Report F2.4: Finding of study in F2 describing current best practice farmers and their techniques

The Iraq Salinity Project is an initiative of Government of Iraq, Ministries of Agriculture, Water Resources, Higher Education, Environment, and Science and Technology, and an international research team led by ICARDA – the International Center for Agricultural Research in the Dry Areas, in partnership with the University of Western Australia, the Commonwealth Scientific and Industrial Research organization (CSIRO) of Australia, the International Water Management Institute (IWMI), Sri Lanka, and the International Center for Biosaline Agriculture (ICBA), Dubai, United Arab Emirates.

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This technical report series captures and documents the work in progress of the Iraq Salinity Project, in its seven research themes, working at the regional, farm and irrigation system scales. Technical reports feed into the *Iraq Salinity Assessment*, a synthesis and solutions to solving the problem: Situation Analysis (Report 1); Approaches and Solutions (Report 2) and Investment Options (Report 2).

Key words: *southern Iraq, central Iraq, spatial distribution, remote sensing, irrigation, salinity mapping.*

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Abstract

The objective of the present activity was to identify the best soil, agronomic, irrigation and drainage management practices for salinity management at the farm level. Based on the land quality classification, governorates with low to medium salinity (10-15 dS/m) were identified from which districts with the lowest land quality were chosen. Three sites were selected in central and southern Iraq to cover areas suffering from salinity to carry out the study: Dujaila in Wasit Governorate; Musayab in Babil Governorate and Abu-AlKhaseeb in Basrah Governorate. Thirteen outstanding farmers were selected at Dujaila, 17 at Musayab, and 15 at Abu-Alkhaseeb. The criteria for the selection of outstanding farmers was based on their records of marketed crops in addition to the field trips made by the staff to check the actual field situation including the best-bet salinity management techniques they practice. Results of the preliminary analysis indicate that outstanding farmers use a range of best-bet, these include practices such as leveling of land before planting, applying a heavy irrigation prior to planting (preseason leaching), post-harvest mixing of crop residues with soil, use of rotation, use of high tolerant crop to salinity for 2 to 3 seasons before cultivation of wheat, drain or deep ditch around the farmlands, and deep plowing to breakdown the hardpan below plow layer. Detailed analyses of these best-bet practices are needed to understand their cost-benefit ratios, scientific reasons for their effectiveness, and their long-term sustainability in managing salinity.

Introduction

The irrigated areas in central and southern Iraq (the Mesopotamian Plain) have a long history of development. These areas were the birthplace of civilization and have relied on the waters of the Tigris and Euphrates River systems for their ongoing viability. The area is very flat and lies at the downstream end of the large river basins that includes Turkey and Syria. There are also regional groundwater aquifers that flow towards the coast under the Plain and discharge over most of the lower Plain. As a consequence, shallow water-tables of varying salinities and depths underlie the area. Over the long history of irrigation, these shallow groundwater levels have risen closer to the surface and salinity has

been further exacerbated. It is believed that Iraq is losing thousand hectares per year of agricultural cropping land as a result of salinity.

The irrigated areas experience semi-arid climate with average annual rainfall below 250 mm and annual evaporation rates being extremely high, around 2000 mm per year (FAO, 1998). As a consequence the crop water requirement is also very high, approaching 4000 to 5000 m^3 per hectare. This is nearly 4-fold higher than annual rainfall, therefore necessitating intensive irrigation to sustain crop production.

Salinity problem in Iraq

Irrigation throughout the region occurs as long thin strips adjacent to the rivers that take advantage of the better soils and minimizes the transport of water. All irrigated areas are serviced by delivery infrastructure and all have some form of drainage. Previously, the drainage from irrigation was either returned to the river, or seeped into the regional groundwater system - in most cases eventually returning to the river over the long term. Today, the drainage infrastructure has fallen into disrepair, rendering the system ineffective and contributing extensively to the current salinity crisis.

Recently the demand for water in the Tigris and Euphrates Rivers basins has increased dramatically in Turkey and Syria. This has caused a reduction in flow at the downstream end of the basins, though the exact reduction varies from year-to-year. Greater water withdrawal and return of saline drainage water back into the rivers in upstream countries has reduced the quality of water that flows into the Iraq part of the basins. This apparent water scarcity and water quality deterioration, together with inefficient delivery and drainage systems combine to present the current problems of increasing salinization of irrigated fields and reduction in productivity. The deterioration of drainage infrastructure and lack of maintenance in the recent past has further compounded the situation. The recent events of climate change may have affected water availability and quality in the Tigris and Euphrates River basins, although data on climate change effects on the water balance in Iraq are not yet available to quantify the possible implications of the climate change. A promising project, started in 1994 was the Main Drain design to collect the outflows from the drains in the Lower Mesopotamian Plains and carry it to sea. When complete the diversion of drainage systems in the cultivated lands may have a positive effect on the problem of salinity in the Plain.

Salt management or salinity control is a critical component of irrigated agriculture in arid and semi-arid regions. Successful crop production cannot be sustained without maintaining an acceptable level of salts in the root zone.

The objectives of the present activity are to identify the best soil, agronomic, irrigation and drainage management practices for salinity management at farm level. This can be accomplished through farmer survey data collection and analysis to (a) help identifying the outstanding farmers in the selected sites, possibly in differing salinity affected areas, (b) determine what makes these farmers outstanding, in terms of soil, agronomic or irrigation techniques, (c) benchmark the outstanding farmers with surrounding farmers, and (d) determine what are the best practices used by the outstanding farmers that can be usefully promoted in other areas.

Organization of Report

Report 2.4 synthesizes the findings of reports F1.5 (on analysis of survey data), F1.6 (on results of survey data and secondary data collection), F2.1 (on identifying outstanding farmers), F2.2 (on what makes these farmers outstanding), and F2.3 (on what are the best bet practices outstanding farmers use that can usefully be promoted in other areas and communicated to other farmers).

Activity: F1.5: Analysis of Survey data

For survey data, the questionnaire prepared and adopted by the staff was sufficient to give a clear picture of the current status of farmers' fields and most agricultural activities. Also, the many visits accomplished by the staff enlarged our scope of understanding the real problems and constraints facing farmers in cultivation of saline lands. Three sites were selected in central and southern Iraq to cover areas suffering from salinity to carry out the abovementioned activities: Site 1: Dujaila, Wasit Governorate; Site 2: Musayab, Babil Governorate; and Site 3: Ab-AlKhaseeb, Basra Governorate (Fig. 1).

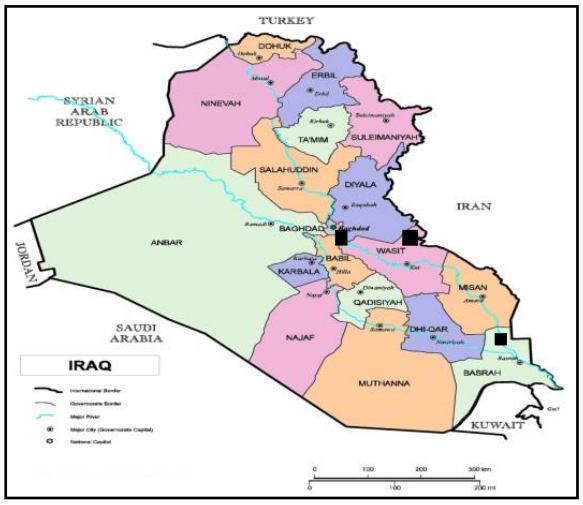

Figure 1. Location map of the investigated sites.

Site 1: Dujaila, Wasit Governorate

The 1st. field survey was on 15-3-2011 to Site 1 (Dujaila) (Fig. 2). We met the Director of Agriculture office and the man who is in charge of lands. Throughout that meeting,

Figure 2. First teamwork visit to Agricultural Office, Site 1, Dujaila.

we learnt a lot about soil nature, level of salinity, irrigation water, system of irrigation and drainage undertaken. Based on that, the lands of the area can be grouped under three categories:

A. Reclaimed Lands: Lands with field and collective drains: the distance between the field drains is 50 m. Most of these field drains are ineffective because of absence of any maintenance work since 1980.
B. Semi-Reclaimed Lands: Lands with only collective drains. These drains are ineffective because of growth of weeds and phragmites and the nonuniformity of bed which raises the levels of drainage waters in these drains.
C. Unreclaimed Lands: Lands with no field drains or open drains. Therefore, these lands are the most lands that suffer from salinity.

For the source of irrigation water, this sector (A) is the best one in receiving irrigation water, followed by Sector (B). However, Sector (C), it suffers from water

supply because there are no efficient programs for water conveying and distribution. Further, Sector (C) is located at downstream of the Irrigation Water Canal (Dujaila Project).

- Accordingly, our staff focused on Sector (C) (Figure 3) as the area of interest in which this sector is the most suffering from salinity and water supply.
- We examined records of this sector (Sector C) for selection the best outstanding farmers based on crops marketing, cultivated areas, total areas, and type of cultivated crops.
- Prepare a questionnaire form based on data collected through last field's visits to learn some secondary information for each farmer related to social, economics, and cultural and educational conditions. Also, information related to nature of land, topography, geographical boundaries as well as other information deals with sources of irrigation water, their quality, and distance from main source, and the method of irrigation. Copy of the questionnaire form is given in Appendix 1.

Figure 3. Field survey of Sector C, Dujaila.

A. Analysis of Survey Data , socio-economic

1. From questionnaire forms, it is evident that most of farmers' families take important part in agricultural work. This would give indication on family type of work for the outstanding farmers to achieve good income. At the same time, it reflects the low income of such families which push the whole family members to contribute in agricultural works as an alternative of the machinery work. Such families have low income; consequently, they are unable to buy machines or even to rent particularly at the first seasons. Uncertainty, on the field revenue guided the farmers to minimize all costs.

   Also, it is evident that no governmental support by the Governmental Establishment is occurred. There are neither centers nor groups responsible of renting machines at subsidizes prices affordable for the farmers of the site. Therefore, the farmers were placed in hard position to decide whether they leave their lands or go ahead cultivation lands depending on their family power to work in the field all day. In fact, this action has negative impact on the promotion of family members toward education. Most youth members have been discouraged of continue education; rather they are involved in field work helping other family members. Also, it is clear that the woman is playing an important role in field work which has negative effect on their original duties at home in taking care of the children and others.

2. Examining of the questionnaire forms indicates that most of farmers have tendency to grow animals besides their fields. Grow of animals would provide their needs from animal products. However, this activity may give wrong conclusions in some cases where some farmers stick with the production of animal feed rather than management and cultivation of saline soil for the production of grains. Some farmers are not sure about the sufficiency of irrigation water for their grown crops as well as the requirements from fertilizers and high rank seeds. Therefore, the risk associated with cultivation of their saline soils is high.
3. Most of economic status of farmers is between medium to poor. Some of farmer's economy is medium to good. This stems from the facts that those families are depending on another source for living, but not the production of their lands. Those families may involve in growing animals (cattle, sheep, or poultry) at the same site or they are working far from their fields for other farmers or member of families working at cities for governmental sectors (Ministry of Defense or Ministry of Interior Affairs) far from agricultural work. Therefore, the main task will be on immediate family members, husband, wife, and few children and the work will be confined to small area for the production of animals with no use of the large area.
4. The role of Governmental Establishment was very limited in this Site or even was not occurred. Extension people are not confound to be hand by hand help to farmers in cultivation their saline lands in scientific ways getting benefit from other countries experiences. Also, there are no rules of NGO or other organizations in giving hands to farmers.
5. Farmers have no idea about the right use of fertilizers or pesticides according to recommendations of MoA. Share of each farmer from fertilizers or pesticides is not known by extensions. Also, farmers have no idea about the use of biopesticides to control the weeds. The use of chemical- or bio-pesticides is limited to farmers who own more than 120 donums (30 ha). However, farmers with 20-30 donums (5-7.5 ha) are interested in using their lands for animal feed.
6. Most farmers are not able to use their whole land, but only 30% at best (Figure 4); the remaining will be subjected to salt accumulation. In this regards, we observed large tracts of lands are covered by a layer of salts (Sabakh type) with brown color with some natural native plants of salt tolerant. Removing of such crust may help in minimize the amount of water for leaching. Leveling of land is essential step toward reclamation process followed by dividing the area into plots and provides outlets or ditches to discharge leaching water.
7. The use of farmer's saline lands depends basically on the type of Governmental support through providing the fuel, fertilizers, seeds, pesticides, and machinery rent with subsidized prices.

Figure 4. Salt-affected land of limited uses at Sector C, Dujaila.

8. Also, the supply of water was assured since the areas under investigation (Sector C) is located downstream of the main canal. Non efficient of water convey and distributing is very common. In addition, the transporting canal is not lined and when they are lined they need a lot of maintenance. The poor transporting canals forced most farmers to use pumps to discharge the water remaining in these canals for their purpose. This action is an additive cost to total cost in cultivation lands of Sector C.

9. Some farmers live far away from their cultivated lands. For instance, they live at the center of the district or nearby town far from the village because of limited health and other services.

One point needs to be raised, sometimes close farmers (mostly relatives) are agreed to cultivate their land jointly. In this case, the land will be large enough to be cultivated and serviced. They grow vegetables in plastic houses and grow animals. Therefore, their use of land is more stable and they can rent machines and bye a pump and consequently, they are in good position to accept recommendations in enlarge the cultivated lands during the successive seasons.

- **B. <u>Analysis of Survey Data, Biophysical</u>**

Analysis of social data, indicate that most farmers of Sector C, are of low income and poor education along with poor extension services. Although farmers have no Governmental support, we noted some of them put plan to cultivate their saline lands. They started application some practices although they are limited but bright points to move in the process and call for other farmers of the same conditions to follow.

Among these practices noted in this area are the followings:

1. The cultivated area was nearly 30-50 donums (7.5-12.5 ha). Step 1 included leveling of land for better leaching and uniform distribution of irrigation water.
2. Supply of single irrigation to the land at the beginning of season.
3. It was noted for some farmers a practice in digging a drain or ditch around the land which will be used for surface drainage or outlet for drainage water.
4. It was noted for limited number of farmers, the practicing of deep plowing for breakdown the hardpan and ease of leaching salts.
5. Many outstanding farmers adopted a rotation for barley or wheat after legumes (clover or sesbania).
6. Number of farmers depended on mix plant residues after harvest with soil to minimize resalinization during summer season.

Evaluation of yield and land productivity of these cultivated lands after application of the abovementioned practices, we noticed the improvement in yield as a result in improvement of physical, chemical, and biological properties of soil.

In spite of the improvement in land productivity of those farmers, most of them are worry about that future. They know well that the way in cultivation of such lands is a big challenge and leaving any piece of land without continuous cultivation may subject that land to resalinization process. This challenge is always associated with the shortage of irrigation water.

Site 2: Musayab, Babil Governorate

The investigated site is a part of big project in Iraq established in the late 50s of the last century. The design of the project was based on the presence of three open drains surrounding each farming unit with irrigation canal from the fourth side. However, most of these farming units (distributed to farmers) have been changed dramatically. It is hard to find the original shape of farming units at the present time.

Figure 5. Visiting Musayab Site, Babil Governorate

The same procedure that was used in Dujaila Site was followed in this Site. These included the visit to Agricultural Office at Ijbala, Musayab and the many field tours (Figures 5 and 6). In general, most of the drains are deteriorated during the past 60 years of project operation with very poor collective drains. The main canal is originated from Euphrates River. Lands with high salinity were excluded from the study.

Figure 6. Salt-affected lands at Musayab Site.

Accordingly, the team focused on lands with 10-15 dS/m which meet the objectives of Component F (Figs 7 and 8). The textural class of soil of the area is Loamy Sand to Loam. Farmers suffer from water shortage and they use the available water in rational way.

Figure 7. Post-harvest soil sampling at Musayab Site.

Figure 8. Soil sampling at Musayab Site.

Seventeen farmers have been selected based on soil salinity and the use of practices in management their saline lands. Questionnaire forms have been distributed on the selected farmers and important information has been tabulated regarding the bio-physical and socio-economic parameters. Most farmers are poor to medium in living and the majority of family members are involved in farming works. Animal growing is practiced by most farmers to cover part of living. Governmental support is missing at the present time. In many cases, farmers work as group in maintaining the drains and the irrigation ditches. No practicing of modern irrigation systems and the common way is the flooding.

Most farmers used post-harvest crop for animal feed and normally they utilize the entire land for cultivation. The area of farming unit is between 30 and 60 donum (7.5-15 ha). Lands are utilized according to "Contract of Land" number 35 and 117.

Farmers are practicing the followings to manage their saline lands:

1. Mixing of post-harvest crop with the upper soil layer or spreading of straw on soil surface.
2. Some farmers burn post-harvest crop and mix the residuals with soil.
3. The entire land is divided for best cultivation with winter and summer crops and vegetables. Also, it is divided to control irrigation and drainage of excess water.
4. Leveling of land using sometimes heavy machines like bulldozers.
5. Using of pre-season irrigation as a leaching requirement.
6. Adopting of rotation; mung beans after wheat or barley with summer and winter vegetables intercrop or in separate plots.
7. Farmers are cultivating tolerant varieties (IPA 99 and Abu-Ghraib) to salinity at the beginning of utilizing their land when salinity is high then they replace those with less tolerant varieties particularly wheat.

8. Adding manure to plots cultivated to vegetables.
9. Plow fallow land to minimize or prevent the capillary action.
10. Some farmers use high rate in seeding to increase the percent of germination. They increased the rate from 80 to 100 kg/donum (320 to 400 kg seed/ha).

Site 3: Abu-Alkhaseeb, Basra Gover.

The Abu-Alkhaseeb Site is located far in the south of Iraq, Basra Governorate on a strip along Shatt Al-Arab (merge of the Tigris and Euphrates Rivers). The land is mainly a date-palm orchards. The soil of the area is mostly heavy silty clay loam to silty clay. The source of irrigation water is the Shatt Al-Arab and irrigation is based on the cycles of tide and ebb. Pumping is the main tool to convey water from channels to fields after the tide raise water level in these channels. No drainage systems are found in the areas. Salinity of water ranged between 3.5 and 13.0 dS/m. Farmers are cultivated vegetables in plastic houses (mainly United States Aids) and grow okra, egg plants, and tomatoes (Figs. 9 and 10). Alfalfa is a common forage plant in the area.

Analysis of survey data:

Fifteen farmers have been selected from the area that use numerous practices in managing salinity and received the questionnaire forms (Fig. 11).

Fig. 9. Growing of vegetables, Abu-Alkhaseeb, Basra.

Figure 10. Growing eggplants, Abu-Alkhaseeb, Basra.

Figure 11. Visiting farmers at Abu-Alkhaseeb.

Evaluation of the forms indicates the followings:

1. Economic status of farmers is week and most family members work in agriculture.
2. They have limited numbers of machines.
3. Most of farmers grow animal (catles, sheep, and poultry) to cover part of their living expenses.
4. Woman plays a major role in agriculture work.
5. No Governmental support.
6. Using of mineral fertilizers is limited because of salinity.
7. Because of high salinity of Shatt Al-Arab water, farmers buy RO water (Reverse Osmosis) from local market to supply irrigation water for vegetables. This would add extra costs for input in agriculture production.
8. Farmers plow their lands during summer to minimize the capillary action.
9. To avoid the effect of salinity of the plastic houses, farmers make a ditch along the house, fill it with manure layer and then with sand layer on top. For planting vegetables (cucumber and egg plants), seeds are placed inside the sand layer.
10. Some farmers mix post-harvest plants with soil and some add animal manure if any.

Analysis of the survey data:

Survey has been carried out in the three Sites (Dujaila, Musayab, and Abu-Alkhaseeb) on the selected outstanding farmers. Selection of outstanding farmers has been mainly based on criteria related to adoption of successful practices in management of saline soil, yield produced and marketed, and cost/benefit analysis of total input and output. To accomplish this task, questionnaire forms was designed to cover both socio-economic statuses of framers as well bio-physical parameters of their cultivated lands. A total of 45 questionnaire forms has been distributed; 13 in Dujaila, 17 in Mussayab, and 15 in Abu-Alkhaseeb.

A precise analysis of the questionnaire forms and the comparison among farmers for the same site would lead to many important and conclusive results regarding biophysical data and socio-economic data. Table 1 illustrates profile description of the Dujaila Site. Soil of the Site ranged from Silty Clay Loam to heavy Silty Clay Loam for the depth 0-55 sm. Other characteristics of the profile including poor aggregation and the accumulation of salts are common in the area. Analysis of biophysical data based on questionnaire forms of the outstanding farmers at the three investigated sites (Dujaila, Musayab, and Abu-Alkhaseeb) is given in Table 2. Values are given as a range from minimum to maximum for the digitized properties. Other types of answers are description of cases. Similarly, Table 3 summarizes the data of socio-economics for the three Sites. Surprisingly, the range in number of farmers' family members is very high. For the three Sites, the range is 2-32. For standard living, it ranges from poor to medium. For women contribution in agricultural work, it ranged from None-limited in Dujaila. However, it was "None" for both Mussayab and Ab-Alkhaseeb Sites.

Table 4 explains the practices that have been used at Dujaila Site which resulted in great reduction in soil salinity and the cultivation of lands. It is clear that most farmers used at least two practices in managing their lands salinity. Also, the reduction in soil salinity ranged between nearly 50 to 70%. That reduction was sufficient to improve soil environment and cultivate lands to crops. Figure 12 presents electrical conductivity of the 13 farmers' lands before practicing and after practicing of the recommended practices at Dujaila Site. The high reduction in salinity upon practicing of the recommended practices is evident in all farmers' lands.

Land utilized out of total land owned by farmers at Dujaila Site is given in Fig. 13). Most farmers used part of their lands instead of the entire lands at the first seasons of cultivation.

Table 1. Profile Description for Dujaila Site, Wasit Governorate.

Governorate : Wasit
Profile No.: 1
Location: Dujaila Site
Date : 21 – 10- 2011
Salinity: Strongly Saline Soils (S_3)
Vegetation: Tamarix Spp.
Physiography: Basin
Parent Material: Alluvium
Classification : Alluvial, Typic Torrifluvents

Depth (cm)	Description
0-28	Light Yellowish Brown (10YR 6/4 (D); Dark Yellowish Brown 10YR 4/4 (M); Si.C.L.; Weak coarse SAB, Hard sticky plasticity, High salt accumulation; Common fine & very fine pores; Very fine roots, Gradual smooth boundary.
28-55	Dark Yellowish Brown 10YR 4/4 (m); Heavy Silty Clay loam; Medium SAB, friables, sticky plastic; Many salt accumulation, Very spot of salt accumulation, Common, very fine pores; Few very fine roots, Smooth boundary.
55-95	Brown to Dark Brown 10YR 4/3 (m); Loam, Week medium SAB , Very Friable, slightly plasticity, Porous, few fine roots, Common 10YR 6/8, Few fine pores; Few fine roots, Common salt accumulation, Diffuse smooth boundary.
95-125	Yellowish Brown (10YR 5/4 (M) . Heavy Si.C.L., Common accumulation of salts & $CaCO_3$; Spots few gypsum crystals, Comm pores, Very few very fine roots , Few black spots on pad face.

Table 2. Analysis of biophysical data based on questionnaire forms of the outstanding farmers at the three investigated sites (Dujaila, Musayab, and Abu-Alkhaseeb).

No.	Parameters	Values in Range		
		Site 1 Dujaila (13 Farmers)	**Site 2 Musayab (17 Farmers)**	**Site 3 Abu-Khaseeb (15 Farmers)**
1	Soil Type	Si. C. L. – Si. C.	Loam - Si. L.	Si. C. L. - Si. C.
2	Soil EC (dS/m) (Before practicing)	30-70	10-12	10-20
3	Soil EC (dS/m) (After practicing)	15-23	4.6-7.8	7-15
4	Irrig. Water Quality:			

	EC (dS/m):	1.0 -1.3	1.3-1.8	2.5 – 6.0
5	Distance of source (Irrig. wat.) (km)	0.3-3.0	3-35	Close to (Shatt Al-Arab)
6	Surface plowing	Disking/mold plow	Disking/mold plow	Disking
7	Sub soiling	2 /13	1/17	None
8	Major crop	Barley/wheat	Wheat/corn	Vegetables/alfalfa
9	Variety:	Local	Ibaa (wheat) Corn (Hybrid)	Local
10	Mixing of plant residue	2/13	Yes	Yes
11	Seeding method	Manual (11/13) Machine (2/13)	Manual	Manual
12	Irrigation method (Flooding)	Gravity (6/13) Pumps (7/13)	Pumps	- Plastic House: Drip - Forage crop: Flood.
13	Preseason irrigation	9/13	Yes	None
14	Over irrigation	3/13	None	Yes
15	Fallow with plowing	9/13	9/17	Dividing
16	Machinery	Renting (9/13)	1/17	8/15
17	Machines belong to farmer	4/13	16/17	7/15
18	Sprinkler irrig. sys.	None	None	None
19	Drainage facilities	None	Deteriorated	None
20	Reuse drainage water	None	1/17	None
21	Rotation	Wheat or Barley-legumes (4/13)	Wheat/Corn-legumes (17)	None (9/15) Veg.-alfalfa (6/15)
22	Crops cultivated	Field crops + vegetables (3/13)	Wheat, corn, vegetables, alfalfa (17)	Forage, vegetables,
23	Orchards	3/13	None	Date palms
24	Availability of water	Rational	Rational (weekly)	Shatt Al-Arab (Tidal)
25	Irrig. Water sufficiency	Insufficient	Insufficient	Available
26	Fertilizer use	Yes	Yes	Yes
27	Herbicides use	2/13	None	None
28	Biopesticides	None	None	None
29	Organic farming	None	None	None

Table 3. Analysis of socio-economic data based on questionnaire forms of the outstanding farmers at the three investigated sites (Dujaila, Musayab, and Abu-Alkhaseeb).

No.	Parameters	Values in Range		
		Site 1 Dujaila (13 Farmers)	**Site 2 Musayab (17 Farmers)**	**Site 3 Abu-Alkhaseeb (15 Farmers)**
1	Family members	6 - 32	4-30	2-20
2	No. Working members	2 - 18	1 – 16	3 -12
3	Engagement of members in farm work	Good - Limited - very Limited	Limited	Good
4	Education	Primary school - High Education	Primary – University	Intermediate-University
5	Woman contribution in farm work	Limited - None	Yes	Yes
6	Standard living	Medium - Poor	Medium - Good	Medium
7	Other Agricultural activities	Livestock farming (6/13)	None-Animal farming (5)	Animal farming
8	Land owner	The same farmer	- Owner (3) - Contract (14)	- Owner (6) - Contract (9)
9	Type of land holding	Contract (Law 35)	Contract (Laws 35 and 117)	Contract (Laws 35 and 117)
10	Role of Governmental Establishments	None – Very limited	None	None
11	Role of extension	None - Poor	None	None
12	Role of NGO	None	None	None
13	Farmer's skills	Yes, (Animal Farming)	Yes, (Animal Farming)	Yes, (Animal Farming)
14	Crop return	Farmer	Low-Medium	Low-Medium
15	Household income	Family	The farmer	The farmer
16	Experiences in agric.	3 – 30 years	20-30 years	20 years
17	Type of housing	- Rural (4) - Village (13)	Bricks, field	Bricks, field

18	Reasons not to cultivate all lands	- low incomes (1) - salinity and water shortage (12)	Salinity, water shortage	Water salinity
19	Selection of crop and variety	tolerant to salinity	- tolerant to salinity - local market	- tolerant to salinity - local market

Table 4. Soil salinity before and after practicing of soil management tools and the associated practices at Site 1, Dujaila.

Farmer No.	Soil EC (dS/m)		% Reduction in Salinity	Type of Practicing
	Before practicing	After practicing		
1	62.8	23.4	62.7	Rotation + Preseason irrigation
2	70.4	21.3	69.7	Preseason irrigation + Plowing in summer
3	68.4	18.2	73.4	Subs soil plowing + Preseason irrigation
4	46.6	20.1	56.9	Rotation + Preseason irrigation
5	62.3	22.2	64.3	Mixing of plant residue + Plowing in Summer
6	34.7	15.2	56.2	Rotation + Preseason irrigation
7	32.6	18.0	44.8	Mixing of Plant residue + Preseason irrigation
8	49.3	21.0	57.4	Plowing in Summer + Sub soil plowing
9	38.6	12.2	68.4	Drainage + Rotation
10	43.6	13.2	69.7	Rotation + Preseason irrigation + Plowing in Summer
11	36.5	18.3	49.9	Preseason irrigation + Plowing in summer
12	42.3	14.2	66.4	Plowing in summer + Drainage
13	52.6	22.4	57.4	Preseason irrigation + Rotation

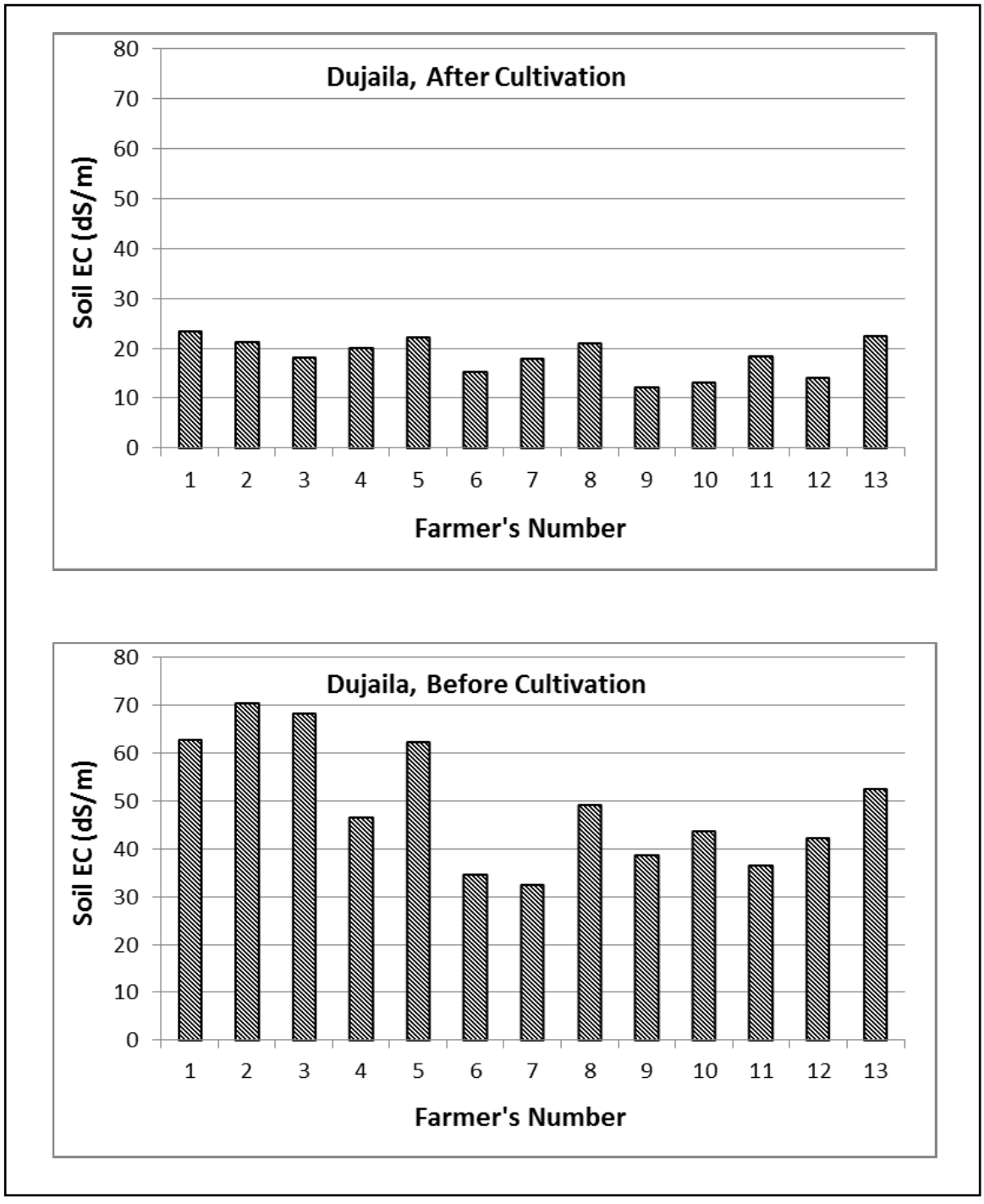

Figure 12. Soil salinity before and after application of the recommended practices for the 13 farmers at Dujaila Site.

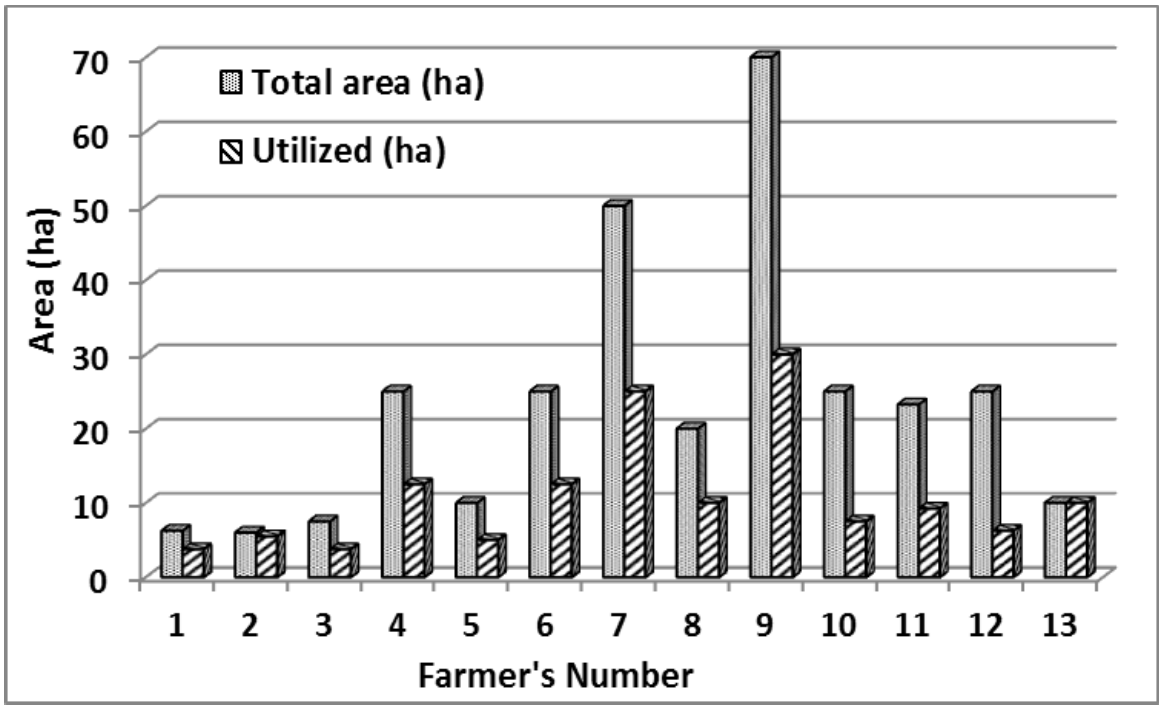

Figure 13. Total area owned and utilized area at present time for outstanding farmers at Dujaila Site.

Activity F2.1: Identifying the outstanding farmers in the selected sites, possibly in differing salinity affected areas.

Site 1. Dujaila:

The right judgment on the outstanding farmers in this sector was based on records of marketed crops in addition to the field trips by our staff to check the actual field situation. The survey in this sector indicated the presence of different levels of salinity in this area associated with the shortages of water which resulted in considering the land as abandoned and out of service. It seems that the appearance of this spot-like salinity in farmers' fields is common.

On the other hand, we found some of farmers started to adjust themselves to live with salinity and to improve the hard conditions of salinity. Therefore, the specific conditions of each farmer, the history of the salinity problem, and the socio-economic status would be main factors in determining the type of practices that match the nature of the land. The followings are the practices of 13 outstanding farmers:

1. Farmers begin with small area which can be cultivated or controlled since the radical solution of the salinity problems is not available at present time. This solution includes the operation of net of drains (tile with open and collective drains) along with leaching and cultivation with most tolerant plants and lowering the groundwater as important steps in the process of reclamation.
2. These solutions are hard to be achieved for the present time and even for the future; particularly those require water for leaching. The shortage of water is elevated problem during summer and even winter season and it is a limiting factor for cultivation of lands for major and other crops.
3. For instance, if the land is highly saline and the soil is poorly permeable, this would lead to the presence of hard layer below plow layer that prevents the movement of salts and water. In this case, the deep plowing is good option to breakdown the hard pan and improves the leaching and movement of salts and water. This practice is under way for this farmer and waiting just the availability of the specific machine through renting after the assurance of economic feasibility. The deep plowing is not expensive and may cost nearly ID 250,000/ha (nearly $ 220/ha). Furthermore, it is needed only every 4-5 years and distributing of the cost over five seasons will make the action economically feasible.
4. In some cases, farmer's lands required precise leveling. Farmers may go for this action using the available simple leveling machine or grader when there is need to remove part of high land and fill the depression ones. Following this action of

leveling, farmer give preseason heavy leaching. These actions are successful practices in removing salts far from the root zone and the starting of cultivation the land would maintain the salt balance and remove excess salts from rising up again. Also, these actions will make the field in better conditions for the next seasons including the removal of weed seeds.

5. Some farmers think of using their lands by cultivation wheat, barley, or corn. After harvest, they leave all plants remain to be mixed with soil far away from grazing or burning. Under such conditions, farmers may think of using the rotation system by cultivation of barley followed by sorghum or corn, or barley plus clover during winter followed by summer crops. This system of rotation may be expanded to other areas and later on to replace barley by wheat, the target of sustainable system.
6. Some farmers opened a drain or ditch around their field to collect excess surface water or drainage water and keep drainage water away from their cultivated fields. This action was practiced by limited number of farmers because of the expensive operation in digging the drain. Sometimes farmer start with limited length of drain to cover small area then expand that to more areas and so on by connect the drains with each other for the purpose of serving the whole cultivated area. Farmer practicing the dig of a drain is normally selecting the depression area for the open drain and thus keep salts accumulation and drainage water far enough from cultivated land.

Site 2. Mussayab:

Outstanding farmers (17) identification was based on records of yield produced as well as adoption of practices to survive under saline conditions. The average yield of the outstanding farmers approached 5 ton/ha for wheat. The followings are examples of those outstanding farmers:

1. Farmers are working in group to dig deep channels (2.5 m) used for irrigation particularly during the rational period.
2. Some farmers make use of the deteriorated drains as water reservoir particularly during summer season.
3. Soil textural class of the area is Sandy Loam to Loam which makes all “reclamation work” easy task including the leveling and leaching.
4. Some farmers use the bulldozer for land leveling. Others do plowing then leveling and disking.
5. Farmers then cultivate their land to most tolerant crops such as barley, alfalfa, okra, and eggplants. In the later seasons, farmers cultivate tolerant wheat varieties (IPA 99).
6. Farmers use post-harvest plants for animal grazing and mix the residual with soil.

7. Farmers open drains to 70 cm depth to discharge leaching water and drainage water to the collective drain.

Site 3. Abu-Alkhaseeb:

The Abu-Alkhaseeb Site is a date palm orchard interplant with vegetables and forage crop mainly alfalfa. The source of irrigation water is the saline water of Shatt Al-Arab and irrigation in this area is based on the cycle of tide and ebb. Salinity of water is changing with time. Because of limited income from date palms, farmers of the area grow vegetables in plastic houses and animals to cover life expenses. Evaluation of the questionnaire forms for the 15 farmers in this Site indicate the followings:

1. All family members work in agriculture particularly the women.
2. Farmers plow their lands during summer to prevent or minimize the capillary action and hence control the salinization of land.
3. Farmers buy low-saline water from the local market and use this water alternatively with the high-saline water of Shatt Al-Arab in irrigation of vegetables and forage plants.
4. Farmers use a layer of manure in a ditch inside the plastic house and they place a layer of sand above the manure layer. This bed for seed is practiced by farmers to high-saline water of Shatt Al-Arab to minimize or escape the effect of salinity on seed germination and plant development.
5. Farmers mix post-harvest plants with soil and sometimes they add manure to soil.

Activity F2.2: Determine what makes these farmers outstanding, in terms of soil agronomic or irrigation techniques or use of social/physical/economic capital.

Site 1. Dujaila:

Some of the criteria used for selection of the outstanding farmers were based on the records of yield in addition to the field trips made by teamwork. The later was performed to check the actual field situation including leveling of field, control of weeds, and presence of lateral irrigation channels required to convey water to their fields. Also, from these trips we can assure the level of adoption of these practices by farmers.

Among these practices that adopted by farmers of the sector:

1. Leveling of land before cultivation.
2. Giving a heavy irrigation at preseason (Tarbasa). It is like providing a leaching requirement before cultivation.
3. Mixing of post-harvest plants with soil surface.
4. Use of rotation, for legumes (clover, alfalfa, broad beans, or mung beans) after grain crop of wheat.
5. Avoid fallow during summer season. The fallow would give chance to resalinization to occur particularly in areas where groundwater is high or in critical level for capillary rise to take place. In case, the fallow is unavoidable, plowing of fallow land is essential to breakdown the capillarity and minimizes the capillary action.
6. It was noted for some farmers, the use of high tolerant crop to salinity (barley) for two to three seasons before cultivation wheat. This practice has been proven by farmers to be effective in improving soil environment. After this practice, barley can be replaced by wheat, corn, legumes, and vegetables.
7. There was a concern by some farmers to dig a drain or deep ditch around the land or part of the land. Farmer started with drain in only part of his land and then expands the drain to cover the entire area. Our staff task was focused on encourage farmers doing the practice of digging the drain simply by calculate the cost/benefit ratio for a short- and long-term. Such type of calculation will be in favor of practicing the digging of a drain to serve lowering the groundwater and collect the surface leaching water from land particularly during the first seasons.
8. Some farmers believe in the importance of deep plowing in breakdown the hard layer below plow layer. Farmers noticed irrigation water stands at the upper part of soil surface with poor percolation which resulted in death of seedlings and failure of germination. Farmers are trying to use a big machine (rotor) to breakdown the hardpan layer.

From our trips to outstanding farmers who involved in these practices for several seasons, some of them were trying to level or line of seeding far from salinity effect for crops like cotton, sunflower, and mung beans. Vegetable crops are cultivated by the same way.

10. Farmers worry about the method of furrow irrigation in wasting of irrigation water. They look forward to a Governmental support in supplying of sprinkler or drip irrigation systems on subsidized prices.
11. Outstanding farmers believe that the critical stage in the production business is over and no more risk in cultivation their lands. Therefore, continue cultivation of land is a must to keep their soils far from resalinization processes.

In summary, the outstanding of those famers stems from the fact that they succeeded in identifying the many problems facing cultivation of saline lands and then to move practicing ways suitable with nature of their lands. They look forward for any Governmental support particularly for the very expensive machines. The later remains the concern of most farmers. Therefore, thinking of the problem, identifying the problem, practicing ways to solve the problems, and finally bring the abandoned or waste land into productive ones, are all good examples to consider those farmers outstanding.

select different way of seeding in furrow irrigation.

Site 2. Mussayab:

Outstanding farmers of Mussayab Site are practicing the followings in managing their saline lands:

1. Dividing the whole land into parts to control irrigation, leveling, and other agricultural practices.
2. Normal plowing to 30 cm depth and giving preseason heavy irrigation to leach some salts.
3. Starting with few pieces of the land and planting most tolerant crops to salinity (Barley, alfalfa, okra, and egg plants).
4. Farmers expand these practices to other pieces of the land.
5. After few seasons, farmers replace the salinity tolerant crops by wheat.
6. Few farmers use subsoil plowing to depth of 70 cm in the reclamation process.
7. Farmers mix post-harvest plants with soil to improve physical conditions of the soil.
8. Some farmers add straw on the soil surface to increase the percent of germination and increase the water soil water holding capacity.
9. Some farmers add manure (poultry) and mix it with soil.
10. Some farmers plow the land during summer season to minimize the capillary action.

11. Deepen the irrigation channels to more than one meter for storing more water which can be used at time of water shortage.

Site 3. Abu-Alkhaseeb:

Outstanding farmers are adopting numerous ways to survive salinity of irrigation water and making their land productive. The followings are reasons for considering those farmers of the Site outstanding:

1. Cultivation of the plastic houses to vegetable crops by using the manure layer and the sand layer to manage salinity of irrigation water.
2. Use of cycle method of irrigation with high-saline and low-saline waters. In this respect, farmers use the low-saline water (RO type) every other season.
3. Using of mineral fertilizers although they are expensive to maximize yields.

Activity F2.3: Determine what are the best practices used by the outstanding farmers that can be usefully promoted in other areas and communicated to other farmers.

Site 1. Dujaila:

Evaluation of practices adopted by the outstanding farmers with the main objective of living with salinity to solve related problems, farmers continue cultivation their lands. Outstanding farmers got improved yield with successive cultivation. Scientific evaluation of these practices indicates that some of them are overlapped and some of them are expensive.

Among these practices that can be promoted to other farmers are as follow:

1. Mix of harvested plants with the surfaces soil (Fig. 14). This practice is inexpensive, simple, and does not required effort and can be done by mold plow. The benefit of this practice is big in improving soil properties. The soil of the area is Clay or Clay Loam and it is needed an amendment to loose soil aggregates and improve aggregation. It is believed therefore, that the best soil amendment is plant straw, leaves, and residues. Decomposition of plant remains would improve physical and biological properties of soil and may add nutrients to the rhizosphere which in turn improve soil environment for root development.

Figure 14. Practicing of mix post harvest plants with soil at Dujaila Site.

2. Deep plowing using the rotor (Fig. 15) to breakdown the hardpan or hard layer below the plow layer. This layer has been formed after decades in using the common plow under moist conditions which resulted in compaction of such layer. Using the rotor at depths of 60-80 cm below soil surface in lines every 4 to

Figure 15. Use of rotor to breakdown hardpan in deep plowing at Dujaila Site.

6 m apart would be very efficient in breakdown the hard layer. This practice can be repeated every other five years to assure the movement of salts and water below the root zone.

3. Digging of a drain or deep ditch around the land would provide best draining and discharge the excess irrigation water (Fig. 16). This practice may work well

Figure 16. Digging of a drain or deep ditch around the land at Dujaila Site.

when the remaining plant materials are mixed with the upper soil layer and avoiding the fallow during summer months.

3. Adoption of rotation system using tolerant varieties of wheat or barley followed by legumes and avoiding leaving land fallow would provide the best conditions to improve soil environment.
4. Cultivate of salinity tolerant crops during the first seasons mainly barley. In this respect, land is divided, leveled, and cultivated to cops (Fig. 17).

Figure 17. Cultivate of salinity tolerant crops (barley) at Dujaila Site.

From the above-mentioned practices, it is hard to separate each one from the rest in implementation them on the field scale. The overlapping is expected and sometimes farmers are practicing more than one practice at the same time. For instance, farmers do the leveling, mix plant materials, and plant rotation and so on.

Site 2. Mussayab:

Practices of outstanding farmers that can be promoted to other farmers in the area are as follow:

1. Dividing the whole land into parts to control irrigation, leveling, and other reclamation practices.
2. Starting with few pieces of the land and planting most tolerant crops to salinity (Barley, alfalfa, okra, and egg plants) (Fig. 18).

Figure 18. Cultivate of salinity tolerant crops (okra) at Mussayab Site.

3. Farmers expand these practices to other pieces of the land.

4. After few seasons, farmers replace the salinity tolerant crops by wheat.
5. Farmers mix post-harvest plants with the soil to improve physical conditions of the soil (Fig. 19).

Some farmers plow the land during summer season to minimize the capillary action (Fig. 20).

Site 3. Abu-Alkhaseeb:

Practices adopted by farmers of the area in cultivation of vegetables are as follow:

1. Cultivation of the plastic houses to vegetable crops by using the manure layer and the sand layer to manage salinity of irrigation water (.
2. Use of cycle method of irrigation with high-saline and low-saline waters. In this respect, farmers use the low-saline water (RO type) every other season.

Figure 19. Mix of post-harvest plants with the soil at Mussayab Site.

Figure 20. Plowing of land during summer at Mussayab Site.

Conclusions

Through this **F2** part of the study, many activities have been implemented included the office work and the field work. Outstanding farmers have been identified from records of Agricultural Office basically the marketed crops through Governmental silo and compare such record with other farmers record who have not been involved in the recommended practices. Therefore, the yield indicator made our job easy in identifying outstanding farmers and the practices behind the successful cultivation of their saline soils. Also, we got acquainted with their need from machines and other source of capital.

For Site 1. Dujaila: Evaluation of the field applicability of the practices and their successful application by outstanding farmers, we concluded that there are four promising practices which can be adopted and promoted to other farmers. Those practices are the best among others practices to deal with soil salinity and they are suitable to conditions of central and southern Iraq with the high temperature during summer and the low rainfall during winter and the shortage of irrigation water in general.

1. Mixing of harvested plants with the surfaces soil.
2. Deep plowing using the rotor to breakdown the hardpan or hard layer below the plow layer.
3. Digging of a drain or deep ditch around the land would provide best draining and discharge the excess irrigation water.
4. Adoption of rotation system using tolerant varieties of wheat or barley followed by legumes and avoiding leaving land fallow.

For Site 2. Mussayab: Practices of outstanding farmers that can be promoted to other farmers in the area are as follow:

1. Mixing of post-harvest plants with soil to improve physical conditions of the soil.
2. Dividing the whole land into pieces to control irrigation, leveling, and other reclamation practices.
3. Cultivation of most tolerant crops to salinity (Barley, alfalfa, okra, and egg plants) at beginning. Then replace these crops with wheat.
4. Plow land during summer season to minimize the capillary action.

For Site 3. Abu-Alkhaseeb: Practices adopted by farmers of the area in cultivation of vegetables that can promoted to other farmers:

1. Cultivation of the plastic houses to vegetable crops by using the manure layer and the sand layer to manage salinity of irrigation water.
2. Use of cycle method of irrigation with high-saline and low-saline waters.

References

1. FAO . 1998. Crop evapotranspiration, Irrigation and Drainage Paper No. 56. Rome. Italy.

Appendix 1

Soil Salinity Management in Central and Southern Iraq

(Component F)

Survey 1: Outstanding Farmers

Governorate:

Form number:

Farmer's name:

No.	ITEM	
1	General Information	
	1. District	
	2. Village	
	3. Location	
	4. Climate	
2	Site Description	
	1. Geographic boundaries	
	2. Area	
	3. Topography	
	4. Ownership	
3	Field Data	
	1. Soil Textural Class	
	2. Physical characteristics (aggregation)	
	3. Chemical characteristics	EC: pH:
	4. Water quality	EC: pH:
	5. Source of irrigation water	

4	Agricultural Practices Adapted	
	1. Leveling	
	2. Surface plowing	
	3. Sub soiling	
	4. Rotation	
	5. crops cultivated	
	6. Utilized area	
	7. Crop species adapted	
	8. Organic matter application	
	9. Mixing of plant residue	
	10. Seeding method	
	11. Irrigation method	
	12. Irrigation water quality	
	13. Irrigation, pre- season	
	14. Leaching requirement	
	15. Plowing in summer	
	16. Fallow	
	17. Machinery	
	18. No. of machines belong to farmer	
	19. No. of irrig. pumps	
	20. No. sprinkler irrig. systems	
	21. Distance from irrig. water	
	22. Removing of accumulated salts by drainage	
	23. Drainage water reuse	

	24. Crops cultivated	- Cereals: - Vegetables: - Forage: - Perennial plants:
	25. Current status soil salinity	
5	Social Data	
	1. Family members	
	2. No. Working members	
	3. Engagement of members in farm work	
	4. Education	
	5. Woman contribution in farm work	
	6. Standard living	
	7. Agricultural and non-agric. activities of farmer	
	8. Availability of irrigation water	
	9. Sufficiency of irrigation water	
	10. Land owner	
	11. Type of land holding	
	12. Role of Governmental Establishments	
	13. Role of extension	
	14. Role of NGO	
	15. Farmer's skils	
	16. Promising technologies to improve livelihood of farmers	

	17. Application of fertilizers according to recommendations	
	18. Application of pesticides	
	19. Biological control	
	20. Organic farming	
6	Challenges and Constraints Facing Farmers	
	1. Soil	
	2. Water - Distance to source - Sufficiency	
	3. Crop	
	4. Standard living	
	5. Marketing	
	6. Communication	
	7. Decision makers	
	8. Other activities	
	9. Intension to initiate work and the need for support	
7	Farm Revenue	
	1. Crop return	
	2. Household income	
	3. Experiences in agric.	
	4. Type of housing	
	5. Reasons not to cultivate all lands	
	6. Selection of crop and variety	
	7. Source of fertilizers and pesticides	

	8. Selection of improved varieties	
	9. Animal grazing within the field	