13.25	0.00	1010
DF- 2	10.34	16.72	50.05	98.97	124.65	161.68	192.44	213.20	113.80	38.90	9.88	0.00	1031
F - 1	3.56	2.02	28.29	62.52	95.36	140.30	187.48	176.00	97.60	20.77	5.00	0.00	819
F - 2	0.00	2.86	36.15	81.96	109.03	147.05	187.48	182.98	92.20	19.56	2.00	0.00	861
FD- 1	4.99	3.70	30.71	65.76	98.48	148.40	195.42	203.90	112.00	30.44	6.50	0.00	900
FD- 2	0.00	4.12	37.96	84.39	111.37	153.13	193.43	203.90	103.00	26.81	3.13	0.00	921
A - 1	0.00	12.10	73.02	166.20	169.57	176.30	185.00	208.55	72.40	18.35	0.00	0.00	1081

Table F.1.8.1 Relation between development intensity and water loss

Governorate	Name of Oasis	Area (ha)	Present Condition			Plan(1) Max. loss length :50m			Plan(2) Max. loss length :25m		
			Loss L.(m)	Loss(%)	Effici(%)	Loss(%)	Effici(%)	Dec. Loss	Loss(%)	Effici(%)	Dec. Loss
Gafsa	Kasba	698	100	25.0	75.0	6.5	93.5	18.5	3.3	96.8	21.8
	Oued Shili	56	200	51.0	49.0	8.0	92.0	43.0	4.0	96.0	47.0
Tozeur	Tozeur	973	180	40.4	59.6	6.5	93.5	33.9	3.3	96.8	37.2
	Draa Sud	200	25	8.0	92.0	8.0	92.0	0.0	4.0	96.0	4.0
Kebili	Mansoura	86	170	38.6	61.4	6.5	93.5	32.1	3.3	96.8	35.4
	Atilet	220	175	46.0	54.0	8.0	92.0	38.0	4.0	96.0	42.0
Gabes	Oasis de Gabes	734	170.2	39.0	61.0	6.5	93.5	32.5	3.3	96.8	35.8
	Limaoua 1 et 2	148	135	37.7	62.3	8.0	92.0	29.7	4.0	96.0	33.7

Note: Water loss is based on the water loss measurement.

Table F.1.8.2 Irrigation achievement on present condition (Case 1)

Name of Oasis	Area (ha)	Supplied Water(mm) ①	Efficiency			Irrigation Effici.⑤ ②*③*④	Net Water Require. ⑥	Gross Water Require. ⑦=⑥/⑤	Irrigation Achievement ⑧=①/⑦
			Main ②	Secondary ③	Applica. ④				
Kasba	698	1045	0.9	0.750	0.80	0.540	1152	2133	49
Oued Shili	56	1352	0.9	0.490	0.85	0.375	1510	4028	34
Tozeur	973	1890	0.9	0.596	0.80	0.429	1669	3889	49
Draa Sud	200	1120	0.9	0.920	0.85	0.704	1392	1978	57
Mansoura	86	1437	0.9	0.614	0.80	0.442	1622	3669	39
Atilet	220	1503	0.9	0.540	0.85	0.413	1578	3820	39
Oasis de Gabes	734	1155	0.9	0.610	0.80	0.439	1031	2347	49
Limaoua 1 et 2	148	927	0.9	0.623	0.85	0.477	861	1807	51

Table F.1.8.3 Irrigation achievement on Plan (1) (Case 2)

(Maximum length of unimproved channel is 50m)

Name of Oasis	Area (ha)	Supplied Water(mm) ①	Efficiency			Irrigation Effici.⑤	Net Water Require.	Gross Water Require.	Irrigation Achievement
			Main ②	Secondary ③	Applica. ④	②*③*④	⑥	⑦=⑥/⑤	⑧=①/⑦
Kasba	698	1045	0.9	0.935	0.80	0.673	1152	1711	61
Oued Shili	56	1352	0.9	0.920	0.85	0.704	1510	2145	63
Tozeur	973	1890	0.9	0.935	0.80	0.673	1669	2479	76
Draa Sud	200	1120	0.9	0.920	0.85	0.704	1392	1978	57
Mansoura	86	1437	0.9	0.935	0.80	0.673	1622	2409	60
Atilet	220	1503	0.9	0.920	0.85	0.704	1578	2242	67
Oasis de Gabes	734	1155	0.9	0.935	0.80	0.673	1031	1531	75
Limaoua 1 et 2	148	927	0.9	0.920	0.85	0.704	861	1223	76

Table F.1.8.4 Irrigation achievement on Plan (2) (Case 3)

(Maximum length of unimproved channel is 25m)

Name of Oasis	Area (ha)	Supplied Water(mm) ①	Efficiency			Irrigation Effici.⑤	Net Water Require.	Gross Water Require.	Irrigation Achievement
			Main ②	Secondary ③	Applica. ④	②*③*④	⑥	⑦=⑥/⑤	⑧=①/⑦
Kasba	698	1045	0.9	0.9675	0.80	0.697	1152	1654	63
Oued Shili	56	1352	0.9	0.9600	0.85	0.734	1510	2056	66
Tozeur	973	1890	0.9	0.9675	0.80	0.697	1669	2396	79
Draa Sud	200	1120	0.9	0.9600	0.85	0.734	1392	1895	59
Mansoura	86	1437	0.9	0.9675	0.80	0.697	1622	2328	62
Atilet	220	1503	0.9	0.9600	0.85	0.734	1578	2149	70
Oasis de Gabes	734	1155	0.9	0.9675	0.80	0.697	1031	1480	78
Limaoua 1 et 2	148	927	0.9	0.9600	0.85	0.734	861	1172	79

Table F.1.8.5 Increase of irrigation achievement on Plan(1) and Plan(2)

Name of Oasis	Area (ha)	Present Achiev.(%)	Plan(1) Max=50m		Plan(2) Max=25m	
			Achiev.(%)	Inc. (%)	Achiev.(%)	Inc. (%)
Kasba	698	49	61	12	63	14
Oued Shili	56	34	63	29	66	32
Tozeur	973	49	76	28	79	30
Draa Sud	200	57	57	0	59	2
Mansoura	86	39	60	20	62	23
Atilet	220	39	67	28	70	31
Oasis de Gabes	734	49	75	26	78	29
Limaoua 1 et 2	148	51	76	24	79	28

Table F.1.8.6 Relation between development intensity and cost

(Model : 150m x 150m =2.25 ha)

Intensity (m)	Max=100m	Max=75m	Max=50m	Max=25m
PVC(ϕ 200) (m)	275	275	400	875
No of Turn-out	4	6	9	36
Cost (D)	3976	4376	6420	17306
Cost (D/ha)	1767	1945	2853	7692
Loss Length (m)	50	37.5	25.5	12.5
Conveyance Loss (%)	16	12	8	4
Efficiency (%)	84	88	92	96
Saved Loss	19.5	23.5	27.5	31.5
Loss/Cost/ha	0.011	0.012	0.010	0.004

Note: Conveyance loss of present condition is 35.5 %

Development intensity shows maximum length of unimproved canal

Table F.2.1.1 Relation between leaching water requirements and irrigation water loss

Governorate	Name of Oasis	Conductivity of Irr. Water (mmhos/cm)	Ratio of Leaching Water Requirements				Ratio of Irrigation Water Loss after Hydrant				
			Date palm	Fig,Olive, Pomegranate	Alfalfa	Tomato	Irrigation Efficiency			Water Loss	Ratio= Loss/Net W.Req
							Secondary ①	Applica. ②	Efficiency ③=①*②	④=1.0-③	⑤=④/③
Gafsa	Kasba	1.7	0.05	0.10	0.11	0.11	0.935	0.800	0.748	0.252	0.34
	Oued Shili	4.8	0.16	0.34	0.39	0.38	0.920	0.850	0.782	0.218	0.28
Tozeur	Tozeur	2.4	0.08	0.14	0.16	0.16	0.935	0.800	0.748	0.252	0.34
	Draa Sud	2.9	0.09	0.18	0.21	0.20	0.960	0.850	0.816	0.184	0.23
Kebili	Mansoura	3.3	0.11	0.21	0.24	0.23	0.935	0.800	0.748	0.252	0.34
	Atilet	3.7	0.12	0.24	0.28	0.27	0.920	0.850	0.782	0.218	0.28
Gabes	Oasis de Gabes	3.3	0.11	0.21	0.24	0.23	0.935	0.800	0.748	0.252	0.34
	Limaoua 1 et 2	3.5	0.11	0.23	0.26	0.25	0.920	0.850	0.782	0.218	0.28

Note : Conductivity of irrigation water is based on water quality test

Table F.2.3.1 Drainage duty on pilot oasis

Governorate	Name of Oasis	Cropping Patern	Irrigation Efficiency	Rainfall (mm/month) ①	G.Water Req(mm/mo) ②	N.Water Req(mm/mo) ③	Drainage Duty(mm/day) (①+②-③)/31	Drainage Duty(l/s/ha) mm/day/8.64
Gafsa	Kasba	O-2	0.673	1.1	332.41	223.71	3.54	0.41
	Oued Shili	D-1	0.704	8.7	375.14	264.10	3.86	0.45
Tozeur	Tozeur	D-1	0.673	1.3	440.27	296.30	4.69	0.54
	Draa Sud	DF-1	0.704	1.3	387.06	272.49	3.74	0.43
Kebili	Mansoura	D-3	0.673	1.5	408.56	274.96	4.36	0.50
	Atilet	D-4	0.704	1.5	386.56	272.14	3.74	0.43
Gabes	Oasis de Gabes	FD-2	0.673	0.7	302.97	203.90	3.22	0.37
	Limaoua 1 et 2	F-2	0.704	1.0	266.31	187.48	2.58	0.30

Table F.2.4.1 Interval of underdrain on 7 oases by Hooghoudt's formula

(Drain Depth : H=2.0m)

Name of Oasis	k(*1) (cm/sec)	k (cm/day)	H(*2) (cm)	m (cm)	q (mm/day)	Interval (m)
Oued Shili	0.1000	8640	10	100	3.86	328
Oued Shili	0.0120	1037	10	100	3.86	114
Tozeur	0.0041	354	150	100	4.69	110
Tozeur	0.0110	950	20	100	4.69	107
Draa Sud	0.0098	847	300	100	3.74	252
Draa Sud	0.0057	492	300	100	3.74	192
Draa Sud	0.0510	4406	30	100	3.74	275
Ras El Ain (*3)	0.0095	821	130	100	4.36	165
Regim Maatoug 2 (*4)	0.0330	2851	300	100	3.74	462
Oasis de Gabes	0.0490	4234	130	100	3.22	435
Aouinette (*5)	0.0300	3197	300	100	2.58	590

Note (*1) K is based on insitu permeability test
(*2) H shows distance from drains to impermeable layer
(*3) Drainage duty is substituted Maosoura for Ras El Ain
(*4) Drainage duty is substituted Atilet for Regim Maatoug 2
(*5) Drainage duty is substituted Limaoua for Aouinette

ANNEX - G

WATER MANAGEMENT

ANNEX - G

WATER MANAGEMENT

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ANNEX - G

WATER MANAGEMENT

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G.1 GENERAL

Present condition on water management system including : a) function and activities of Commissariats Regionaux au Developpement Agricole(CRDA), b) function and activities of Associations d'Interet Collectif (AIC), c) irrigation method, d) operation and maintenance of irrigation system, and e) amortization method and loan system, was investigated during the study period together with relevant expert and counterpart personnel dispatched from CRDA.

Data and information regarding irrigation method, which were collected at Direction Generale du Genie Rural(DGGR) and CRDA, are as follows:

(1) Number of sectors in each oasis and their area,
(2) Present irrigation condition including : a) system capacity, b) irrigation interval, c) water application hour, d) design application amount, and e) irrigated area in 1994.

(3) Annual amount of water applied in 1994, and
(4) Irrigation achievement in 1994.

Detailed data and information regarding operation and maintenance (OM) of irrigation facilities, which were collected mainly at CRDA, are as follows:

(1) Function and activities of CRDA,
(2) Function and activities of AIC including : a) number of member, b) number of executive, c) number of employees and d) annual budget,
(3) Annual OM cost of irrigation facilities, and
(4) Annual water charge.

In addition to the above, water-loss was measured by using two methods, flow method and ponding method, to quantify water-loss through earth ditches and to determine the intensity of lined canal and/or pipes for on-farm development. Interviews were also conducted at eight oases with randomly selected ten farmers in each oasis, in order to grasp the problems encountered and evaluate the present condition of irrigation system, OM system and water cost as well as hearing their opinion regarding improvement of irrigation ditches.

G.2 Present Irrigation Method and Problems

G.2.1 Present Irrigation Method

The terminal system consists of quaternary canals and farm ditches for water distribution, and secondary, collector and field drains. Length of quaternary canals and above drains per hector are 200 to 300 m and 50 m, respectively. The quaternary canals are mostly of excavated earth ditches, and hence percolation loss of distributed water through hydrant is fairly large. The improvement programs for water saving with public financial incentives to farmers in accordance with the national policy has been promoted under the instruction of CRDA. However, the progress is stagnated because of shortage of governmental budget in the Study area. Regarding to drainage facilities, although some drains are blocked by natural vegetation and sand conveyed by wind, the existing ones are generally well maintained.

Basin irrigation is predominant in the Study area. The size of basin is not standardized and depends on the type of oasis, cultivated crops and locality. It is understood that the size of basin in the traditional oases is bigger than those in new oases as shown below:

Oasis	Governorate	Oasis type	Crops	Size
Ibn Chabat 3	Tozeur	New	Palm tree	4mX 4m
Draa Sud	Tozeur	New	Palm tree	3mX 3m
Mansoura	Kebili	Traditional	Palm tree	6mX 6m
Atilet	Kebili	New	Palm tree	2mX 6m
Oasis de Gabes	Gabes	Traditional	Palm tree	5mX 20m
Limaoua	Gabes	New	Forage	2.5mx 15m

Irrigation plan is determined by AICs with the assistance of CRDA, and the features of irrigation plan in each governorate are shown in Table G.2.1. As seen in the table, there are big differences in irrigation interval, seven(7) days in Gafsa and Tozeur, while, 20 days and 16 days in Kebili and Gabes, respectively. It should be also noted that maximum water requirements estimated by the Study Team range between 6.4 mm and 7.9 mm per day regardless water-loss through field ditch. Whereas the designed maximum net water requirements at parcel calculated from system capacities

range from 2.0 mm to 3.1 mm per day which correspond to 29% to 37% of the estimated ones. This fact indicates that most of the irrigation areas are chronically insufficient in hot summer(see Attachments G.1 and G.2).

Utilization ratio of present irrigation facilities is defined as the ratio between actually consumed water volume at pump station and maximum capacity at hydrant calculated by using the data of irrigation plan such as number of sector, system capacity and system operation time. The obtained values are 54%, 60%, 87% and 67% in Gafsa, Tozeur, Kebili and Gabes, respectively as shown in Table G.2.2 and Attachment G.3 in more detail.

G.2.2 Encountered Problems of the Oases

(1) Result of interview in the selected oases

In order to grasp the interest and intention of CRDA and farmers in the eight (8) pilot oases, interview was conducted at Kasba and Oued Shili in Gafsa, Oasis de Tozeur and Draa Sud in Tozeur, Atilet and Mansoura in Kebili, and Limoua and Oasis de Gabes in Gabes. The first interest of farmers in the oases is to save irrigation water and decrease OM cost by the construction of lined canal in the parcel. And the second interest is to solve poor drainage problems. The summary of interview is shown in Table G.2.3.

(2) Encountered problems in the Project area

The problems on the present irrigation method are as follows:

1) Imperfect consolidation of parcel ditches and basin cause big water loss in quartier,

2) Inappropriate irrigation interval and application water amount prevent appropriate productivity of agricultural products,

3) Water is not saved by farmers in case that water is sold in unit of hector per year.

G.3 Present Irrigation Achievement

Although the irrigation area of 153 oases is 23,435 ha, the actually irrigated area in 1994 is 22,687 ha corresponding to 97 % of the whole area of oases.

Based on the study of present cropping pattern of each oasis, net water requirement, irrigation efficiency estimated through oasis sample survey and measurement of irrigation loss, the irrigation achievement ratios are estimated. The achievement ratio range from 39% to 51% with an average of 45 % as summarized below and detailed in Attachment G.4.

	Irrigation area (ha)	Irrigated area (ha)	Irrigation achievement (%)
Gafsa	3,467	3,294	36
Tozeur	5,622	5,622	50
Kebili	7,213	7,019	39
Gabes	7,133	6,752	51
Total	23,435	22,687	44

G.4 Measurement of Water Loss through Field Ditches

Eight(8) oases, three(3) new and five (5) traditional oases in the four governorates Gafsa, Tozeur, Kebili and Gabes, were selected in cooperation with CRDA officials concerned. The measurement was carried out by the two(2) methods at each measuring site. The work was carried out during the period of one(1) month commencing from September 18, 1995. In the first half working period, the measurement was conducted by ponding method, and in the second half of the period, by the flow method.

It is a common practice to adopt the flow method to obtain the average amount of percolated water from the difference between the inflow and out flow measured by weirs. Because this method is measured under the same condition as the actual conveyance of water, the obtained result seems to be the most reliable one.

However, it should be noted that water loss varies with time, during transition period and steady period. To estimate such water-loss, the ponding method was supplementary employed.

As a result, the total water loss is estimated at approximate 30% of irrigation water per 100 m in the new oases and approximate 25% per 100 m in the traditional oases. Although the water-losses rate do not vary in proportion to the length of unconsolidated ditches (earth ditches), the loss rates by ditches length are shown below:

Water-losses rate by ditch length (%)

	12.5m	25m	50m	75m	100m	125m	150m	175m	200m
Traditional	3.3	6.5	13.0	19.0	25.0	30.0	35.0	39.5	44.0
New	4.0	8.0	16.0	23.0	30.0	35.5	41.0	46.0	51.0

Methodology, analysis and results are detailed in Attachment G.5.

G.5 Water Management

G.5.1 Operation and Maintenance(OM) of system facilities

(1) Executing agencies and share of the OM works

The OM works of system facilities are conducted by Associations d'Interet Collectif (AIC) and Commissariarts Regionaux au Developpement Agricole(CRDA). Although the demarcations of OM works for hydraulic facilities are different by each governorate, the operation works for irrigation facilities and OM works for drains inside of oases are generally executed by AICs and the other OM works by CRDAs. The more details is below:

The operation works for irrigation facilities have been carried out by AICs generally. However, two(2) irrigation systems with big dimension pipelines such as Batterie des Forages de Ragouba(B.F.R.) in Gafsa governorate and Presqu'ile de Kebili System (P.I.K.) which requires high level technics are operated and maintained by CRDAs. The repair and periodical inspection for deep tube-wells and pumping station which require high level technics and costs are cared by CRDA and for pipeline for water conveyance and distribution by AICs.

Among the repair works, small repair works such as replacement of articles for consumption carry out by AICs operators, but, periodical inspection and repair of pumping station are entrusted to private company under the supervise of CRDA.

On the OM works for drains, principal and secondary drains are maintained by CRDA and tertiary and quarternary drain (field drain) by AICs as shown in Table G.5.1.

(2) Organization and the Activity of CRDA and AIC

1) CRDA

Management for the consolidation of agricultural hydraulic facilities are borne by Director General Genie Rural(DGGR) and CRDA which are substructure of Ministry of Agriculture. The former provides the management service to nation-wide and the latter to governorate-wide(see Figure G.5.1).

CRDA was established under the Ministry of Agriculture on March 1989, and basically

consists of the following five divisions:

- Agricultural extension and promotion division(AEPD),
- Hydraulics and rural infrastructure division(HRID),
- Reforestation and soil conservation division(RSCD),
- Agricultural studies and development division(ASDD), and
- Administrative and financial division(ASDD).

The staffing scale of CRDAs organization vary from 300 to 400, the organization of CRDA Kebili is exemplified as shown in Figure G.5.2. The number of staff is 298 in total, and the staff of HRID which bears the responsibility for the consolidation of agricultural hydraulic facilities and the OM works reaches to 89. OM staffs of Arrondissement de l'Exploitation des Perimeteres Irrigues(PI) counts 52 corresponding to 60 % of total staffs of HRID.

Among them, organization and function concerned to water saving are as follows:

a) PI under HRID
Planning and execution of OM works for existing irrigation areas, drafting of improved irrigation plan, extension of irrigation technics and water saving technics, execution of periodical seminar for irrigation technics

b) Cellules Territoriales de Vulgarisation (CTV) and Cellules de Rayonnement Agricole (CRA) under AEPD

Extension works on general agricultural technics including irrigation technics

c) AIC cell
Information on functioning and promotion of AICs, Administrative assistance such as financial management, loans procedures, institutional assistance for AICs, monitoring and evaluation of AICs in cooperation with Service AIC under DGGR.

Among above organization, PI consist of three(3) units, OM, Water saving and Cooling system units. The number of technical staff is insufficient, eight(8) to 14 in each governorate, comparing with the number of AIC as shown in below table. The water saving unit promote the projects for consolidation of terminal facilities. However the number of full-time worker is nought or only one(1). The insufficient staffing is one of

the constraints for execution of efficient OM works and promotion of consolidation projects for terminal facilities arrangement. Thus, CRDAs request staff increment to the Ministry of Agriculture , and recommend AICs to federate in district base in order to execute efficient OM works.

2) AIC

AIC was established under the national decree, Law No. 87-35 of 6 July 1987. The institutional development promoted mainly by CRDAs. The purpose of activities is to execute efficient OM works for hydraulic facilities which are turn over from CRDAs, and the AICs carry out the following activities to accomplish this purpose:

- Operational works and maintenance works for hydraulic facilities
- Administrative works for OM works

In general, one oasis is managed by one AIC, but some oases have plural AICs. As of October 1995, there are 153 oases in the Study area, in which 146 oases have AICs of 169 in total as shown in table below . Only seven oases in Tozuer, three(3) traditional oases using natural springs and four(4) new oases where the terminal facilitices are under consolidation , have not established AICs. The reason of non-establishment of AIC is that in case of the former oases, close cordination on water utilization among the water users is not always necessary due to the easiness of OM works for natural springs. However, in case of the later oases, the farmers aimes to establish AIC organization after the completion of consolidation works. Thus Most of farmers who have farm land in the oases recognize the role of AIC and join to AICs activities. Therefore, it seems that the AICs have borne the role as a managemental organization for OM works of hydraulic facilities.

	Irrigation area (ha)	No. of AIC	Member	Land holding (ha/cap.)	Executive	Worker
Gafsa	3,467	8	6,105	0.6	64	36
Tozeur	5,622	44	7,356	0.8	253	50
Kebili	7,213	69	30,464	0.2	369	220
Gabes	7,133	48	17,777	0.4	204	176
Total	23,435	169	61,702	0.4	890	482

The member of AIC consist of farmer, the executives are elected among the member in every two years. The composition consist one chairman, one treasurer and four counselors. As a operational staff for irrigation facilities, one AIC employed one or two pump operator(s) and a few valve keepers.

The AIC holds periodical meeting for approve of settlement of accounting of AIC in this year and decision of new budget based on OM plan. As a daily routine works, the AICs execute various service such as acceptance of water request and water charge from member, and instruction of water delivery to operational staffs.
On the maintenace works, although small repairing works execute by AICs themselves, the periodical inspection works of pumping station are carried out in form of AICs consignment works to private companies under CRDAs supervision.
More detail information is given in Attachment G.6.

G.5.2 Present water management

Water management of irrigation water is carried out by AICs and the water distribution is made based on the irrigation schedule decided by AIC with the assistance of PI of CRDA. The actual allocation of irrigation water is executed by pump operators and valve keepers who are previously instructed by AIC office. Operation time for the water delivery is about 20 hours which starts 23 and ends 19 in the next day. The actual water management at water sources facilities, water conveyance and delivery facilities, and terminal facilities are described in below:

(1) Water management at water sources facilities
Although three(3) kinds water sources, deep tube-well, shallow well and artesian well are used in the Study area. Most of oases relied on deep tube-wells and have pumping stations. The operation of pumping stations are made by pump operators, and the pumping water amount, pump operation time and operation condition are recorded in daily report. Though those pumping stations are properly operated, flow measurement meters at some stations shall be facilitated

Water cooling facilities are set up at water source sites in case of high groundwater temperature. They are operated and maintained by CRDAs and the temperature is controlled so as to be cool in less than 45°C.

(2) Water management at water conveyance and delivery facilities

Pipeline system with closed type is predominate as a water conveyance and delivery facilities, and ones of semi-closed type with a lifted tank also can be seen in the Study area. Reservoir with storage capacity for discharge control are facilitated only for irrigation net works with big dimension operated by CRDA ,and ones of AIC have not such reservoirs. The monitoring and control of diverting water in the systems are executed by using flow-meters and preseted valves.

(3) Water management at terminal facilities

The control of diversion water at terminal facilities is made by the adjustment of operation duration of valves of hydrants at terminal facilities which is previously decided in accordance with the acreage of service area of the hydrants. The valve operations are executed by valve keepers. The farmer to be received the derivation service of irrigation water are previously informed about the date of irrigation from AICs and are waiting for the arrival of irrigation water at their field. However, the timely arrival of scheduled water at the field located at lowest part of field ditches is rarely achieved, and delay of irrigation schedule can be seen in many oases. One of the reason is that most of field ditches (quaternary canal) in terminal facilities constructed by sandy soil with high permeability. Therefore, the water flow is very low than planned ones, another reason is that size of basin for water receiving is too big to irrigate on time.

G.5.3 Present strategy for water saving

As a methodology for water saving, three(3) plans are taken up as stated below:

1) Water saving by consolidating quarternary canal in quartier,
2) Water saving by introducing newly developed irrigation methods, and
3) Water saving through the improvement of water management technology.

The consolidation projects for the improvement of quarternary canal with credit oriented to farmer have been promoted by the Government since 1992. In the Study area, the following various consolidation methods of quarternary canal can be observed:

a) Canalization by cast-in place concrete canal (at Draa Sud in Tozeur),
b) Canalization by asbestos concrete canal(at Atilet in Kebili),
c) Canalization by vinyl chloride pipes(at Ibn Chabat in Tozeur) and
d) Canalization by perforated pipes in green house(at El Hammer in Gabes).

Nevertheless, the progress of above projects implementation is very low. For instance, Programme Regional de Developpement(PRD) and Fond Special de Develop Agricole (FOSDA) are implemented in Kebili. However, the achievement since the beginning of the projects is only about 400 ha out of the total 7,200 ha. The main reason of the delay is the shortness of governments budget for these projects. Therefore, the government endures to accomodate the budget from international organizations.

Although basin irrigation is most predominated in the Study area, some farmers adopt drip irrigation for cropping of vegetables and fruits and also for water saving. However, the number of farmers who adopt a drip irrigation is limited because of the high initial cost of facilities construction

As to the improvement of water management techniques, Arrondisment des Perimetres Irrique(PI), CTV-CRA and Cell AIC under CRDA have responsibility on irrigation planning, extension work for agriculture and promotion of activities of AIC in administrative matters, respectively. However, lack of manpower and transportation means prevent close contact with the field.

G.5.4 Operation and maintenance cost and water charge

(1) Present share of OM cost

The OM cost of system facilities is borne mainly by AIC and CRDA. The unit OM costs depend on each local condition and range from 168 DT to 327 DT per hector per year. The present share of AIC is about 70 percent of the whole cost as shown in Table B.5.2. AICs bears 125 to 232 DT per hector.

(2) Content of OM cost

OM cost of AIC mainly consist of personal expenses , electric charge and repairing cost of small spare-part. Among the items of costs, electric charge and personal expenses take high share of 62 % and 20 %, respectively.

(3) Water charge

The AICs collect association fee including above OM cost and administrative fee. However total association fees, AICs annual budget, are not always balanced the OM cost required. The budgetary deficits are observed in 42 AICs among 169 AICs. These 42 AICs are classified in four groups by insufficient rate to required OM cost as shown in Table G.5.3. According to this table, 18 AICs have deficit of less than 15% of OM

cost, and 17 AICs have deficit of 100%. It is ruled that AICs return the negative balances in six(6) months, and if they cannot return, the Governorates which have right of approve of their budgets compensate the balances instead of them. However, since some part of OM cost must be borne by beneficiary, it will be necessary to raise water charge for the future. The average OM cost is about 160 DT per hector, while net extra benefit can be expected at 900 DT in minimum per hector excluding annual repayment for construction cost (see 9.5 Financial Evaluation in Main Text) . Therefore, the raise of water charge will be feasible.

There is four(4) kinds collection unit for water charge, per unit area per annual, per unit hour per annual, per unit hour and per unit quantity of water. In order to promote of water utilization in saving manner to farmers, CRDAs have recommended to AICs to change collection unit to per unit quantity of water by giving concept which irrigation water is also one of economic materials.

The time of collection of water charge is different by governorate. The collections in Gafsa and Kebili governorates are ruled to carry out before water receiving , and in Tozuer and Gabes in year end after receiving water. Although the achievement rate of collection is 100% naturally in former case, the rate in latter case is more than 80 %. Thus, the member of AICs recognize the necessity to pay water charge. It seems that the progress of consolidation projects for terminal farm promotes the higher achievement of the collection rate.

G.5.5 Reasons of high OM cost

It is said that OM cost for irrigation facilities is rapidly rising up because of the following reasons:

1) Frequent repairing of water source facilities
Recently, water user is obliged to use groundwater in much deeper aquifer that has high temperature and salinity contamination. And the water quality affects to the facilities life.

2) High cost of cooling facilities
The temperature of lifted-up water from CI reaches to 70 ^{o}C and the water must be cooled by 40 ^{o}C. The water cooling cost is very high compared with the available amount of water.

3) High cost of pumping operation
Sixty-two percent of AIC OM cost is occupied by electric charge. The reason is high pumping lift due to lowering of groundwater level.

4) Unsoundness of canal systems
Dissolved calcium cation is sedimented in pipeline of irrigation system as water temperature is decreases, and the scale and sedimented material badly affect the system.

5) No consolidation of terminal irrigation facilities
Diversion water amounts at hydrant are not stable because of no flow-meter, and the terminal irrigation facilities such us parcel ditches and basins are not consolidated. Accordingly, effective water supply to each parcel does not realize since much water loss takes place in the quatier.

6) Over irrigation at upper stream of parcel ditches
Water users have the tendency of over irrigation because the users is charged to purchase of water by the unit of ha/year.

G.5.6 Problem of high OM costs

The major water sources are lifted-up water by electric motor pumps with high cost. It is a heavy burden to pay water charge for farmers who engage in arbor culture with farm land of 0.4 ha. Some farmers can irrigate only a part of their own farmland corresponding to 30 to 40 percent of their holding land due to high water charge and limitation of developed water resources. Accordingly, it is necessary to use lifted-up water effectively, and careful consideration is given to the improvement of parcel ditch in quatier.

In and around the oasis, strong wind hazard takes place frequently and drainage canal are buried by desert sand. Accordingly, it became serious problem to maintain drains of open channel. The poor maintenance causes salt accumulation.
More detailed information is tabled in Attachment G.7.

G.5.7 Recommendation for water saving

Water saving is most effective method to supply irrigation water to each parcel in equally. The following counter measure shall be pursued :

- Installation of water-meter at each hydrant,
- Promotion for consolidation of field ditches and basins,
- Change payment unit of water charge to water amount base
- Enhancement of farmers training program on water saving and water management by CRDA, and
- Provision of government project budget for consolidation

G.6 Water management and operation and maintenance plans

G.6.1 Water management plan

The water management at terminal facilities is made by the operation of valves at hydrant. However, proper allocation in accordance with irrigation schedule is not achieved. Through the consolidation of terminal facilities, it is necessary to be established new water management method in considering following items:

1) Improvement of irrigation interval
Each crop can be irrigated by an appropriate interval since initial water-losses decrease through the improvement of terminal facilities. The following irrigation interval shall be adopted :

Olive	: 11 to 17 days
Date	: 8 to 14 days
Fruits	: 8 to 12 days
Annual crops	: 4 to 7 days

2) Equality distribution of irrigation water
By the observance of time schedule of irrigation, equality distribution of irrigation water to every field plots covered by a hydrant shall be pursued.

3) Restriction of pump operation time
Although proposed irrigation efficiencies are not always satisfiable, the pump operation time shall be restrained in present operation time due to decrease tendency in remaining water resources amount.

4) Appropriate diversion of irrigation water
In order to realize a stable diversion of irrigation water at each hydrant, it is recommedable to install a flow-meter at each hydrant.

5) Rationalization of field plot size
The size of basin shall be miniaturized and leveled for the purpose of improvement of water distribution efficiency.

G.6.2 Operation and maintenance plan

The water management and OM works have been carried out by cooperation of CRDAs and AICs. Since the both authorities have enough function to execute above roles, it does not seem to be necessary to establish another organization for OM worksto project facilities, and it is recommended to enhance the function and cooperation works of both outhrities as follows:

(1) Enhancement of cooperation in planning of annual irrigation plan
Annual irrigation plan shall be made up on the basic information such as an available lift-up water amount of water facility and cropping plan. Since CRDA maintains water facilities and AIC maintains irrigation channel, the cooperation of both authorities is indispensable especially in decision of irrigation schedule. In light of this, much cooperation between CRDA and AIC must be persuade.

(2) Enhancement of farmers irrigation and water saving technology
CRDA shall offer necessary training and information on irrigation technics and water saving technology for AICs staff and farmers by using pamphlets and audio equipments. The content to be trained shall be follow:

- Daily inspection method of tube-well and pumping station, and recording and reporting method of operating condition
- Daily inspection method of pipeline and the valves
- Daily inspection method of quaternary canal
- Irrigation method by rotational irrigation
- Water management method at water source facilities site, pipeline system and terminal facilities.
- Appropriate size of basin and necessity of the leveling works

The rationalization of basins size and the leveling shall be executed by farmer themselves.

(3) Adaptation of water-selling system by water amount
Presently the collection unit and time of water charge are different by AIC. However, the unit shall be change to water-selling system by water amount from a view point of water economy. It become possible to deliver irrigation water properly to each basin by the implementation of consolidation project. Therefore, the unit of water charge changes to one by water amount and the collection time must be before water supply. Thus, the

enhancement of AICs financial foundation contributes better OM works.

(4) Promotion of AICs federation

In order to execute an effective cooperation works for OM works of hydraulic facilities, among AICs and between AIC and CRDA, AICs federation in district-wide shall be promoted. Although the realization of AIC federation will require long time, if it realise, matual coordination among AICs on OM works will become possible. The purposes of AICs federation are as follow:

- Extraction and consultation of problems on OM works in district-wide, and the planning of implementation program
- Efficient consultation between AICs and CRDAs

(5) Enhancement of PI staff and the motorization

In order to enhancement of farmers technology on irrigation and water saving, to promote new water-selling system and AICs federation , the staff, materials and equipment of "Arrondissment des Perimetres Irrigue" (PI) shall be increased. The required number of staff will be decided in consideration of the irrigation area, number of district and sub-division of CRDA.

G.6.3 Proposed staffs , equipment and materials

In accordance with enhancement plan of staff and motorization, The following PIs staff and equipments(4-wheel-drive and motor -bicycle) for transportation of these staff to field of oases shall be increased. The required number of vehicle is examined considering no vehicle is available for water saving unit in PI.

The required numbers are shown below:

	Gafsa	Tozeur	Kebili	Gabes	Total
Irrigation area (ha)	3,467	5,622	7,213	7,133	23,435
District	5	5	5	7	22
Sub-division	5	2	3	4	14
1. Staff					
Engineer	1	1	1	1	5
Technician	1(1)	3	4(1)	5	13(2
Driver	2	3	5	5	15
Total	4(1)	7	10(1)	11	32(2)
2. Vehicle					
Vehicle	2	2	3	5	15

Note: the figures in parentheses are number of present staff of water saving unit in PI

G.7 Proposed Annual OM Cost

In accordance with concepts described in Chapter G.6, the OM costs for 153 oases are estimated by 800,000 DT as shown in Table G.7.1.1.(See Attachment G.8 in detail). The ratio of OM cost to construction cost is about 1.4%. Total cost consist of OM cost of proposed facilities, personnel expenses of increased member of PI and cost of vehicle and their operation cost. About 72 % of cost is share of OM cost for facilities.

G.8 Proposed OM Plan

The objects for OM works are concrete open canal and pipe line for irrigation, and under drain in parcel and open earth drain as collector for field drain in quatier. AIC shall execute the OM works by AICs OM work-unit. The OM works are monthly inspection and maintenance works for above facilities. The OM works shall be executed in monthly bases with periodical consultation from the water saving unit of PI. In addition, the unconsolidated downstream stretch of quaternary canal shall be cared by the water user.

Table G.2.1 Irrigation method and attainment ratio of capacity of irrigation system

Gorvernorate	Service area of secteur (ha)	Service area of hydrant (ha)	System Cap. of secteur (l/sec)	Duration of application (hr/ha)	Irrigation interval Range (days)	Irrigation interval Average (days)	System Operation Time (hrs/day)	*)Designed maximum net water requirement at parcel (mm/day)	**)Estimated maximum net water requirement at parcel (mm/day)	Attainment ratio of present irrigation facilities (%)
								(1)	(2)	(3)=(1)/(2)
Gafsa	52	8.8	30	2.8	5-14	***)13/7	20	2.3	7.9	29
Tozeur	28	3.5	31	3.8	5-11	7	20	3.1	8.6	37
Kebili	31	3.1	21	10.0	15-60	21	20	2.6	8.8	30
Gabes	44	2.4	22	7.0	10-40	16	21	2.0	6.4	31

(note)

*) Irrigation efficiency is evaluated by oases sample survey

**) Esimated values by JICA

***) tree/vegetable

Table G.2.2 Utilization ratio of irrigation system

Govenorate	Number of sectuer (nos)	System capacity of secte (lit./se	System operation time (hrs/day)	Maximum cap. of irrigation facilities at hydrant ('000 m3/year	Actually consumed water volume at pump station ('000 m3/year)	Utilization ratio of irrigation facilities (%)
				(1)	(2)	(3)=(2)/(1)
Gafsa	67	30	20	52,586	28,376	54
Tozeur	204	31	20	148,613	89,529	60
Kebili	235	21	20	130,842	113,279	87
Gabes	164	22	21	99,388	66,193	67

Table G.2.3 Summary of results and implications of interview with farmers

	Water shortage	Poor drainage	Lack of mainte-nance machine	Lack of spair part	Lack of ope'nal staff	Problem of plant desease	Salt hazard	Problem of hot water	High cost of pump operation	Problem of budgetary deficit	Necessisty of const. of flume canal	Others
1.Gafsa												
CRDA	-	-	-	○	○	-	-	-	-	-	○	
Oued Shili	○	○	-	-	-	○	-	-	○	○	○	lack of portable water
Kasba	○	○	○	-	○	-	-	-	○	-	-	lack of vehicle for operational staff
2.Tozeur												
CRDA	○	○	-	-	○	-	-	○	-	-	○	
Draa Sud	○	○	-	-	-	-	○	-	-	-	-	
Oasis de Tozeur	-	○	○	-	-	○	-	-	○	-	○	dengerous night work lack of farm raod
3.Kebili												
CRDA	-	-	-	-	-	-	-	-	○	-	○	
Atilet/Jemna	○	○	-	-	-	○	○	-	○	-	○	
Mansoura	○	-	○	-	-	○	-	○	○	-	○	lack of farm raod
4.Gabes												
CRDA	○	-	○	○	○	-	-	-	-	-	○	
Limoaua	○	-	○	-	-	○	-	-	○	-	○	
Gabes	○	-	○	○	-	-	○	-	○	-	○	
Total	9	6	6	3	4	5	3	2	8	1	10	

Table G.5.1 Responsibility and share of the OM works

	Operation		Maintenance		
	CRDA	AIC	CRDA	AIC	Governorate
1.Irrigation					
1) Gafsa					
- Raguba Irri. System	O	-	O	-	-
- Others	-	O	O	-	-
2) Tozeur	O	△	O	△	-
3) Kebili					
- Well	O	-	O	-	-
- Pumping Sta.	△	O	O	△	-
- Canal system	-	O	O	△	-
4) Gabes	-	O	O	△	-
2.Drainage					
1) Gafsa					
- Principal	O	-	O	-	-
- Secondary	O	-	O	-	-
- Tertiary	-	O	-	O	-
2) Tozeur					
- Principal	O	-	O	-	△
- Secondary	O	-	O	-	-
- Tertiary	O	-	O	-	-
3) Kebili					
- Principal	O	-	O	-	△
- Secondary	-	O	-	O	-
- Tertiary	-	O	-	O	-
4) Gabes					
- Principal	O	-	O	-	△
- Secondary	-	O	-	O	-
- Tertiary	-	O	-	O	-

legend:

O: main executer

△: sub executer

Table G.5.2 Present OM cost by Govenorate

	Gafsa	Tozeur	Kebili	Gabes	Average
1.Total OM cost					
1.1 Unit cost (TD/ha)	202	327	228	168	231
1.2 Sharing rate of OM cost (%)					
- AIC	67	71	67	75	70
- CRDA	33	29	33	25	30
2. OM cost of AIC					
2.1 Unit cost (TD/ha)	135	232	151	125	161
2.2 Distribution of OM cost (%)					
- Personnel charges	12	4	28	36	20
- Electric charges	47	82	67	50	62
- Water charge by CDRA	37	0	0	0	9
- Repairing cost	4	14	4	10	8
- Others	0	0	1	4	1
Total	100	100	100	100	100

Table G.5.3 AICs financial condition by Governorate

Gorvernorate	Num.of Oasis (Nos) (1)	Num.of AIC (Nos) (2)	*) Average OM cost of AIC (DT/ha/year)	Num.of Oasis without AIC (Nos) (3)	Num.of AIC with baguetary deficit (Nos) (4)	No.of oasis with badgetary deficit: Insufficiency rate to OM cost L.T.15% (nos)	15-50% (nos)	50-100% (nos)	100% (nos)	Total (nos)
Gafsa	8	8	135	0	6	1	1	0	1	3
Tozeur	30	44	232	7	18	3	2	1	12	18
Kebili	67	69	151	0	19	11	2	1	4	18
Gabes	48	48	125	0	3	3	0	0	0	3
Total	153	169	(Ave. 161)	7	46	18	5	2	17	42

Note)
*) These value does not include OM cost of CRDA

Table G.7.1 Planned OM cost for proposed facilities

OM cost('000 DT)	Gafsa	Tozeur	Kebili	Gabes
(1) Construction Cost	7,306.0	17,194.0	23,754.0	23,993.0
(2) OM Cost				
A) OM cost for facilities	58.4	137.6	190.0	191.9
B) OM cost for Staff	16.8	30.8	36.6	40.8
C) OM cost for equipment and material	12.3	20.6	30.9	30.9
Total	87.6	189.0	257.5	263.6
(3) OM cost/ Construction cost (%)	1.2	1.1	1.1	1.1

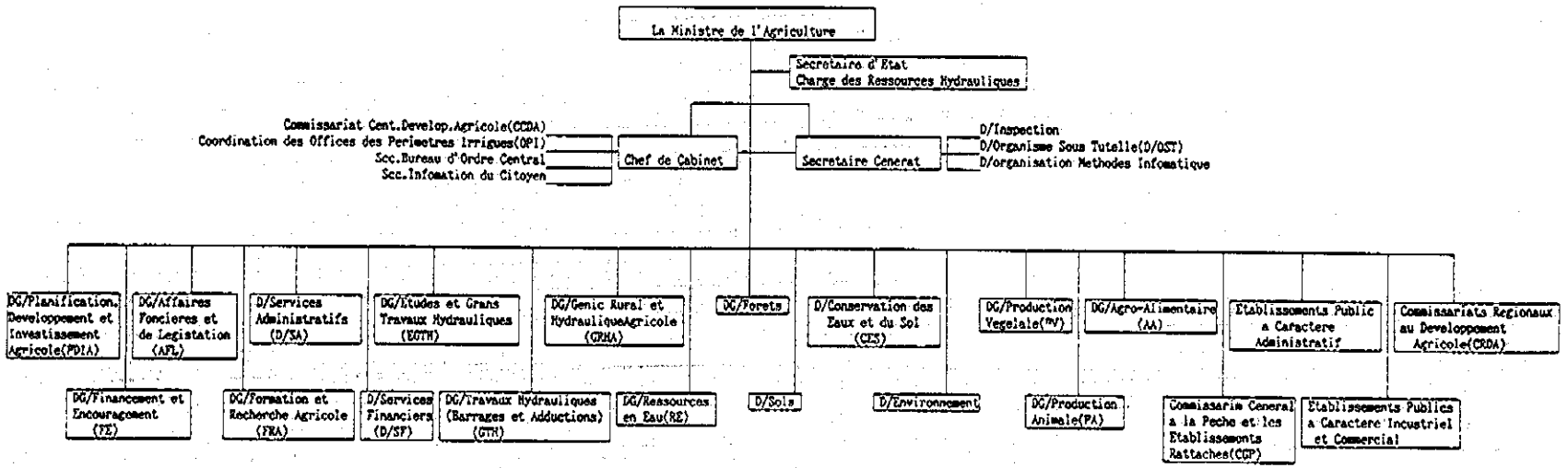
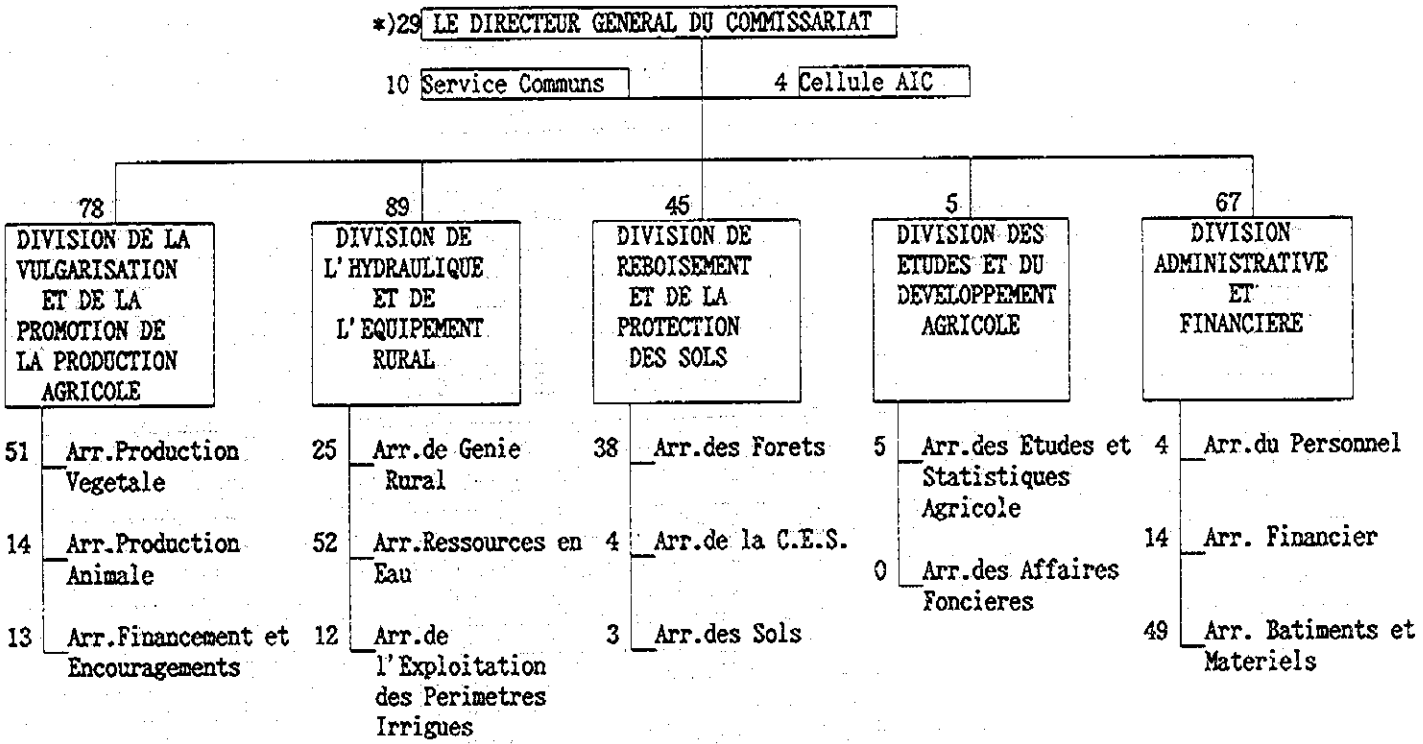


Figure G.5.1 Organization of Ministry of Agriculture



Notice)
*) Number of Staff

Decret n'89 - 834 du 29 Juin 1989
CRDA : Commissariat Regional au Developpement Agricole

Figure G.5.2 Organization of CRDA Kebili

Attachment G.1

Irrigation method

Table G. A. 1 (1) Irrigation Method in Gafsa Gorvernorate

Code Num.	Name of Oasis	Irrigation area (ha)	Irrigated area in 1994 (ha)	Number of sectuer (nos)	Number of hydrant (nos)	System capacity of secteur (lit./sec)	Duration of application (hr:min./ha)	Irrigation interval (Tree/Vege.) (days)	Designed maximum gross water requirement at hydrant (mm/day)	System operation time (hrs/day)	Actually applied water depth in 1944 (mm/year)
GF-1	Kasba	698	673	14	68	30	5:20/2:40	14/7	4.1	20	1,045
GF-2	Sud Ouest	703	677	14	67	30	5:20/2:40	14/7	4.1	20	593
GF-3	El Guettar	450	434	7	36	33	1:58/2:56	14/7	4.5	20	760
GF-4	Lalla	700	674	14	74	30	5:20/2:40	14/7	4.1	20	1,772
GF-5	El Ksar	578	557	12	64	30	5:20/2:40	14/7	4.1	20	1,025
GF-6	Oued Shili	56	44	1	17	40	5:20/2:40	14/7	5.5	20	1,352
GF-7	Thelja	65	63	1	11	30	3:04/3:04	6/6	5.5	20	708
GF-8	Segdoud	217	172	4	55	20	3:25/3:25	10/5	4.9	20	1,070
	Total/Ave.	3,467	3,294	67	392	30	5:36/2:48	13/7	4.6	20	1,059

Average service area of sectuer 51.7 ha
Average service area of hydrant 8.8 ha
Average duration of application 5.6/2.8 hrs (tree)/(veg.)
Average Irrigation interval 14/7 days (tree)/(veg.)
Average acctually irrigated water depth 2.9 mm/day

Table G. A. 1 (2) Irrigation Method in Tozeur Gorvernorate

Code Num.	Name of Oasis	Irrigation area (ha)	Irrigated area in 1994 (ha)	Number of sectuer (nos)	Number of hydrant (nos)	System capacity of secteur (lit./sec)	Duration of Application (hr:min./ha)	Irrigation interval (days)	Maximum designed water consump. (mm/day)	System operation time (hrs/day)	Actually applied water depth in 1993 (mm/year)
TZ- 1	Tozeur	(929)	(929)	(26)	368						
	(Abbes)	285	285	8	-	30	3:50	7	5.9	20	2,314
	(Hafir)	85	85	2	-	37	3:20	7	6.3	20	1,638
	(Rabbat)	274	274	8	-	25	5:00	7	6.4	20	2,123
	(Wassat)	285	285	8	-	30	not fix	7	-	20	1,494
TZ- 2	Kastilia	50	50	3	11	35	4:00	7	7.2	20	5,266
TZ- 3	Oued El Koucha	62	62	1	-	54	2:00	7	5.6	20	2,060
TZ- 4	Neflayette	72	72	2	15	30	6:40	6	12.0	20	2,360
TZ- 5	Chemsa	90	90	4	37	26	4:27	5	8.3	20	2,380
TZ- 6	Helba Est	75	75	1	14	55	2:00	7	5.7	20	2,068
TZ- 7	Helba Ouest	50	50	1	16	55	2:30	7	7.1	20	3,108
TZ- 8	Jhim 1	40	40	1	7	40	3:13	7	6.6	20	2,285
TZ- 9	Jhim 2	167	167	2	52	30	1:56	7	3.0	20	560
TZ-10	Ibn Chabbat 3	325	325	12	90	30	2:30	5	5.4	20	1,615
TZ-11	Nefta	(852)	(852)	(58)	229	-	-	-	-	-	-
	(Remada)	342	342	21	-	25	3:00	6	4.5	20	964
	(Beni Ali)	210	210	14	-	25	3:00	7	3.9	20	1,422
	(Fatnassa)	300	300	23	-	25	3:00	6	4.5	20	1,431
TZ-12	Ghardgaya	40	40	2	13	40	6:00	5	17.3	20	2,333
TZ-13	Ibn Chabbat 1	240	240	12	60	25	2:30	5	4.5	20	1,617
TZ-14	Ibn Chabbat 2	272	272	15	88	25	2:30	5	4.5	20	1,618
TZ-15	Draa Sid	198	198	10	50	20	2:30	5	3.6	20	1,131
TZ-16	Hazoua 1	72	72	3	30	27	8:00	8	9.7	20	1,328
TZ-17	Hazoua 2	48	48	2	34	19	7:00	7	6.8	20	2,381
TZ-18	Hazoua 3	(238)	(238)	5	84	22				-	-
	Hazoua (2et3 eme)	66	66	-	-	22	4:00	7	5.1	20	2,084
	Hazoua (4 eme)	54	54	-	-	22	5:00	7	5.7	20	1,592
	Hazoua (5 eme)	64	64	-	-	26	4:00	7	5.1	20	1,367
	Hazoua (6 eme)	54	54	-	-	27	5:00	7	6.7	20	1,508
TZ-19	Oued Loghrissi	78	78	3	78	23	5:00	7	5.9	20	1,214
TZ-20	Tazrarit	48	48	2	26	38	3:30	7	6.8	20	2,023
TZ-21	Cedada	55	55	1	-	45	3:15	8	6.6	20	1,089
TZ-22	Dghoumes	104	104	3	32	25	3:30	7	4.5	20	1,436
TZ-23	Degache	(822)	(822)	-	172	-	-	-	-	-	-
	(El Hanachi)	56	56	1	-	32	3:15	8	4.7	20	1,516
	(Ouled Hmida)	57	57	2	-	45	3:15	10	5.3	20	1,474
	(Sidi Addallah)	90	90	2	-	32	3:15	11	3.4	20	1,349
	(Ain Rebeh)	89	89	2	-	37	3:15	8	5.4	20	1,618
	(Ouled Majed)	324	324	7	-	32	3:15	8	4.7	20	1,343
	(Zaouit El Arab)	42	42	1	-	32	3:15	8	4.7	20	1,752
	(El Mahassen)	164	164	3	-	32	3:15	11	3.4	20	1,323
TZ-24	Chabbou	90	90	2	30	27	3:20	7	4.6	20	2,670
TZ-25	El Hamma	400	400	13	88	30	4:00	12	3.6	20	1,708
TZ-26	Tamerza	80	80	Water resource is spring water and no irrigation plan						-	2,938
TZ-27	Chebika	23	23	Water resource is spring water and no irrigation plan						-	1,917
TZ-28	Foum El Khanga	48	48	Water resource is spring water and no irrigation plan						-	1,344
TZ-29	Mides	29	29	2	-	22	4:20	11	3.1	20	2,252
TZ-30	Ain El Karma	25	25	Water resource is shallow well and no irrigation plan						-	896
	Total 10	5,622	5,622	204	1,624	31	3.8	7	6	20	1,691

Average service area of sectuer 27.6 ha
Average service area of hydrant 3.5 ha
Average duration of application 3.8 hrs
Average Irrigation interval 7 days
Average acctually irrigated water depth 4.6 mm/day

Table G. A. 1 (3) Irrigation Method in Kebili Governorate

Code Num.	Name of Oasis	Irrigation area (ha)	Irrigated area in 1994 (ha)	Number of sectuer (nos)	Number of hydrant (nos)	System capacity of sectuer (lit./sec)	Duration of Application (hr:min./h)	Irrigation interval (days)	Maximum designed water consump. (mm/day)	System operation time (hrs/day)	Actually applied Water depth in 1944 (mm/year)
KB- 1	Bechri	162	135	5	63	21	12	20	4.5	20	2,040
KB- 2	Bouabdallah	270	270	8	88	21	12	45	2.0	20	1,244
KB- 3	Fatnassa	205	205	6	22	15	12	60	1.1	20	1,206
KB- 4	El Gliaa	94	94	3	9	25	12	19	5.7	20	1,443
KB- 5	Menchia	140	140	4	20	22	12	20	4.8	20	1,873
KB- 6	Nagga	181	118	6	27	20	12	15	5.8	20	1,217
KB- 7	Oum Somaa	162	-	5	73	21	12	25	3.6	20	-
	O.Somaa Nord	-	90	-	-	-	-	-	-	-	1,210
	O.Somaa Sud	-	133	-	-	-	-	-	-	-	830
KB- 8	Oued Zira	176	170	5	36	22	12	20	4.8	20	1,243
KB- 9	Ouled Touati	62	62	3	13	25	12	15	7.2	20	1,463
KB-10	Tenchig	54	54	3	11	15	12	15	4.3	24	1,296
KB-11	Zaouiet El Anes	125	135	3	25	20	12	25	3.5	24	864
KB-12	Zaouiet El Harth	81	85	3	41	20	12	25	3.5	20	1,570
KB-13	Ziret Louhichi	86	86	3	20	22	12	20	4.8	20	1,371
KB-14	Chouchet Nagga	26	26	1	4	25	10	15	6.0	20	1,396
KB-15	Guataya	150	150	5	21	20	12	20	4.3	24	1,960
KB-16	Jedida	133	230	4	43	18	12	45	1.7	20	1,437
KB-17	Mansoura	86	-	4	35	18	12	45	1.7	20	-
KB-18	Nabta	162	162	5	48	20	10	20	3.6	20	369
KB-19	Telmine	240	240	6	80	21	8	17	3.6	20	1,218
KB-20	Tembib	118	118	4	48	22	8	19	3.3	20	597
KB-21	Tombar	127	127	4	63	25	8	20	3.6	20	1,759
KB-22	Limagues	57	80	2	18	25	8	25	2.9	20	1,573
KB-23	Mazraa Neji	66	59	2	22	26	8	15	5.0	20	2,021
KB-24	Oum El Farth 1 et 2	(55)	-	2	36	27	8	15	5.2	20	-
	Oum El Farth 1	40	40	-	-	-	-	-	-	-	2,809
	Oum El Farth 2	15	15	-	-	-	-	-	-	-	3,059
KB-25	Stiftini	82	72	3	19	25	8	20	3.6	20	2,998
KB-26	Saidane	30	30	1	8	25	8	20	3.6	24	2,685
KB-27	Barghouthia	52	55	2	12	25	10	19	4.7	20	1,320
KB-28	Bazma	146	146	4	78	25	10	20	4.5	20	1,626
KB-29	S'chelli	135	125	4	55	22	10	19	4.2	20	1,016
KB-30	Blidette	75	75	3	25	15	10	30	1.8	24	3,323
KB-31	Zarcine	70	80	3	30	15	10	30	1.8	24	2,916
KB-32	Jemna	112	112	4	37	25	10	15	6.0	20	981
KB-33	Ktouria	81	90	3	29	20	10	20	3.6	20	1,728
KB-34	Msaid	95	95	3	39	25	10	17	5.3	20	1,337
KB-35	Rahmat	85	85	3	37	22	10	20	4.0	20	1,725
KB-36	Ras El Ain	268	268	8	62	25	10	20	4.5	20	2,037
KB-37	Souk El Baiez	65	65	2	20	27	12	20	5.8	20	1,848
KB-38	Ben Zitoun 1et2	147	170	5	61	21	12	17	5.3	24	1,387
KB-39	Bourzine	94	94	3	35	22	12	20	4.8	20	1,158
KB-40	Guellada	103	100	3	44	25	12	20	5.4	24	1,679
KB-41	Kelwamen	47	47	2	12	15	12	19	3.4	20	1,158
KB-42	Klibia	92	94	3	30	22	12	20	4.8	24	2,647
KB-43	Sidi Hamed	100	100	3	20	27	10	19	5.1	20	998
KB-44	Atilet	220	222	4	74	26	8	15	5.0	20	1,503
KB-45	Doz	280	280	8	30	26	10	19	4.9	20	1,663
KB-46	El Ghoula	75	75	2	33	27	10	20	4.9	20	1,451
KB-47	El Golaa	65	67	2	31	27	10	19	5.1	20	1,219
KB-48	Grad	111	110	3	25	25	10	20	4.5	20	1,485
KB-49	El H'say	90	90	3	30	26	10	21	4.5	20	714
KB-50	Nouiel	97	97	3	30	22	10	19	4.2	24	1,897
KB-51	Zaafrane	101	101	3	25	27	10	17	5.7	24	2,464
KB-52	Bouhamza	80	80	3	25	26	10	17	5.5	20	2,100
KB-53	Ksar Ghilane	100	100	4	34	22	12	19	5.0	24	2,955
KB-54	Sakkouma	80	80	3	34	26	12	17	6.6	20	2,268
KB-55	Tarfaya	77	80	3	19	25	12	19	5.7	20	1,270
KB-56	Dhomrana	45	45	2	40	18	12	20	3.9	20	1,413
KB-57	Saida	64	74	2	28	27	12	15	7.8	24	1,471
KB-58	Ghidma	80	85	3	24	22	12	19	5.0	24	744
KB-59	Sabria	60	60	2	22	26	12	19	5.9	20	1,983
KB-60	El Faouar 1	87	87	3	18	15	12	30	2.2	24	612
KB-61	El Faouar 2	80	80	3	40	20	12	20	4.3	24	1,843
KB-62	Bechni	100	100	4	25	25	12	19	5.7	24	1,654
KB-63	Dargine	72	72	3	20	20	12	19	4.5	24	893
KB-64	Matrouha	100	104	4	48	15	12	30	2.2	24	1,802
KB-65	Regim Maatoug 1	104	104	4	100	20	12	19	4.5	24	1,753
KB-66	Regim Maatoug 2	96	100	4	48	18	12	20	3.9	24	2,216
KB-67	Tarfayet Elma	52	52	2	8	25	12	17	6.4	20	1,396
-	Total	7,213	7,272	235	2,330	21	10	20	4.2	20	1,629

Average service area of sectuer 30.7 ha
Average service area of hydrant 3.1 ha
Average duration of application 20.2 hrs
Average Irrigation interval 7 days
Average acctually irrigated water depth 4.5 mm/day

Table G. A. 1 (4) Irrigation Method in Gabes Governorate

Code Num.	Oasis(AIC)	Irrigation area (ha)	Irrigated area in 1994 (ha)	Number of secteur (nos)	Number of hydrant (nos)	System capacity of secteur (lit./sec)	Duration of Application (hr:min./ha)	Irrigation interval (days)	Maximum designed water consump. (mm/day)	System operation time (hrs/day)	Actually applied water depth in 1994 (mm/year)
GB- 1	Ain Zrig	140	110	3	39	18	10	15	4.3	24	605
GB- 2	Tenoula 1	40	40	1	20	17	5	17	1.8	20	335
GB- 3	Tenoula 2	20	20	1	8	11	5	15	1.3	20	1,310
GB- 4	Zrig Dakhlania	30	30	1	13	24	8	12	5.8	20	867
GB- 5	Teboulbou	520	520	7	143	22	4	18	1.8	22	1,048
GB- 6	Oasis de Gabes	734	730	16	157	25	10	23	3.9	22	1,155
GB- 7	Limaoua 1 et 2	148	143	4	65	26	5	17	2.8	20	927
GB- 8	M'dou	40	40	1	23	37	5	14	4.8	20	1,168
GB- 9	Chott El Ferik	31	27	1	14	18	8	12	4.3	20	1,044
GB-10	Bouchamma	143	140	4	91	20	10	18	4.0	20	991
GB-11	Mahjoub	374	374	8	86	27	6	13	4.5	20	848
GB-12	Salem	99	99	2	23	36	6	13	6.0	20	934
GB-13	Sboui	72	72	2	18	25	6	13	4.2	20	1,000
GB-14	Faycal	260	260	6	58	19	6	13	3.2	20	955
GB-15	M'zira Ghannou	280	270	6	92	22	6	13	3.7	20	690
GB-16	Methouia	268	210	6	116	25	11	17	5.8	20	795
GB-17	Ouedhref	263	210	6	119	26	10	17	5.5	20	978
GB-18	Aouinette	232	180	6	97	18	12	10	7.8	20	0
GB-19	Chenchou 1	57	55	1	21	27	5	17	2.9	20	1,458
GB-20	Chenchou 2	40	40	1	16	25	14	16	7.9	20	1,028
GB-21	Tekouri	32	30	1	13	16	12	32	2.2	20	1,047
GB-22	Hamma Oasis	400	350	12	80	18	10	24	2.7	20	771
GB-23	Mzira Hamma	80	75	2	38	16	14	38	2.1	20	971
GB-24	Bechima 1	280	270	6	275	15	15	30	2.7	20	321
GB-25	Bechima 2	290	260	6	268	15	15	40	2.0	24	1,116
GB-26	Khebayet	96	96	2	75	41	15	18	12.3	24	2,569
GB-27	Ben Ghilouf	180	180	5	143	14	8	14	2.9	24	1,574
GB-28	Glib Dokhane	70	70	2	49	23	12	12	8.3	24	2,557
GB-29	Oued Nekhla	30	20	2	14	18	4	10	2.6	20	1,380
GB-30	Arram	163	163	4	57	22	4	13	2.4	20	821
GB-31	Mareth 1	100	100	2	38	30	5	14	3.9	20	904
GB-32	Mareth 2	180	180	4	51	26	5	16	2.9	20	1,165
GB-33	Mareth 3	30	30	1	12	14	6	12	2.5	20	407
GB-34	Mareth 5	115	115	2	36	36	4	17	3.0	20	995
GB-35	Mareth 6	88	88	2	33	17	3	10	1.8	20	559
GB-36	Zeral 2	174	174	3	26	22	5	13	3.0	24	1,363
GB-37	Zerkine 1 et 3	116	116	3	51	20	5	17	2.1	20	1,189
GB-38	Zerkine 2	156	156	3	65	25	4	16	2.3	22	1,106
GB-39	Ayoune Zerkine	30	30	1	66	18	8	17	3.0	20	657
GB-40	Madssia	58	40	1	16	15	4	17	1.3	20	628
GB-41	Kettana 1	98	98	2	31	23	3	10	2.5	20	1,350
GB-42	Kettana 3	140	140	3	33	19	4	12	2.3	24	1,154
GB-43	Kettana 4	125	125	3	40	20	4	11	2.6	22	944
GB-44	Sidi Sellam	120	120	4	31	26	6	15	3.7	20	850
GB-45	Zrig Barrania	71	71	2	22	25	6	13	4.2	20	1,142
GB-46	Ghandri	30	30	1	16	20	6	12	3.6	20	573
GB-47	Laaradh 1	35	25	1	31	22	6	15	3.2	20	616
GB-48	Laaradh 3	55	30	1	96	28	6	20	3.0	20	787
-	Total	7,133	6,752	164	2,925	22	7	16	3.6	21	993 (2.7mm/day)

Average service area of secteur 43.5 ha
Average service area of hydrant 2.4 ha
Average duration of application 16.0 hrs
Average irrigation interval 7.0 days
Average acctually irrigated water depth 2.7 mm/day

Attachment G.2

Capacity of present irrigation system

Table G.A.2(1) Capacity of present irrigation system in Gafsa Gorvernorate

Code Num.	Name of Oasis	Actual capacity of present irrigation facilities: System capacity of secteur (lit./sec)	Duration of application (hr:min./ha) (Tree/Vege.)	Irriga. interval (days) (Tree/Vege.)	Supplied water at hydrant (mm/day)	Irriga. effi.: Quaternary canal	Irriga. effi.: Field applica.	Supplied net water at parcel (mm/day) (1)	JICA estimation: Crop. type	JICA estimation: Max. net water requir. at parcel (mm) (2)	Attainment ratio of present irri. facili. (%) (3)=(1)/(2)
GF- 1	Kasba	30	5:20/2:40	14/7	4.1	0.672	0.80	2.2	O-2	7.3	30
GF- 2	Sud Ouest	30	5:20/2:40	14/7	4.1	0.439	0.80	1.4	O-2	7.3	20
GF- 3	El Guettar	33	1:58/2:56	14/7	4.5	0.290	0.80	1.0	DF-2	8.1	13
GF- 4	Lalla	30	5:20/2:40	14/7	4.1	0.520	0.80	1.7	O-1	6.9	25
GF- 5	El Ksar	30	5:20/2:40	14/7	4.1	0.682	0.80	2.2	FD-2	7.7	29
GF- 6	Oued Shili	40	5:20/2:40	14/7	5.5	0.490	0.85	2.3	D-1	8.8	26
GF- 7	Thelja	30	3:04/3:04	6/6	5.5	0.678	0.85	3.2	D-1	8.8	36
GF- 8	Segdoud	20	3:25/3:25	10/5	4.9	0.650	0.85	2.7	D-4	8.5	32
	Total/Ave.	30	5:36/2:48	13/7	4.6	0.553	0.82	2.1	-	7.9	27

Table G.2(2) Capacity of present irrigation system in Tozeur Gorvernorate

Code Num.	Name of Oasis	Actual capacity of present irrigation facilities: System capacity of secteur (lit./sec)	Duration of Application (hr :min./ha)	Irriga. interval (days)	Supplied water at hydrant (mm/day)	Irriga. effi.: Quaternary canal	Irriga. effi.: Field applica.	Supplied net water at parcel (mm/day) (1)	JICA esimation: Crop. type	JICA esimation: Max. net water requir. at parcel (mm/day) (2)	Attainment ratio of present irri.facili. (%) (3)=(1)/(2)
TZ- 1	Tozeur										
	(Abbes)	30	3:50	7	5.9	0.616	0.80	2.9	D-1	9.6	30
	(Hafir)	37	3:20	7	6.3	0.614	0.80	3.1	D-1	9.6	32
	(Rabbat)	25	5:00	7	6.4	0.680	0.80	3.5	D-1	9.6	36
	(Wassat)	30	not fix	7	-	0.660	0.80	-	D-1	9.6	-
TZ- 2	Kastilia	35	4:00	7	7.2	0.730	0.80	4.2	DF-2	8.8	48
TZ- 3	Oued El Kouc	54	2:00	7	5.6	0.524	0.80	2.3	D-1	9.6	24
TZ- 4	Neflayette	30	6:40	6	12.0	0.710	0.80	6.8	D-2	7.5	91
TZ- 5	Chemsa	26	4:27	5	8.3	0.480	0.80	3.2	D-2	7.5	43
TZ- 6	Helba Est	55	2:00	7	5.7	0.670	0.80	3.0	D-2	7.5	41
TZ- 7	Helba Ouest	55	2:30	7	7.1	0.920	0.80	5.2	DF-1	8.8	59
TZ- 8	Jhim 1	40	3:13	7	6.6	0.542	0.85	3.0	DF-2	8.8	35
TZ- 9	Jhim 2	30	1:56	7	3.0	0.614	0.80	1.5	DF-1	8.8	17
TZ-10	Ibn Chabbat	30	2:30	5	5.4	0.920	0.85	4.2	DF-1	8.8	48
TZ-11	Nefta										
	(Remada)	25	3:00	6	4.5	0.542	0.80	2.0	D-1	9.6	20
	(Beni Ali)	25	3:00	7	3.9	0.542	0.80	1.7	D-1	9.6	17
	(Fatnassa)	25	3:00	6	4.5	0.542	0.80	2.0	D-1	9.6	20
TZ-12	Ghardgaya	40	6:00	5	17.3	0.614	0.80	8.5	DF-2	8.8	96
TZ-13	Ibn Chabbat	25	2:30	5	4.5	0.920	0.85	3.5	DF-1	8.8	40
TZ-14	Ibn Chabbat	25	2:30	5	4.5	0.920	0.85	3.5	DF-1	8.8	40
TZ-15	Draa Sud	20	2:30	5	3.6	0.832	0.85	2.5	DF-1	8.8	29
TZ-16	Hazoua 1	27	8:00	8	9.7	0.598	0.80	4.7	DF-1	8.8	53
TZ-17	Hazoua 2	19	7:00	7	6.8	0.678	0.85	3.9	DF-1	8.8	45
TZ-18	Hazoua 3										
	Hazoua (2et3	22	4:00	7	5.1	0.678	0.85	2.9	DF-1	8.8	33
	Hazoua (4 et	22	5:00	7	5.7	0.678	0.85	3.3	DF-1	8.8	37
	Hazoua (5 et	26	4:00	7	5.1	0.678	0.85	2.9	DF-1	8.8	33
	Hazoua (6 et	27	5:00	7	6.7	0.678	0.85	3.9	DF-1	8.8	44
TZ-19	Oued Loghris	23	5:00	7	5.9	0.650	0.80	3.1	DF-1	8.8	35
TZ-20	Tarrarit	38	3:30	7	6.8	0.650	0.80	3.6	DF-1	8.8	40
TZ-21	Cedada	45	3:15	8	6.6	0.587	0.80	3.1	D-4	9.3	33
TZ-22	Dghoumes	25	3:30	7	4.5	0.650	0.80	2.3	DF-1	8.8	27
TZ-23	Degache										
	(El Manachi)	32	3:15	8	4.7	0.533	0.80	2.0	D-2	7.5	27
	(Ouled Hmida	45	3:15	10	5.3	0.533	0.80	2.2	D-2	7.5	30
	(Sidi Addall	32	3:15	11	3.4	0.533	0.80	1.5	D-2	7.5	19
	(Ain Rebeh)	37	3:15	8	5.4	0.533	0.80	2.3	D-2	7.5	31
	(Ouled Majed	32	3:15	8	4.7	0.533	0.80	2.0	D-2	7.5	27
	(Zaouit El A	32	3:15	8	4.7	0.533	0.80	2.0	D-2	7.5	27
	(El Mahassen	32	3:15	11	3.4	0.533	0.80	1.5	D-2	7.5	19
TZ-24	Chakmou	27	3:20	7	4.6	0.578	0.85	2.3	D-2	7.5	30
TZ-25	El Hamma	30	4:00	12	3.6	0.542	0.85	1.7	D-1	9.6	17
TZ-26	Tamerza	-	-	-	-	-	(0.85)	-	D-1	-	-
TZ-27	Chebika	-	-	-	-	-	(0.85)	-	D-2	-	-
TZ-28	Foum El Khan	-	-	-	-	-	(0.85)	-	D-2	-	-
TZ-29	Midès	22	4:20	11	3.1	0.798	0.85	2.1	D-2	7.5	28
TZ-30	Ain El Karma	-	-	-	-	-	(0.80)	-	D-2	-	-
	Ave.	31	3:48	7	5.8	0.644	0.816	3.1	-	8.6	36

Table G.A.2(3) Capacity of present irrigation system in Kebili Gorvernorate

Code Num.	Name of Oasis	Actual capacity of present irrigation facilities: System capacity of secteur (lit./sec)	Duration of Application (hr/ha)	Irriga. Interval (days)	Supplied water at hydrant (mm/day)	Irriga. effi. Quaternary canal	Irriga. effi. Field applica.	Supplied net water at parcel (mm/day) (1)	JICA estimation: Crop. type	Max.net water requir. at parcel (mm) (2)	Attainment ratio of present irri. facili. (%) (3)=(1)/(2)
KB- 1	Bechri	21	12	20	4.5	0.650	0.80	2.4	D-3	8.92	26
KB- 2	Bouabdallah	21	12	45	2.0	0.609	0.80	1.0	D-3	8.92	11
KB- 3	Fatnassa	15	12	60	1.1	0.714	0.80	0.6	D-3	8.92	7
KB- 4	El Gliaa	25	12	19	5.7	0.632	0.80	2.9	D-3	8.92	32
KB- 5	Menchia	22	12	20	4.8	0.533	0.80	2.0	D-3	8.92	23
KB- 6	Nagga	20	12	15	5.8	0.614	0.80	2.8	D-3	8.92	32
KB- 7	Oum Somaa	21	12	25	3.6	0.533	0.80	1.5	D-3	8.92	17
	O.Somaa Nord	-	-	-	-	-	-	-	-	-	-
	O.Somaa Sud	-	-	-	-	-	-	-	-	-	-
KB- 8	Oued Zira	22	12	20	4.8	0.506	0.80	1.9	D-3	8.92	22
KB- 9	Ouled Touati	25	12	15	7.2	0.398	0.80	2.3	D-3	8.92	26
KB-10	Tenchig	15	12	15	4.3	0.614	0.80	2.1	D-4	8.83	24
KB-11	Zaoulet El Anes	20	12	25	3.5	0.560	0.80	1.5	D-3	8.92	17
KB-12	Zaoulet El Harth	20	12	25	3.5	0.452	0.80	1.2	D-3	8.92	14
KB-13	Ziret Louhichi	22	12	20	4.8	0.650	0.80	2.5	D-3	8.92	28
KB-14	Chouchet Nagga	25	10	15	6.0	0.596	0.85	3.0	D-4	8.83	34
KB-15	Guataya	20	12	20	4.3	0.560	0.80	1.9	D-3	8.92	22
KB-16	Jedida	18	12	45	1.7	0.690	0.80	1.0	D-3	8.92	11
KB-17	Mansoura	16	12	45	1.7	0.452	0.80	0.6	D-3	8.92	7
KB-18	Rabta	20	10	20	3.6	0.636	0.80	1.8	D-3	8.92	21
KB-19	Telmine	21	8	17	3.6	0.614	0.80	1.7	D-4	8.83	20
KB-20	Tembib	22	8	19	3.3	0.690	0.80	1.8	D-4	8.83	21
KB-21	Tombar	25	8	20	3.6	0.578	0.80	1.7	D-4	8.83	19
KB-22	Limagues	25	8	25	2.9	0.632	0.80	1.5	D-3	8.92	16
KB-23	Mazraa Neji	26	8	15	5.0	0.710	0.80	2.8	D-3	8.92	32
KB-24	Oum El Farth										
	1 et 2	27	8	15	5.2	0.710	0.80	2.9	D-3	8.92	33
	Oum El Farth 1	-	-	-	-	-	-	-	-	-	-
	Oum El Farth 2	-	-	-	-	-	-	-	-	-	-
KB-25	Stiftimi	25	8	20	3.6	0.730	0.80	2.1	D-3	8.92	24
KB-26	Saidane	25	8	20	3.6	0.756	0.85	2.3	FD-2	8.01	29
KB-27	Barghouthia	25	10	19	4.7	0.614	0.80	2.3	D-3	8.92	26
KB-28	Bazma	25	10	20	4.5	0.710	0.80	2.6	DF-2	8.37	31
KB-29	B'chelli	22	10	19	4.2	0.614	0.80	2.0	D-3	8.92	23
KB-30	Blidette	15	10	30	1.8	0.614	0.80	0.9	D-4	8.83	10
KB-31	Zarcine	15	10	30	1.8	0.470	0.80	0.7	D-3	8.92	8
KB-32	Jemna	25	10	15	6.0	0.774	0.80	3.7	D-3	8.92	42
KB-33	Mtouria	20	10	20	3.6	0.560	0.80	1.6	D-3	8.92	18
KB-34	Msaid	25	10	17	5.3	0.560	0.80	2.4	DF-2	8.37	28
KB-35	Rahmat	22	10	20	4.0	0.670	0.80	2.1	DF-2	8.37	25
KB-36	Ras El Ain	25	10	20	4.5	0.650	0.80	2.3	D-3	8.92	26
KB-37	Souk El Baiez	27	12	20	5.8	0.660	0.80	3.1	DF-2	8.37	37
KB-38	Ben Zitoun let2	21	12	17	5.3	0.614	0.80	2.6	D-3	8.92	29
KB-39	Bourzine	22	12	20	4.8	0.730	0.80	2.8	D-4	8.83	31
KB-40	Gueliada	25	12	20	5.4	0.614	0.80	2.7	D-4	8.83	30
KB-41	Ketwemen	15	12	19	3.4	0.650	0.80	1.8	D-4	8.83	20
KB-42	Klibia	22	12	20	4.8	0.740	0.80	2.8	D-3	8.92	32
KB-43	Sidi Hamed	27	10	19	5.1	0.614	0.80	2.5	D-3	8.92	28
KB-44	Atilet	26	8	15	5.0	0.550	0.85	2.2	D-4	8.83	25
KB-45	Douz	26	10	19	4.9	0.614	0.80	2.4	D-4	8.83	27
KB-46	El Ghoula	27	10	20	4.9	0.935	0.80	3.6	DF-2	8.37	43
KB-47	El Golaa	27	10	19	5.1	0.935	0.80	3.8	D-4	8.83	43
KB-48	Grad	25	10	20	4.5	0.935	0.80	3.4	D-4	8.83	38
KB-49	El H'say	26	10	21	4.5	0.650	0.80	2.3	DF-2	8.37	28
KB-50	Nouiel	22	10	19	4.2	0.560	0.80	1.9	DF-2	8.37	22
KB-51	Zaafrane	27	10	17	5.7	0.834	0.80	3.8	D-4	8.83	43
KB-52	Bouhamza	26	10	17	5.5	0.650	0.80	2.9	D-4	8.83	32
KB-53	Ksar Ghilane	22	12	19	5.0	0.650	0.80	2.6	D-1	9.10	29
KB-54	Saikouma	26	12	17	6.6	0.935	0.80	4.9	DF-2	8.37	59
KB-55	Tarfaya	25	12	19	5.7	0.935	0.80	4.3	DF-2	8.37	51
KB-56	Dhomrana	18	12	20	3.9	0.784	0.85	2.6	D-4	8.83	29
KB-57	Smida	27	12	15	7.8	0.667	0.85	4.4	DF-2	8.37	53
KB-58	Ghidma	22	12	19	5.0	0.851	0.80	3.4	D-3	8.92	38
KB-59	Sabria	26	12	19	5.9	0.632	0.80	3.0	D-3	8.92	34
KB-60	El Faouar 1	15	12	30	2.2	0.722	0.85	1.3	D-3	8.92	15
KB-61	El Faouar 2	20	12	20	4.3	0.690	0.85	2.5	D-3	8.92	28
KB-62	Bechni	25	12	19	5.7	0.671	0.85	3.2	D-3	8.92	36
KB-63	Dargine	20	12	19	4.5	0.920	0.85	3.6	D-3	8.92	40
KB-64	Matrouha	15	12	30	2.2	0.650	0.85	1.2	D-3	8.92	13
KB-65	Regim Maatoug 1	20	12	19	4.5	0.766	0.85	3.0	D-3	8.92	33
KB-66	Regim Maatoug 2	18	12	20	3.9	0.742	0.85	2.5	D-4	8.83	28
KB-67	Tarfayet Elma	25	12	17	6.4	0.689	0.85	3.7	D-4	8.83	42
-	Ave.	22	11	21	4.4	0.666	0.81	2.4	-	8.80	27

Table G.A.2(4) Capacity of present irrigation system in Gabes Gorvernorate

Code Num.	Oasis(AIC)	Actual capacity of present irrigation facilities							JICA estimation		Attainment ratio of present irri.facili. (%)
		System capacity of secteur (lit./sec)	Duration of Appli-cation (hr/ha)	Irriga. interval (days)	Supplied water at hydrant (mm/day)	Irriga. effi. Quater-nary canal	Field applica.	Supplied net water at parcel (mm/day)	Crop. type	Max. net water requir. at parcel (mm/day)	
								(1)		(2)	(3)=(1)/(2)
GB- 1	Ain Zrig	18	10	15	4.3	0.650	0.80	2.2	FD-2	6.60	34
GB- 2	Temoula 1	17	5	17	1.8	0.720	0.80	1.0	F-2	6.08	17
GB- 3	Temoula 2	11	5	15	1.3	0.710	0.80	0.7	F-2	6.08	12
GB- 4	Zrig Dakhlania	24	8	12	5.8	0.670	0.80	3.1	FD-2	6.60	47
GB- 5	Teboulbou	22	4	18	1.8	0.528	0.80	0.7	FD-2	6.60	11
GB- 6	Oasis de Gabes	25	10	23	3.9	0.578	0.80	1.8	FD-2	6.60	27
GB- 7	Limaoua 1 et 2	26	5	17	2.8	0.527	0.85	1.2	F-2	6.08	20
GB- 8	M'dou	37	5	14	4.8	0.614	0.80	2.3	F-2	6.08	38
GB- 9	Chott El Ferik	18	8	12	4.3	0.650	0.80	2.2	A	6.75	33
GB-10	Bouchamma	20	10	18	4.0	0.632	0.80	2.0	DF-2	6.90	29
GB-11	Mahjoub	27	6	13	4.5	0.594	0.80	2.1	A	6.75	32
GB-12	Salem	36	6	13	6.0	0.605	0.80	2.9	FD-2	6.60	44
GB-13	Sboui	25	6	13	4.2	0.670	0.80	2.2	FD-2	6.60	34
GB-14	Paycal	19	6	13	3.2	0.634	0.80	1.6	A	6.75	24
GB-15	M'ziraa Ghannouch	22	6	13	3.7	0.674	0.80	2.0	A	6.75	29
GB-16	Methouta	25	11	17	5.8	0.628	0.80	2.9	DF-2	6.90	42
GB-17	Ouedhref	26	10	17	5.5	0.506	0.80	2.2	DF-2	6.90	32
GB-18	Aouinette	18	12	10	7.8	0.641	0.80	4.0	O-2	5.92	67
GB-19	Chenchou 1	27	5	17	2.9	0.560	0.80	1.3	A	6.75	19
GB-20	Chenchou 2	25	14	16	7.9	0.667	0.85	4.5	A	6.75	66
GB-21	Tekouri	16	12	32	2.2	0.599	0.80	1.0	FD-2	6.60	16
GB-22	Hamma Oasis	18	10	24	2.7	0.614	0.80	1.3	D-3	7.35	18
GB-23	Mziraa Hamma	16	14	38	2.1	0.660	0.80	1.1	FD-2	6.60	17
GB-24	Bechima 1	15	15	30	2.7	0.690	0.80	1.5	DF-2	6.90	22
GB-25	Bechima 2	15	15	40	2.0	0.560	0.80	0.9	FD-2	6.60	14
GB-26	Khebayet	41	15	18	12.3	0.720	0.80	7.1	FD-2	6.60	107
GB-27	Ben Ghilouf	14	8	14	2.9	0.774	0.80	1.8	FD-2	6.60	27
GB-28	Glib Dolhane	23	12	12	8.3	0.680	0.80	4.5	FD-2	6.60	68
GB-29	Oued Nekhla	18	4	10	2.6	0.690	0.80	1.4	DF-2	6.90	21
GB-30	Arram	22	4	13	2.4	0.680	0.80	1.3	FD-2	6.60	20
GB-31	Mareth 1	30	5	14	3.9	0.614	0.80	1.9	F-2	6.08	31
GB-32	Mareth 2	26	5	16	2.9	0.560	0.80	1.3	F-2	6.08	22
GB-33	Mareth 3	14	6	12	2.5	0.750	0.80	1.5	FD-2	6.60	23
GB-34	Mareth 5	36	4	17	3.0	0.407	0.80	1.0	F-2	6.08	16
GB-35	Mareth 6	17	3	10	1.8	0.560	0.80	0.8	F-2	6.08	14
GB-36	Zarat 2	22	5	13	3.0	0.650	0.80	1.6	F-2	6.08	26
GB-37	Zerkine 1 et 3	20	5	17	2.1	0.700	0.80	1.2	F-2	6.08	20
GB-38	Zerkine 2	25	4	16	2.3	0.596	0.80	1.1	F-2	6.08	18
GB-39	Ayoune Zerkine	18	8	17	3.0	0.596	0.80	1.5	F-2	6.08	24
GB-40	Madssia	15	4	17	1.3	0.935	0.80	1.0	F-2	6.08	16
GB-41	Kettana 1	23	3	10	2.5	0.416	0.80	0.8	F-1	6.08	14
GB-42	Kettana 3	19	4	12	2.3	0.614	0.80	1.1	F-1	6.08	18
GB-43	Kettana 4	20	4	11	2.6	0.497	0.80	1.0	F-1	6.08	17
GB-44	Sidi Sellam	26	6	15	3.7	0.690	0.80	2.1	F-1	6.08	34
GB-45	Zrig Barrania	25	6	13	4.2	0.632	0.80	2.1	O-2	5.92	35
GB-46	Ghandri	20	6	12	3.6	0.650	0.80	1.9	F-1	6.08	31
GB-47	Laaradh 1	22	6	15	3.2	0.650	0.80	1.6	F-1	6.08	27
GB-48	Laaradh 3	28	6	20	3.0	0.750	0.80	1.8	F-1	6.08	30
-	Ave.	22	7	16	3.7	0.633	0.80	1.9	-	6.42	29

Attachment G.3

Utilization ratio of irrigation system

Table G.A.3(1) Utilization ratio of irrigation system in Gafsa Governorate

Code Num.	Name of Oasis	Number of secteur (nos)	System capacity of secteur (lit./sec)	System operation time (hrs/day)	Maximum cap. of irrigation facilities at hydrant ('000 m3/year) (1)	Actually consumed water volume at pump station ('000 m3/year) (2)	Utilization ratio irrigation facilities (%) (3)=(2)/(1)
GF- 1	Kasba	14	30	20	11,038	5,685	52
GF- 2	Sud Ouest	14	30	20	11,038	4,016	36
GF- 3	El Guettar	7	30	20	6,071	3,294	54
GF- 4	Lalla	14	30	20	11,038	7,784	71
GF- 5	El Ksar	12	30	20	9,461	4,712	50
GF- 6	Oued Shili	1	40	20	1,051	600	57
GF- 7	Thelja	1	30	20	788	444	56
GF- 8	Segdoud	4	20	20	2,102	1,841	88
	Total/Ave.	67	30	20	52,586	28,376	54

Table G.A.3(2) Utilization of irrigation system in Tozeur Governorate

Code Num.	Name of Oasis	Number of secteur (nos)	System capacity of secteur (lit./sec)	System operation time (hrs/day)	Maximum cap. of irrigation facilities at hydrant ('000m3/year) (1)	Actually Consumed Water Volume at pump station ('000m3/year) (2)	Utilization ratio of irrigation facilities (%) (3)=(2)/(1)
TZ- 1	Tozeur	(26)					
	(Abbes)	8	30	20	6,307	6,594	105
	(Hafir)	2	37	20	1,945	1,386	71
	(Rabbat)	8	25	20	5,256	5,816	111
	(Wassat)	8	30	20	6,307	4,230	67
TZ- 2	Kastilia	3	35	20	2,759	2,633	95
TZ- 3	Oued El Kouc	1	54	20	1,419	1,277	90
TZ- 4	Neflayette	2	30	20	1,577	1,699	108
TZ- 5	Chemsa	4	26	20	2,733	2,142	78
TZ- 6	Helba Est	1	55	20	1,445	1,551	107
TZ- 7	Helba Ouest	1	55	20	1,445	1,554	108
TZ- 8	Jhim 1	1	40	20	1,051	914	87
TZ- 9	Jhim 2	2	30	20	1,577	935	59
TZ-10	Ibn Chabbat	12	30	20	9,461	5,250	55
TZ-11	Nefta	(58)	-	-	-	-	-
	(Remada)	21	25	20	13,797	3,297	24
	(Beni Ali)	14	25	20	9,198	2,986	32
	(Fatnassa)	23	25	20	15,111	4,292	28
TZ-12	Ghardgaya	2	40	20	2,102	933	44
TZ-13	Ibn Chabbat	12	25	20	7,884	3,880	49
TZ-14	Ibn Chabbat	15	25	20	9,855	4,400	45
TZ-15	Draa Sud	10	20	20	5,256	2,240	43
TZ-16	Hazoua 1	3	27	20	2,129	956	45
TZ-17	Hazoua 2	2	19	20	999	1,143	114
TZ-18	Hazoua 3	(5)	22	-	-	-	-
	Hazoua (2et3	2	22	20	1,156	1,376	119
	Hazoua (4 et	1	22	20	578	860	149
	Hazoua (5 et	1	26	20	683	875	128
	Hazoua (6 et	1	27	20	710	815	115
TZ-19	Oued Loghris	3	23	20	1,813	947	52
TZ-20	Tazrarit	2	38	20	1,997	971	49
TZ-21	Cedada	1	45	20	1,183	599	51
TZ-22	Dghoumes	3	25	20	1,971	1,493	76
TZ-23	Degache	-	-	-	-	-	-
	(El Manachi)	1	32	20	841	849	101
	(Ouled Haida	2	45	20	2,365	840	36
	(Sidi Addali	2	32	20	1,682	1,214	72
	(Ain Rebeh)	2	37	20	1,945	1,440	74
	(Ouled Majed	7	32	20	5,887	4,350	74
	(Zaouit El A	1	32	20	841	736	88
	(El Mahasser	3	32	20	2,523	2,170	86
TZ-24	Chamou	2	27	20	1,419	2,403	169
TZ-25	El Hamma	13	30	20	10,249	6,831	67
TZ-26	Tamerza			-	-	(2350)	-
TZ-27	Chebika			-	-	(441)	-
TZ-28	Foum El Khanga			-	-	(645)	-
TZ-29	Midès	2	22	20	1,156	653	56
TZ-30	Ain El Karma			-	-	(224)	-
	Total	1,828	31	20	148,613	89,529	60

Table G.A.3(3) Utlization ratio of irrigation system in Kebili Governorate

Code Num.	Name of Oasis	Number of secteur (nos)	System capacity of secteur (lit./sec)	System operation time (hrs/day)	Maximum cap. of irrigation facilities ('000 m3/year) (1)	Actually consumed water volume at pump station ('000 m3/year) (2)	Utilization ratio of irrigation facilities (%) (3)=(2)/(1)
KB- 1	Bechri	5	21	20	2,759	2,755	100
KB- 2	Bouabdallah	8	21	20	4,415	3,359	76
KB- 3	Fatnassa	6	15	20	2,365	2,473	105
KB- 4	El Glaa	3	25	20	1,971	1,356	69
KB- 5	Menchia	4	22	20	2,313	2,622	113
KB- 6	Nagga	6	20	20	3,154	1,437	46
KB- 7	Oum Somaa	5	21	20	2,759	2,193	79
	O.Somaa Nord	-	-	-	-	(1,089)	-
	O.Somaa Sud	-	-	-	-	(1,104)	-
KB- 8	Oued Zira	5	22	20	2,891	2,113	73
KB- 9	Ouled Touati	3	25	20	1,971	907	46
KB-10	Tenchig	3	15	24	1,419	700	49
KB-11	Zaoulet El Anes	3	20	24	1,892	1,166	62
KB-12	Zaoulet El Harth	3	20	20	1,577	1,335	85
KB-13	Ziret Louhichi	3	22	20	1,734	1,179	68
KB-14	Chouchet Nagga	1	25	20	657	363	55
KB-15	Guataya	5	20	24	3,154	2,940	93
KB-16	Jedida	4	18	20	1,892	3,305	175
KB-17	Mansoura	4	18	20	1,892	-	-
KB-18	Rabta	5	20	20	2,628	598	23
KB-19	Telmine	6	21	20	3,311	2,922	88
KB-20	Tembib	4	22	20	2,313	705	30
KB-21	Tombar	4	25	20	2,628	2,234	85
KB-22	Limagues	2	25	20	1,314	1,259	96
KB-23	Mazraa Neji	2	26	20	1,367	1,192	87
KB-24	Oum El Farth I et 2	2	27	20	1,419	-	-
	Oum El Farth 1	-	-	-	-	1,124	-
	Oum El Farth 2	-	-	-	-	459	-
KB-25	Stiftimi	3	25	20	1,971	2,159	110
KB-26	Saidane	1	25	24	788	805	102
KB-27	Barghouthia	2	25	20	1,314	726	55
KB-28	Bazma	4	25	20	2,628	2,374	90
KB-29	B'chelli	4	22	20	2,313	1,270	55
KB-30	Blidette	3	15	24	1,419	2,492	176
KB-31	Zarcine	3	15	24	1,419	2,333	164
KB-32	Jemna	4	25	20	2,628	1,099	42
KB-33	Ktouria	3	20	20	1,577	1,555	99
KB-34	Msaid	3	25	20	1,971	1,270	64
KB-35	Rahmat	3	22	20	1,734	1,466	85
KB-36	Ras El Ain	8	25	20	5,256	5,460	104
KB-37	Souk El Baiez	2	27	20	1,419	1,201	85
KB-38	Ben Zitoun 1et2	5	21	24	3,311	2,359	71
KB-39	Bourzine	3	22	20	1,734	1,089	63
KB-40	Gualiada	3	25	24	2,365	1,679	71
KB-41	Kelwamen	2	15	20	788	544	69
KB-42	Klibia	3	22	24	2,081	2,488	120
KB-43	Sidi Hamed	3	27	20	2,129	998	47
KB-44	Atilet	4	26	20	2,733	3,337	122
KB-45	Doux	8	26	20	5,466	5,216	95
KB-46	El Ghoula	2	27	20	1,419	1,089	77
KB-47	El Golaa	2	27	20	1,419	816	58
KB-48	Grad	3	25	20	1,971	1,633	83
KB-49	El M'say	3	26	20	2,050	643	31
KB-50	Nouiel	3	22	24	2,081	1,840	88
KB-51	Zaafrane	3	27	24	2,554	2,488	97
KB-52	Bouhamza	3	26	20	2,050	1,680	82
KB-53	Ksar Ghilane	4	22	24	2,775	2,955	106
KB-54	Sakkouma	3	26	20	2,050	1,814	89
KB-55	Tarfaya	3	25	20	1,971	1,016	52
KB-56	Dhomrana	2	18	20	946	636	67
KB-57	Smida	2	27	24	1,703	1,089	64
KB-58	Ghidma	3	22	24	2,081	632	30
KB-59	Sabria	2	26	20	1,367	1,190	87
KB-60	El Faouar 1	3	15	24	1,419	532	38
KB-61	El Faouar 2	3	20	24	1,892	1,474	78
KB-62	Bechni	4	25	24	3,154	1,854	59
KB-63	Dargine	3	20	24	1,892	643	34
KB-64	Matrouha	4	15	24	1,892	1,874	99
KB-65	Regim Maatoug 1	4	20	24	2,523	1,823	72
KB-66	Regim Maatoug 2	4	18	24	2,271	2,216	98
KB-67	Tarfayet Elma	2	25	20	1,314	726	55
	Total	235	21	20	130,842	113,279	87

Table G.A.3(4) Utilization ratio of irrigation system in Gabes Governorate

Code Num.	Oasis(AIC)	Number of sectuer (nos)	System capacity of secteur (lit./sec)	System operation time (hrs/day)	Maximum cap. of irrigation facilities at hydrant ('000 m3/year) (1)	Actually consumed water volume at pump station ('000 m3/year) (2)	Utilization ratio irrigation facilities (%) (3)=(2)/(1)
GB- 1	Ain Zrig	3	18	24	1,703	665	39
GB- 2	Temoula 1	1	17	20	447	134	30
GB- 3	Temoula 2	1	11	20	289	262	91
GB- 4	Zrig Dakhlania	1	24	20	631	260	41
GB- 5	Teboulbou	7	22	22	4,452	5,447	122
GB- 6	Oasis de Gabes	16	25	22	11,563	8,434	73
GB- 7	Limaoua 1 et 2	4	26	20	2,733	1,325	48
GB- 8	M'dou	1	37	20	972	467	48
GB- 9	Chott El Ferik	1	18	20	473	282	60
GB-10	Bouchamma	4	20	20	2,102	1,388	66
GB-11	Mahjoub	8	27	20	5,676	3,172	56
GB-12	Safea	2	36	20	1,892	925	49
GB-13	Sboui	2	25	20	1,314	720	55
GB-14	Faycal	6	19	20	2,996	2,508	84
GB-15	M'zireaa Channou	6	22	20	3,469	1,862	54
GB-16	Methouia	6	25	20	3,942	1,669	42
GB-17	Ouedhref	6	26	20	4,100	2,054	50
GB-18	Aouinette	6	18	20	2,838	-	-
GB-19	Chenchou 1	1	27	20	710	802	113
GB-20	Chenchou 2	1	25	20	657	411	63
GB-21	Tekouri	1	16	20	420	314	75
GB-22	Hamma Oasis	12	18	20	5,676	2,697	48
GB-23	Mzireaa Hamma	2	16	20	841	728	87
GB-24	Bechima 1	6	15	20	2,365	866	37
GB-25	Bechima 2	6	15	24	2,838	2,901	102
GB-26	Khebayet	2	41	24	2,586	2,466	95
GB-27	Ben Ghilouf	5	14	24	2,208	2,833	128
GB-28	Glib Dokhane	2	23	24	1,451	1,790	123
GB-29	Oued Nekhla	2	18	20	946	276	29
GB-30	Arram	4	22	20	2,313	1,339	58
GB-31	Mareth 1	2	30	20	1,577	904	57
GB-32	Mareth 2	4	26	20	2,733	2,097	77
GB-33	Mareth 3	1	14	20	368	122	33
GB-34	Mareth 5	2	36	20	1,892	1,144	60
GB-35	Mareth 6	2	17	20	894	492	55
GB-36	Zarat 2	3	22	24	2,081	2,372	114
GB-37	Zerkine 1 et 3	3	20	20	1,577	1,379	87
GB-38	Zerkine 2	3	25	22	2,168	1,726	80
GB-39	Ayoune Zerkine	1	18	20	473	197	42
GB-40	Madssia	1	15	20	394	251	64
GB-41	Kettana 1	2	23	20	1,209	1,323	109
GB-42	Kettana 3	3	19	24	1,798	1,616	90
GB-43	Kettana 4	3	20	22	1,734	1,180	68
GB-44	Sidi Sellam	4	26	20	2,733	1,020	37
GB-45	Zrig Barrania	2	25	20	1,314	811	62
GB-46	Ghandri	1	20	20	526	172	33
GB-47	Laaradh 1	1	22	20	578	154	27
GB-48	Laaradh 3	1	28	20	736	236	32
-	Total	164	22	21	99,388	66,193	67

Attachment G.4

Present irrigation achievement

Table G.A.4(1) Present irrigation achievement in Gafsa Governorate

Code No.	Name of oasis (AIC)	Irrigated area in 1994 (ha)	Consumed water volume ('000m3)	Consumed water (mm/year)	Present water requirement: Cropping type	Present water requirement: Unit water requirement (mm)	Present water requirement: Irrigation efficiency	Present water requirement: Gross water requirement (mm)	Ratio of irrigation achivement (%)
GF- 1	Kasba	673	7,030	1,045	O-2	1,152	0.484	2,381	44
GF- 2	Sud Ouest	677	4,016	593	O-2	1,152	0.316	3,645	16
GF- 3	El Guettar	434	3,294	760	DF-2	1,270	0.209	6,077	13
GF- 4	Lalla	674	11,950	1,772	O-1	1,271	0.374	3,395	52
GF- 5	El Ksar	557	5,708	1,025	FD-2	1,145	0.491	2,334	44
GF- 6	Oued Shili	44	600	1,352	D-1	1,510	0.375	4,028	34
GF- 7	Thelja	63	444	708	D-1	1,510	0.519	2,909	24
GF- 8	Segdoud	172	1,841	1,070	D-4	1,422	0.497	2,861	37
	Total/Ave.	3,294	34,884	1,059	-	1,304	0.408	3,195	33

Table G.A.4(2) Present irrigation achievement in Tozeur Governorate

Code No.	Name of AIC	Irrigated area in 1994 (ha)	Consumed water volume (1,000m3)	Consumed water (mm/year)	Present water requirement: Cropping type	Present water requirement: Unit water requirement (mm)	Present water requirement: Irrigation efficency	Present water requirement: Gross water requirement (mm)	Ratio of irrigation achievement (%)
TZ- 1	Tozeur	(929)							
	Abbes	285	6,594	2,314	D-1	1,669	0.444	3,763	61
	Hafir	85	1,366	1,638	D-1	1,669	0.444	3,763	44
	Rabbat	274	5,816	2,123	D-1	1,669	0.444	3,763	56
	Wassat	285	4,230	1,484	D-1	1,669	0.444	3,763	39
TZ- 2	Kastilia	50	2,633	5,266	DF-2	1,416	0.442	3,204	164
TZ- 3	Oued El Koucha	62	1,277	2,060	D-1	1,669	0.490	3,409	60
TZ- 4	Neflayette	72	1,699	2,360	D-2	1,530	0.475	3,221	73
TZ- 5	Chemsa	90	2,142	2,380	D-2	1,530	0.526	2,909	82
TZ- 6	Helba Est	75	1,551	2,068	D-2	1,530	0.377	4,058	51
TZ- 7	Helba Ouest	50	1,554	3,108	DF-1	1,392	0.511	2,723	114
TZ- 8	Jhim 1	40	914	2,285	DF-2	1,416	0.346	4,092	56
TZ- 9	Jhim 2	167	935	560	DF-1	1,392	0.482	2,886	19
TZ- 10	Ibn Chabbat 3	325	5,250	1,615	DF-1	1,392	0.704	1,977	82
TZ- 11	Nefta	(852)							
	Remada	342	3,297	964	D-1	1,669	0.390	4,277	23
	Beni Ali	210	2,986	1,422	D-1	1,669	0.390	4,277	33
	Fatnassa	300	4,292	1,431	D-1	1,669	0.390	4,277	33
TZ- 12	Ghardgaya	40	933	2,333	DF-2	1,416	0.442	3,204	73
TZ- 13	Ibn Chabbat 1	240	3,880	1,617	DF-1	1,392	0.704	1,977	82
TZ- 14	Ibn Chabbat 2	272	4,400	1,618	DF-1	1,392	0.704	1,977	82
TZ- 15	Draa Sud	200	2,240	1,120	DF-1	1,392	0.636	2,187	51
TZ- 16	Hazoua 1	72	956	1,328	DF-1	1,392	0.431	3,230	41
TZ- 17	Hazoua 2	48	1,143	2,381	DF-1	1,392	0.519	2,682	89
TZ- 18	Hazoua 3	(238)							
	Hazoua (2 et 3	66	1,376	2,084	DF-1	1,392	0.519	2,682	78
	Hazoua (4 eme)	54	860	1,592	DF-1	1,392	0.519	2,682	59
	Hazoua (5 eme)	64	875	1,367	DF-1	1,392	0.519	2,682	51
	Hazoua (6 eme)	54	815	1,508	DF-1	1,392	0.519	2,682	56
TZ- 19	Oued Loghrissi	78	947	1,214	DF-1	1,392	0.468	2,974	41
TZ- 20	Tarrarit	48	971	2,023	DF-1	1,392	0.468	2,974	68
TZ- 21	Cedada	55	599	1,089	D-4	1,577	0.423	3,728	29
TZ- 22	Dghoumes	104	1,493	1,436	DF-1	1,392	0.468	2,974	48
TZ- 23	Degache	(822)							
	El Manachi	56	849	1,516	D-2	1,530	0.384	3,987	38
	Ouled Hmida	58	840	1,448	D-2	1,530	0.384	3,987	36
	Sidi Addallah	91	1,214	1,334	D-2	1,530	0.384	3,987	33
	Ain Rebeh	92	1,440	1,565	D-2	1,530	0.384	3,987	39
	Ouled Majed	362	4,350	1,202	D-2	1,530	0.384	3,987	30
	Zaouit El Arab	42	736	1,752	D-2	1,530	0.384	3,987	44
	El Mahassen	164	2,170	1,323	D-2	1,530	0.384	3,987	33
TZ- 24	Chaamou	90	2,403	2,670	D-2	1,530	0.416	3,678	73
TZ- 25	El Hamma	400	6,831	1,708	D-1	1,669	0.390	4,279	40
TZ- 26	Tamerza	80	2,350	2,938	D-1	1,669	0.575	2,903	101
TZ- 27	Chebika	23	441	1,917	D-2	1,530	0.575	2,661	72
TZ- 28	Foum El Khanga	48	645	1,344	D-2	1,530	0.575	2,661	51
TZ- 29	Midès	29	653	2,252	D-2	1,530	0.575	2,661	85
TZ- 30	Ain El Karma	25	224	896	D-2	1,530	0.575	2,661	34
	-	5,667	93,189	1,645	-	1,565	0.508	3,080	53

Table G.A.4(3) Present irrigation achievement in Kebili Governorate

Code No.	Name of AIC	Irrigation area (ha)	Irrigated area in 1994 (ha)	Consumed water volume (m3)	Consumed water (mm/year)	Present water requirement: Cropping type	Unit water requirement (mm)	Irrigation efficiency	Gross water requirement (mm)	Ratio of irrigation achivement (%)
KB- 1	Bechri	162	168	2,754,619	1,640	D-3	1,622	0.468	3,466	47
KB- 2	Bouabdallah	270	320	3,358,778	1,050	D-3	1,622	0.438	3,699	28
KB- 3	Fatnassa	205	248	2,472,689	997	D-3	1,622	0.514	3,155	32
KB- 4	El Gliaa	94	94	1,356,282	1,443	D-3	1,622	0.455	3,565	40
KB- 5	Menchia	140	155	2,622,240	1,692	D-3	1,622	0.384	4,227	40
KB- 6	Nagga	181	200	1,436,602	718	D-3	1,622	0.442	3,670	20
KB- 7	Oum Somaa	162	205	2,193,134	1,070	D-3	1,622	0.384	4,227	25
KB- 8	Oued Zira	176	196	2,113,193	1,078	D-3	1,622	0.364	4,452	24
KB- 9	Ouled Touati	62	62	907,200	1,463	D-3	1,622	0.287	5,660	26
KB- 10	Tenchig	54	65	699,840	1,077	D-4	1,578	0.442	3,570	30
KB- 11	Zaouiet El Anes	125	125	1,165,400	933	D-3	1,622	0.403	4,023	23
KB- 12	Zaouiet El Harth	81	81	1,334,880	1,648	D-3	1,622	0.325	4,984	33
KB- 13	Zireț Louhichi	86	86	1,179,360	1,371	D-3	1,622	0.468	3,466	40
KB- 14	Chouchet Nagga	26	28	362,850	1,296	D-4	1,578	0.456	3,461	37
KB- 15	Guataya	150	210	2,939,616	1,400	D-3	1,622	0.403	4,025	35
KB- 16	Jedida	219	219	3,304,800	1,509	D-3	1,622	0.497	3,264	46
KB- 17	Mansoura	(219)	(219)	(3,304,800)	(1,509)	(D-3)	(1,622)	0.325	(3,044)	(50)
KB- 18	Rabta	162	162	597,888	369	D-3	1,622	0.458	3,542	10
KB- 19	Telmine	240	240	2,922,048	1,218	D-4	1,578	0.442	3,570	34
KB- 20	Tembib	118	130	704,955	542	D-4	1,578	0.497	3,175	17
KB- 21	Tombar	127	127	2,234,304	1,759	D-4	1,578	0.416	3,793	46
KB- 22	Limagues	57	59	1,258,617	2,133	D-3	1,622	0.455	3,565	60
KB- 23	Mazraa Neji	66	70	1,192,320	1,703	D-3	1,622	0.511	3,174	54
KB- 24	Oum El Farth Ie12	55	65	1,582,539	2,435	D-3	1,622	0.518	3,131	78
KB- 25	Sliftimi	82	82	2,158,617	2,632	D-3	1,622	0.526	3,084	85
KB- 26	Saidane	30	34	805,427	2,369	FD-2	1,299	0.441	2,946	80
KB- 27	Barghouthia	52	52	725,760	1,396	D-3	1,622	0.442	3,670	38
KB- 28	Bazma	146	146	2,374,488	1,626	DF-2	1,428	0.511	2,793	58
KB- 29	B'chelli	135	135	1,270,080	941	D-3	1,622	0.442	3,670	26
KB- 30	Blidette	75	75	2,492,294	3,323	D-4	1,578	0.442	3,570	93
KB- 31	Zarcine	70	70	2,332,800	3,333	D-3	1,622	0.338	4,799	69
KB- 32	Jemna	112	112	1,099,224	981	D-3	1,622	0.557	2,911	34
KB- 33	Mtouria	81	81	1,555,200	1,920	D-3	1,622	0.403	4,025	48
KB- 34	Msaid	95	95	1,270,080	1,337	DF-2	1,428	0.403	3,543	38
KB- 35	Rahmat	85	85	1,465,906	1,725	DF-2	1,428	0.482	2,963	58
KB- 36	Ras El Ain	288	288	5,460,213	1,896	D-3	1,622	0.468	3,466	55
KB- 37	Souk El Baiez	65	65	1,201,039	1,848	DF-2	1,428	0.475	3,005	61
KB- 38	Ben Zitoun 1 et 2	147	167	2,358,690	1,412	D-3	1,622	0.442	3,670	38
KB- 39	Bourzine	94	98	1,088,610	1,111	D-4	1,578	0.526	3,000	37
KB- 40	Gueliada	103	103	1,678,740	1,630	D-4	1,578	0.442	3,570	46
KB- 41	Kelwamen	47	47	544,320	1,158	D-4	1,578	0.468	3,372	34
KB- 42	Klibia	92	92	2,488,320	2,705	D-3	1,622	0.533	3,043	89
KB- 43	Sidi Hamed	100	100	997,920	998	D-3	1,622	0.442	3,670	27
KB- 44	Atilet	220	220	3,337,432	1,517	D-4	1,578	0.405	3,896	39
KB- 45	Douz	280	280	5,216,148	1,863	D-4	1,578	0.442	3,570	52
KB- 46	El Ghoula	75	82	1,088,610	1,328	DF-2	1,428	0.673	2,122	63
KB- 47	El Golaa	65	65	816,480	1,256	D-4	1,578	0.673	2,345	54
KB- 48	Grad	111	116	1,632,960	1,408	D-4	1,578	0.673	2,345	60
KB- 49	El H'say	90	90	642,600	714	DF-2	1,428	0.468	3,051	23
KB- 50	Nouiel	97	97	1,840,320	1,897	DF-2	1,428	0.403	3,542	54
KB- 51	Zaafrane	101	101	2,488,320	2,464	D-4	1,578	0.600	2,628	94
KB- 52	Bouhamza	80	80	1,679,740	2,100	D-4	1,578	0.468	3,372	62
KB- 53	Ksar Ghilane	100	60	2,954,880	4,925	D-1	1,670	0.468	3,568	138
KB- 54	Sakkouma	80	75	1,814,400	2,419	DF-2	1,428	0.673	2,122	114
KB- 55	Tarfaya	77	72	1,016,064	1,411	DF-2	1,428	0.673	2,122	67
KB- 56	Dhomrana	45	45	635,640	1,413	D-4	1,578	0.600	2,631	54
KB- 57	Smida	64	64	1,088,610	1,701	DF-2	1,428	0.510	2,799	61
KB- 58	Ghidma	80	80	632,250	790	D-3	1,622	0.613	2,647	30
KB- 59	Sabria	60	52	1,189,734	2,288	D-3	1,622	0.455	3,565	64
KB- 60	El Faouar 1	87	60	532,181	887	D-3	1,622	0.520	3,119	28
KB- 61	El Faouar 2	80	58	1,474,286	2,542	D-3	1,622	0.497	3,264	78
KB- 62	Bechni	100	150	1,853,600	1,236	D-3	1,622	0.513	3,160	39
KB- 63	Dargine	72	70	642,600	918	D-3	1,622	0.704	2,304	40
KB- 64	Matrouha	100	40	1,874,362	4,686	D-3	1,622	0.468	3,466	135
KB- 65	Regim Maatoug 1	104	104	1,822,910	1,753	D-3	1,622	0.586	2,768	63
KB- 66	Regim Maatoug 2	96	96	2,216,160	2,309	D-4	1,578	0.568	2,780	83
KB- 67	Tarfayet Elea	52	52	725,760	1,396	D-4	1,578	0.527	2,994	47
	Total	7,213	7,451	91,125,793	1,223	-	1,576	0.482	3,268	37

Table G.A.4(4) Present irrigation achievement in Gabes Governorate

Code No.	Name of oasis (AIC)	Irrigation area (ha)	Irrigated area in 1994 (ha)	Consumed water volume (1,000m3)	Consumed water (mm/year)	Present water requirement: Cropping type	Unit water requirement (mm/year)	Irrigation efficiency	Gross water requirement (mm/year)	Ratio of irrigation achievement (%)
GB- 1	Ain Zrig	140	110	665	605	FD-2	921	0.468	1,968	31
GB- 2	Temoula 1	40	40	134	335	F-2	861	0.518	1,662	20
GB- 3	Temoula 2	20	20	262	1,310	F-2	861	0.511	1,685	78
GB- 4	Zrig Dakhlania	30	30	260	867	FD-2	921	0.482	1,911	45
GB- 5	Teboulbou	520	520	5,447	1,048	FD-2	921	0.380	2,423	43
GB- 6	Oasis de Gabes	734	730	8,434	1,155	FD-2	921	0.416	2,214	52
GB- 7	Limaoua 1 et 2	148	143	1,325	927	F-2	861	0.403	2,136	43
GB- 8	M'dou	40	40	467	1,168	F-2	861	0.442	1,948	60
GB- 9	Chott El Ferik	31	27	282	1,044	A	1,081	0.468	2,310	45
GB-10	Bouchamma	143	140	1,388	991	DF-2	1,031	0.455	2,266	44
GB-11	Mahjoub	374	374	3,172	848	A	1,081	0.428	2,528	34
GB-12	Salem	99	99	925	934	FD-2	921	0.436	2,114	44
GB-13	Sboui	72	72	720	1,000	FD-2	921	0.482	1,911	52
GB-14	Faycal	260	260	2,508	965	A	1,081	0.456	2,368	41
GB-15	M'zireaa Ghannou	280	270	1,862	690	A	1,081	0.485	2,229	31
GB-16	Methouia	268	210	1,669	795	DF-2	1,031	0.452	2,280	35
GB-17	Ouedhref	263	210	2,054	978	DF-2	1,031	0.364	2,830	35
GB-18	Aouinette	232	180	-	-	O-2	929	0.462	2,011	-
GB-19	Chenchou 1	57	55	802	1,458	A	1,081	0.403	2,682	54
GB-20	Chenchou 2	40	40	411	1,028	A	1,081	0.510	2,119	49
GB-21	Tekouri	32	30	314	1,047	FD-2	921	0.431	2,137	49
GB-22	Hamma Oasis	400	350	2,697	771	D-3	1,195	0.442	2,704	29
GB-23	Mzireaa Hamma	80	75	728	971	FD-2	921	0.475	1,938	50
GB-24	Bechima 1	280	270	866	321	DF-2	1,031	0.497	2,074	15
GB-25	Bechima 2	290	260	2,901	1,116	FD-2	921	0.403	2,285	49
GB-26	Khebayet	96	96	2,466	2,569	FD-2	921	0.518	1,777	145
GB-27	Ben Ghilouf	180	180	2,833	1,574	FD-2	921	0.557	1,653	95
GB-28	Glib Dokhane	70	70	1,790	2,557	FD-2	921	0.490	1,881	136
GB-29	Oued Nekhla	30	20	276	1,380	DF-2	1,031	0.497	2,074	67
GB-30	Arram	163	163	1,339	821	FD-2	921	0.490	1,881	44
GB-31	Mareth 1	100	100	904	904	F-2	861	0.442	1,948	46
GB-32	Mareth 2	180	180	2,097	1,165	F-2	861	0.403	2,136	55
GB-33	Mareth 3	30	30	122	407	FD-2	921	0.540	1,706	24
GB-34	Mareth 5	115	115	1,144	995	F-2	861	0.293	2,938	34
GB-35	Mareth 6	88	88	492	559	F-2	861	0.403	2,135	26
GB-36	Zarat 2	174	174	2,372	1,363	F-2	861	0.468	1,840	74
GB-37	Zerkine 1 et 3	116	116	1,379	1,189	F-2	861	0.504	1,708	70
GB-38	Zerkine 2	156	156	1,726	1,106	F-2	861	0.429	2,006	55
GB-39	Ayoune Zerkine	30	30	197	657	F-2	861	0.429	2,007	33
GB-40	Madssia	58	40	251	628	F-2	861	0.673	1,279	49
GB-41	Kettana 1	98	98	1,323	1,350	F-1	819	0.300	2,734	49
GB-42	Kettana 3	140	140	1,616	1,154	F-1	819	0.442	1,853	62
GB-43	Kettana 4	125	125	1,180	944	F-1	819	0.358	2,289	41
GB-44	Sidi Sellam	120	120	1,020	850	F-1	819	0.497	1,648	52
GB-45	Zrig Barrania	71	71	811	1,142	O-2	929	0.455	2,042	56
GB-46	Ghandri	30	30	172	573	F-1	819	0.468	1,750	33
GB-47	Laaradh 1	35	25	154	616	F-1	819	0.468	1,750	35
GB-48	Laaradh 3	55	30	236	787	F-1	819	0.540	1,517	52
	Total	7,133	6,752	66,193	980	-	927	0.457	2,029	48