Soil and Water Salinity in Iraq: Preliminary Analysis of Causes, Effects and Approaches to Management

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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 3).

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Contents

SUMMARY

This report presents research in progress on the causes, effects, of soil and water salinity in central and southern Iraq. Its objective is 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 (6-20 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 researchers to check the actual field situation including the best-bet salinity management techniques they practice.

Findings to date

Results of this preliminary analysis indicate that there is a group of outstanding farmers that uses a range of best-bet practices such as leveling of land before planting, applying a heavy irrigation prior to planting (pre-season 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 analysis of these best-bet practices are needed to understand their cost-benefit ratios, scientific explanations for their effectiveness, and their long-term sustainability in managing salinity.

1. Farmers of the investigated sites are managing their saline land by adopting some practices on their own without the intervention of governmental or scientific establishments.
2. The adopted practices prove to be successful in reducing land salinity, improve land productivity, and thus maximize yields.
3. With the absence of infrastructure to lower the height of saline groundwater and efficient irrigation systems, these practices seem promising in the short- and long-term in managing land salinity in central and southern Iraq.
4. Some successful practices can be disseminated among farmers of the region for better managing of lands suffering from salinity.

Background and Context

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 thousands of hectares 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 2000mm 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.

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.

The current salinity problem in Iraq

Recently the demand for water in the Tigris and Euphrates River 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 designed to collect the discharge 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.

RESEARCH STRATEGY

Site Selection and Characterization

Based on land quality classification, governorates with low to medium salinity were selected in the first stage. Within each of these selected governorates, the districts with the lowest land quality were chosen. The precise identification of the outstanding farmers was undertaken based on published and unpublished reports and sources of information documenting them as "success stories" in agriculture using three criteria; a) highest reported yield per unit area, b) meeting the state yield target continuously, and c)

positive reputation of the farm among officials, authorities and neighboring farmers.

Three sites were selected in central and southern Iraq to cover areas suffering from salinity to carry out the study: Site 1: Dujaila, Wasit Governorate; Site 2: Musayab, Babil Governorate; and Site 3: Abu-AlKhaseeb, Basrah Governorate (Figure 1).

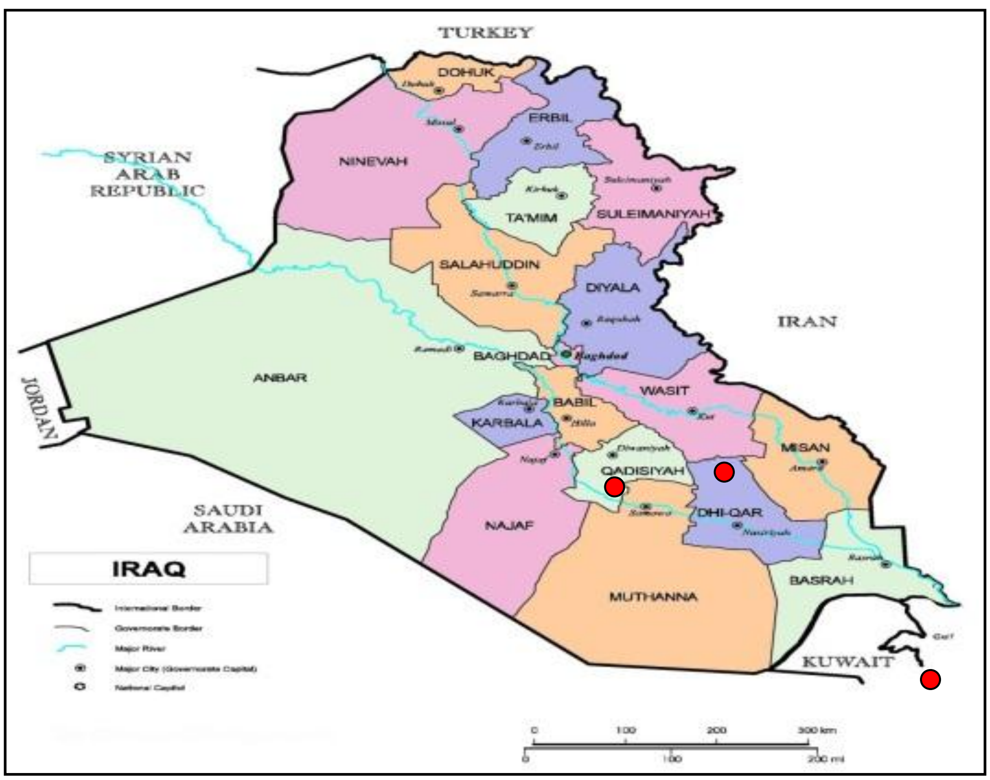

Figure 1. Location map of the investigated sites

● **Location of study site**

1- Weather

The climate is of semi-arid kind. Table 1 presents the 30-year average weather conditions for the three selected study sites. The annual average minimum and maximum temperatures at Dujaila site are 15.4 and 30.1°C, respectively; whereas at Musayab site is 16.6 and 31.1 °C, respectively. The annual cumulative rainfall at Dujaila site (141.4 mm) is approx. 33% higher than at the Musayab site (106.5 mm). In general, the two sites are very similar in terms of long-term weather conditions.

Table 1. Mean monthly temperature, precipitation and solar radiation for two of the study sites during the past 30 years.

	---------------------Dujaila---------------------				---------------Musayab---------------			
Month	Temp (C°)		Rainfall (mm)	Solar radiation (MJ m^{-2} d^{-1})	Temp. C°		Rainfall (mm)	Solar radiation (MJ m^{-2} d^{-1})
	Min	Max			Min	Max		
Jan	4	15	29.6	23.3	8	17	21.5	25.0
Feb	6	18	28.6	31.9	7	19	17.6	32.8
Mar	10	23	22.6	39.7	11	24	13.5	40.5
April	15	29	21.8	48.3	16	30	13.7	48.3
May	21	36	5.2	55.2	22	37	7.0	56.0
June	24	40	0.1	58.6	25	41	0.0	58.6
July	26	43	0.0	58.6	27	44	0.0	58.6
Aug	25	43	0.0	54.7	26	43	0.0	54.7
Sept	22	40	0.2	47.4	23	41	0.0	47.4
Oct	16	33	3.5	36.2	17	34	4.8	36.2
Nov	10	24	12.2	25.9	11	25	11.6	26.7
Dec	6	17	22.4	21.6	7	18	16.5	22.4
Total			141.4				106.5	

2- Soils

The topography is nearly leveled. Soils at Dujaila and Musayab sites are medium texture soils (silty clay loam and sandy clay loam, respectively) classified as Typic Turifluvents whereas soils at Abu-AlKhaseeb site (loam to sandy clay loam) are classified as salted, gypsic, Turifluvents. These are poorly drained, moderately saline (10-20 dS/m) soils and parent material of all soils is the river alluvium.

3-Water

The irrigation water quality ranges between 1.0 and 1.3 dS/m at Dujaila and Musayab sites whereas it ranges between 2.5 and 6 dS/m at Abu-AlKhaseeb site. The source of irrigation water is the Tigris River in the case of Dujaila, Euphrates River in the case of Musayab, and Shat-Alarab River in the case of Abu-AlKhaseeb site. The water table is between 0.5 and 1.5 m from the surface in the case of Dujaila and Musayab sites whereas it fluctuates in the case of Abu-AlKhaseeb site depending on the discharge from Iran and tide and ebb effect in the sea.

4-Cropping systems

The cropping systems in Dujaila and Musayab sites is a mix of field crops such as wheat, barley, maize and sunflower, vegetables such as tomato, cucumber, pepper, okra and tress such as date palms, citrus, olive and apricot.Whereas at Abu-AlKhaseeb site, there are no field crops grown except some for animal feed, it is dominated by date palm orchards, vegetable and tree plantation. The farm productivity is moderate with wheat yields ranging from 2 to 2.5t/ha.In addition to growing crops, many farmers also raise animals such as cows, sheep, poultry and fish.

Profiling of outstanding farmers

A questionnaire survey was conducted to collect information on the practices outstanding farmers carry out to manage salinity. The control farms for comparison were chosen based on their representation of the general situation within the district or the governorate with regard to salinization, land quality, productivity and farm incomes. These control farms represent the norm under which the majority of farming enterprises are currently operating. The basic indicators used in defining the research and the control farms were the level of salinity, yields of major crops and overall profitability of the farm. Information sources with respect to the geography, soils, land and water resources, and weather were obtained from field sampling and various issues of national, governorate and district reports. In addition, the records of the district land management departments were also consulted.

1-Survey questionnaire

The questionnaire form was prepared and adopted by the staff based on many visits to farmers' fields. The form was used to gather information to get a clear picture of the current status of farmers' fields and most agricultural activities including problems and constraints facing farmers in cultivation of saline lands. Furthermore, the survey was conducted to collect additional information on the practices they carry out to manage salinity. A total of 45 questionnaire forms were distributedto 13 farmers at Site 1, 17 farmers at Site 2, and 15 farmers at Site 3. To accomplish this task, questionnaire forms were designed to cover socio-economic status of framers as well as bio-physical parameters of their cultivated lands.

2-Analysis of biophysical and social-economic data

A precise analysis of the questionnaire forms and the comparison among farmers for the same site wasdone. Analysis of biophysical data included parameters such as: soil type and characteristics, current status of soil salinity, water quality, and agricultural practices used by farmers. Estimation of these parameters was based on mean values and range values among farmers of the site.

Analysis of social-economic data included the following parameters: family size and members involved in agricultural work, their level of education, standard livings, type of land holding, role of government in extension, farmer skills, type of housing, and of managing their lands. The same procedure was used to express the final results among the farmers at the three Sites. In general, values were given as range from minimum to maximum for the digitized properties. Other types of answers are description of cases. The analysis is expected to lead to many important and conclusive results regarding biophysical data and socio-economic data.

3-Identification of farmer best-bet practices

Selection of outstanding farmers was mainly based on criteria related to adoption of practices in management of salinity, yield produced and marketed, and cost-benefit analysis of total input and output. These practices that have been used by farmers resulted in great reduction in soil salinity and increase the productivity of cropland. At the same time, most farmers used at least two practices in managing their lands salinity. Also, the reduction in soil salinity ranged between nearly 50 to 70%. This reduction was sufficient to improve soil environment and cultivate land to crops.

INITIAL FINDINGS

Thirteen outstanding farmers were selected at Dujaila, 17 at Musayab, and 15 at Abu-Alkhaseeb. These farmers were selected because they met the selection criteria mentioned in the methodology. The criteria 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.

Survey Results

The questionnaire prepared and adopted by the team (Appendix 1) gave a better picture of the current status of outstandingfarmers' productivity and major agricultural constraints. Also, the frequent visits conducted by the team improved the understanding of the problems and constraints facing the farmers in cultivation on saline lands.

Socio-economic status of farmers

It is evident that most members of the outstandingfarming families take important part in agricultural work (Table 2). This helps the outstanding farmers generate higher incomes. At the same time, the low income families push their family members to contribute in agricultural works as an alternative to the machinery work, thus reducing input costs.

There are neither centers nor groups facilitate renting of machines at subsidizes prices affordable for the farmers of the sites. Therefore, the farmers are placed in difficult position to decide whether they leave their lands barren or continue cultivating depending on their ability to work in the field carry out practices by hand or they may skip some land preparation practices. Also, some farmers may be forced to rent machines at higher price. In fact, this action has negative impact on the motivation of family members toward getting higher education. Most youth are discouraged fromcontinuing education; instead they are involved in field work helping family members. Also, it is clear that the women are playing an important role in field work which has negative effect on their original roles at home in taking care of the children and others.

Analysis of the questionnaire forms indicates that most of outstandingfarmers have tendency to raise animals besides their fields. Raising animals helps meet 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 lands for the production of grains. Some farmers are not sure about the sufficiency of irrigation water for their cultivated crops as well as the requirements for fertilizers and high yielding seeds. Therefore, the risk associated with cultivation of their saline soils is high.

Economic status of most of the farmers is between medium to poor (monthly family income ranging from $300 to $700). Some of farmers' economic status is between medium and good (greater than $700/month). This stems from the fact that those families are depending on other sources for living, and not the producefrom their lands. Such families involve in raising animals (cattle, sheep, or poultry) at the same site or they work far from their fields for other farmers or member of families working in cities for governmental sectors (ministry of defense or ministry of interior affairs) far from agricultural work. So, the main tasksare on immediate family members - husband, wife, and children and the work is confined to small area for the production of animals with no use of the larger area.

The role of governmental establishments was very limited or non-existing at these sites. Extensionistsare not of much help to farmers in cultivating their saline lands in scientific ways,depriving them of getting benefit from other countries' experiences. Also, there are no roles for NGO or other organizations in providing help to the farmers.

Even outstanding farmers have very limited knowledgeof the correct use of fertilizers or pesticides according to recommendations of MoA - level of each farmer'sapplication of fertilizers or pesticides is not known by extensionists. Also, farmers have no idea about the use of bio-pesticides to control the weeds. The use of chemical- or bio-pesticides is limited to farmers who own more than 30 ha of land.

Most farmers are not able to use their entire landholdings, but only 30% at best; the remaining isaffected bylarge salt accumulation. In this regards, it was observed that large tracts of lands are covered by a layer of salts (*Sabakh*), with brown color and some salt-tolerant native vegetation.

The use of farmer's saline lands depends basically on the level and type of governmental support through providing of fuel, fertilizers, seeds, pesticides, and machinery at subsidized prices.

Although, supply of water was assured in the areas under investigation,unreliable water conveyance and distribution is very common. In addition, the transporting canal is not usually lined and when they are lined, they need a lot of maintenance. The poor transporting canals force most farmers to use pumps to lift the water remaining in these canals for their purpose. This action is an additional cost to cost of cultivation.

Some farmers live far away from their cultivated lands such asin the center of the district or nearby town far from the village because of better access to health and other services there.

Sometimes farmers (mostly related) agree to cultivate their lands jointly. In this case, the land is large enough to be economically cultivated and serviced. They grow vegetables in plastic houses and grow animals. Therefore, their land productivity is more stable and they can rent machines and buy pump and consequently, they are in good position to accept recommendations toincrease the cultivated area during the successive seasons.

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

Parameter	Site 1 Dujaila (13 Farmers)	Site 2 Musayab (17 Farmers)	Site 3 Abu-Alkhaseeb (15 Farmers)
Number of family members	6 – 32	4-30	2-20
Numberof working members	2 – 18	1 – 16	3 -12
Engagement of members in farm work	Very limited– Good	Limited - Good	Limited -Good
Education	Primary school - High Education	Primary –University	Intermediate- University
Women contribution in farm work	Limited	Yes	Yes
Standard of living*	Poor - Medium	Medium – Good	Medium
Other agricultural activities	Livestock farming (6)	None (12) -Animal farming (5)	Animal farming (15)
Land owner	The farmer	- Farmer (3) - Contract (14)	- Farmer (6) - Contract (9)
Type of land holding	Contract (Law# 35)	Contract (Laws# 35 and 117)	Contract (Laws# 35 and 117)
Role of governmental establishments	None – Very limited	None	None
Role of extension workers	None – Poor	None	None
Role of NGO	None	None	None
Household income distribution	Family shares the income	Farmer keeps it all	Farmer keeps it all
Experience doing agriculture	3-30 years	20-30 years	20 years
Type of housing	- Rural (4) - Village (9)	Bricks, field	Bricks, field
Reasons not to cultivate all land	- low return (1) - salinity and water shortage (12)	Salinity, water shortage (17)	Water salinity (15)
Criteria for crop and variety selection	tolerant to salinity	- tolerant to salinity - local market	- tolerant to salinity - local market

*Poor: less than USD 300/month; medium: USD 300 – 700/month; good: greater than USD 700

Biophysical status of the sites

Dujaila Site

The 13 outstanding farmers interviewed for this study practice some techniques which distinguishes them from their neighbors. Among these practices noted in this area are the followings:

- Levelling of land before cultivation.
- Preseason application of heavy irrigation (*Tarbasa*). It is to leach before cultivation.
- Post-harvest mixing of plant residues into soil surface
- Use of rotation, for legumes (clover, alfalfa, broad beans, or mung beans) after grain crop
- Avoid fallow during summer season by plowing land to breakdown the capillarity and minimizes the capillary action
- Use of high tolerant crop to salinity (barley or local variety) for two to three seasons before cultivation wheat. After this practice, barley at times is replaced by wheat, corn, legumes, and vegetables.
- Dig a drain or deep ditch around the land or part of the land to lower the groundwater and collect the surface leaching water from land particularly during the first seasons and connect to the collective drain in the area.
- 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.
- Level or line of seeding far from salinity effect for crops like cotton, sunflower, and mung beans. Vegetable crops are cultivated in the same way.
- Continuous cultivation of land is a must to keep their soils far from resalinization processes.

On evaluation of yield and land productivity of these cultivated lands after application of the abovementioned practices, we noticed an improvement in yield as a result in improvement of physical, chemical, and biological properties of soil. These results will be part of next report due in July, 2012.

Musayab Site

Seventeen farmers were selected based on soil salinity and the use of practices in management their saline lands. Most farmers use post-harvest crop for animal feed and normally 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:

- Dividing the land into parts to control irrigation, leveling, and other agricultural practices
- Conventional plowing to 30 cm depth and giving preseason heavy irrigation to leach some salts.
- Planting most tolerant crops to salinity (Barley, alfalfa, okra, and egg plants) to a portion of land.
- Farmers expand these practices to other portions of the land.
- After few seasons, farmers replace the salinity tolerant crops with wheat.
- Few farmers use subsoil plowing to depth of 70 cm in the reclamation process.
- Farmers mix residual plants with soil to improve physical conditions of the soil.
- Some farmers add straw on the soil surface to increase the rate of germination and increase the water soil water holding capacity.
- Some farmers add manure (poultry) and mix it with soil in vegetable production.
- Some farmers plow the land during summer season to minimize the capillary action.
- Deepen the irrigation channels to more than one meter for storing more water which can be used at time of water shortage.

Abu-Alkhaseeb

Evaluation of the forms indicates that the 15 outstandingfarmers are practicing the following to manage their saline lands:

- Cultivation of vegetable crops in plastic houses using manure layer and the sand layer to manage salinity of irrigation water.
- 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.
- Using of mineral fertilizers (soil or foliar application) although they are expensive, to maximize yields.

Table 3. Analysis of biophysical data based on questionnaire forms of the outstanding farmers at the three investigated sites (Dujaila, Musayab, and Abu-Alkhaseeb) which presents comparison between the three sites of the biophysical survey findings.

Parameter	Site 1 Dujaila (13 Farmers)	Site 2 Musayab (17 Farmers)	Site 3 Abu-Khaseeb (15 Farmers)
Soil Type*	Si. C. L. – Si. C.	Loam - Si. L.	Si. C. L. - Si. C.
Soil EC (dS/m) (Before practicing)	30-70	10-12	10-20
Soil EC (dS/m) (After practicing)	15-23	4.6-7.8	7-15
Irrigationwater quality: EC (dS/m):	1.0-1.3	1.3-1.8	2.5-6.0
Distance of source (Irrig. wat.) (km)	0.3-3.0	3-35	Close to (Shatt Al-Arab)
Surface plowing	Disking/mold plow	Disking/mold plow	Disking
Sub soiling	2 /13	1/17	None
Major crop	Barley/wheat	Wheat/corn	Vegetables/alfalfa
Variety	Local	Ibaa (wheat) Corn (Hybrid)	Market
Mixing of plant residue	2/13	Yes	Yes
Seeding method	Manual (11/13) Machine (2/13)	Manual	Manual
Irrigation method (Flooding)	Gravity (6/13) Pumps (7/13)	Pumps	- Plastic House: Drip - Forage crop: Flood.
Preseason irrigation	9/13	Yes	None
Over irrigation	3/13	None	Yes
Fallow with plowing	9/13	9/17	Dividing
Machinery	Renting (9/13)	1/17	8/15
Machines belong to farmer	4/13	16/17	7/15
Sprinkler irrig. sys.	None	None	None
Drainage facilities	None	Deteriorated	None
Reuse drainage water	None	1/17	None
Rotation	Wheat or Barley-legumes (4/13)	Wheat/Corn-legumes (17)	None (9/15) Veg.-alfalfa (6/15)
Crops cultivated	Field crops + vegetables (3/13)	Wheat, corn, vegetables, alfalfa (17)	Forage, vegetables,
Orchards	3/13	None	Date palms
Availability of water	Rational	Rational (weekly)	Shatt Al-Arab (Tidal)
Irrigation Water sufficiency	Insufficient	Insufficient	Available
Fertilizer use	Yes	Yes	Yes
Herbicides use	2/13	None	None
Bio-pesticides	None	None	None
Organic farming	None	None	None

*Si: Silt, C: clay; L: Loam

CONCLUSIONS

- Farmers of the investigated sites are managing their saline land by adopting some practices on their own without the intervention of governmental or scientific establishments.
- The adopted practices prove to be successful in reducing land salinity, improve land productivity, and thus maximize yields.
- With the absence of infrastructures to lower the height of saline groundwater and efficient irrigation systems, these practices seem promising in the short- and long-term in managing land salinity in central and southern Iraq.
- Some successful practices can be disseminated among farmers of the region for better managing lands suffering from salinity.

REFERENCES

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

Appendix 1

Survey sheet of 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. Levelling	
	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	