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Project Report 1

BASELINE SOCIO-ECONOMIC SURVEY IN THE SALT-AFFECTED AREAS OF ETHIOPIA AND SOUTH SUDAN





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REHABILITATION AND MANAGEMENT OF SALT-AFFECTED SOILS TO IMPROVE AGRICULTURAL PRODUCTIVITY (RAMSAP) IN ETHIOPIA AND SOUTH SUDAN

Baseline socio-economic survey in the salt-affected areas of Ethiopia and South Sudan

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Rehabilitation and management of salt-affected soils to improve agricultural productivity in Ethiopia and South Sudan (RAMSAP)

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EXECUTIVE SUMMARY

This study presents the results of a baseline socio-economic survey which was conducted in the target areas of Ethiopia and South Sudan to collect first-hand information on demographic and socio-economic conditions of farmers, extent of salt-affected low productive lands and their impact on the livelihood of rural communities and identify limitations and constraints in the adoption of innovative technologies and approaches for improving agricultural productivity.

The analysis of the household survey showed that the farming system followed by livestock income are the major sources of the households' income in the target areas of Ethiopia. The household earning is done by both men and women. Most of the farm labor activities are performed by men whereas women take part in storage, fodder cutting, animal keeping and household activities. Among the households, lack of access to agricultural information, poor extension services from government and NGOs, and limited access to irrigation / rain water for agricultural production were set as production constraints.

Most of the landholdings are affected by salinity with different ratios of production loss. Observing white crust and dark brown color of the soil in the farmland are the major salinity identification indicators used by the households. Majority of the household revealed that the main causes for salinization are poor irrigation management and drainage related problems. Salinity affects directly or indirectly the livelihoods of the households. From the analysis of the baseline household and visual field reconnaissance survey, the following recommendations can be made:

- Continuous assessment and monitoring should be implemented to avoid the occurrence and increasing trend of soil salinity in the district.
- Surface and subsurface drainage systems should be installed in the waterlogged areas since more farmlands are abandoned from time to time.
- Selection of suitable plant varieties that can deeply extract the amount of perched water near the surface to lower the shallow ground water table, which is the main factor for the cause of salinity and waterlogging.
- For highly salt-affected lands, integrated crop-livestock technology packages need to be introduced to improve food security and diversify incomes of farmers through the sale of animal products and forages to local markets, thus making the production systems economically sustainable.
- Marketing of produce at reasonable prices is the major issue of households. Therefore, there is a need to develop a marketing mechanism for buying agricultural products of smallholder farmers at their true value. This will encourage them to increase their crop production and improve their incomes.

In South Sudan, availability of irrigation water is the most challenging factor in the selected areas and farmers largely depend on seasonal rains. Therefore, developing water resources such as access to groundwater and rainwater harvesting is needed to solve ongoing food security problems. The cost-effective small-scale furrow and drip irrigation systems introduced through the RAMSAP project in the selected sites could be an effective way to overcome water shortages. These irrigation systems have been constructed using locally available materials to keep the cost affordable for small holder farmers.

Most of the farmers in the selected sites depend on locally produced seed, obtained from their harvested crops. These seeds are poorly stored and sometimes infected which results in low crop productivities. Therefore, provision of healthy seed production and training of farmers on storage techniques is widely suggested by respondents during this survey.

Lack of agricultural machinery is also reported as one of the major reasons of low crop yields in the selected areas. Farmers suggest that government should provide machinery on subsidized rates or on rental basis. The required machinery includes tillage equipment, planters,

chemical sprayers, ridges, levelers, ditchers, harvesters, threshers and transporting trailers. In many areas, farmers have enormous numbers of tractors, but they lack agricultural machinery. Most of the farmers use wide level disc planters for land preparation, which uses lots of fuel and damages soil structure due to excessive moment of tractor and the machinery on the soil. In other areas, only tractors and tillage equipment (i.e. planting, chemical spraying, harvesting and threshing) are available. The maintenance of this machinery and spare parts is a major problem in South Sudan.

This socio-economic survey data shows that there is a big technology gap among farmers in the five selected areas. Majority of the farmers rely on traditional methods of cultivation, which results in low crop productivity. This situation has forced farmers to look for other income generation activities in nearby towns and cities. Therefore, intensive extension services are needed to keep farmers informed of the improved agricultural techniques for better production. Farmers usually cultivate crops for domestic consumption due to financial problems. It is, therefore, important to encourage farmers to increase their cultivated area and produce crops for local marketing. This can be done by creating marketing awareness of the farmers. Farmers have given following suggestions to improve agricultural productivity:

- Most farmers use surface irrigation system and suggested the needs for training and provision of appropriate design system to optimize irrigation water use efficiency and crop production in South Sudan.

- The availability of appropriate and low-cost irrigation system using local materials in South Sudan received attention of farmers for its low-cost and ease of installation. The locally produced drip and furrow irrigation systems may help local smallholder farmers due to its affordability. Farmers demand extension of these irrigation methods at larger scale through government support.

- Establishment of agricultural extension services for farmers should be one of the priorities of the government and stakeholders.

- Training of local vegetable growing farmers on modern irrigation methods such as drip and sprinkler irrigation system and provision of irrigation equipment to the farmers.

- Benefits of drip irrigation system can be maximized when they are properly designed, managed, and maintained. Farmers should be provided the consultancy services to properly design drip irrigation system since the drip design is complex. Different manuals produced by different manufacturers on different design factors may also help farmers to ensure properly designed drip irrigation system.

- The state and national governments, who are concerned with agriculture development, should provide seeds and loans to vegetable growers to enable them to improve their crop production and cultivation of crop during dry period.

1. INTRODUCTION

Agriculture sector plays an important role in Ethiopian economy as it supports 80 percent of the work force, whereas 85 percent of the total population living in rural areas is directly dependent on agriculture for their livelihoods. Seven million smallholder farmers of Ethiopia are producing about 95 percent of the total agricul- tural outputs including food crops, cereals, oil seeds and pulses. Cotton and sugar are produced on state-owned large-scale enterprises. Ethiopia has large livestock resources including cattle, sheep, goats and camels. Despite this high biodiversity and distinctive ecosystems, food shortages are widespread. High population growth rate, lack of technological advances, recurrent droughts over the last three decades and accelerating degradation of land and water resources and the environment are considered as the major reasons for stagnation and even drop in crop yields.

In South Sudan, agriculture accounts for 36 percent of the non-oil GDP with 80 percent of the population living in rural areas largely dependent on subsistence farming, and 75 percent of the households consuming cereals as a main part of their daily diet. Despite abundant water supplies, only 5 percent of total 30 million hectares (ha) arable land is cultivated. Crop yields are extremely low, which negatively affect incomes and livelihoods of poor farmers. Lack of agricultural inputs such as seed and fertilizer, poor advisory services and inefficient irrigation management are considered as the major barriers. Although South Sudan has highest livestock per capita in the world, with 23 million head of cattle, sheep, and goats, there is little use of improved varieties of seed or breeds of livestock. To improve livestock productivity, there is a strong need for improved forage varieties that are resistant to common diseases.

Soil salinization is a major threat for the sustainability of irrigated agriculture in Ethiopia and South Sudan as it reduces natural biodiversity as well as farm and livestock productivity. Today, Ethiopia stands first in Africa in the extent of area of salt-affected soils due to human-induced and natural causes. Current estimates suggest that over 11 million ha land is exposed to salinity and sodicity, out of which 8 million ha have combined salinity and alkalinity problems whereas the rest 3 million ha have alkalinity problems. The salt-affected lands in South Sudan are located in the White Nile irrigation schemes. These areas have hardly been utilized for agricultural production despite having great potential due to freshwater availability from Nile.

To address land degradation challenges, International Center for Biosaline Agriculture (ICBA), with the financial support of International Fund for Agricultural Development (IFAD), started a project on "Rehabilitation and management of salt-affected soils to improve agricultural productivity (RAMSAP)" in Ethiopia and South Sudan. This project was launched in 2016 with the aim to understand the extent and causes of soil salinity and develop strategies to rehabilitate and manage saline lands through an introduction of improved water management practices, salt- and drought- tolerant crops, forages and halophytes.

During 2016-17, a baseline socio-economic survey was conducted in the target areas of Ethiopia and South Sudan to collect data on demographic and socio-economic characteristics of farmers, extent of saline lands and their impact on the livelihood of farming communities and identify limitations and constraints in the adoption of innovative technologies and approaches for improving agricultural productivity. The role of women in agriculture and the problems faced by them in maintaining household food security were also addressed. The survey was conducted in the selected districts of different regions of both countries in collaboration with the local partners. Field teams were trained and questionnaire was field tested before commencing the actual survey. The collected data was analyzed to understand farmer perceptions about the extent of salt-affected lands and crop productivity and suggestions for improvement.

2. DESCRIPTION OF STUDY AREAS

2.1 Ethiopia

In Ethiopia, five districts from four regional states were selected for this survey. These included Amibara and Dubti districts from the Afar region, Zeway-Dugda district from the Oromia region, Kewet (Shoa robit) district from the Amhara region, and Raya-Alameta district from the Tigray region. The characteristics of selected sites are briefly discussed below.

2.1.1 Amibara district

This district is in the Gabiressu zone of the Afar region, which is 278 km northeast of Addis Ababa, capital city of Ethiopia. The area represents semi-arid to arid climate with an average elevation of 740 meters above mean sea level. The mean annual rainfall and maximum and minimum temperatures are 571 mm, 34° C and 19°C, respectively. The main crops grown are cotton, with limited cultivation of wheat, maize, and vegetables. Sugarcane is planted mainly on state-owned farms. The soils are predominantly Eutric Fluvents; order Fluvisols followed by Vertisols occupying 30 percent of the total area (Italconsult, 1969; Halcrow and Partners 1982). The problems of salinity and sodicity are wide-spread in the irrigated areas of Amibara district (Gedion, 2009; Frew et al., 2015; Ashenafi and Bobe, 2016). The main causes of salinity and sodicity issues are poor irrigation and water management practices and insufficient drainage infrastructure.

2.1.2 Dubti district

Dubti district is in the Afar region, northern part of the Rift Valley at the lower portion of the Awash basin about 600 km northeast of Addis Ababa with an altitude of 380 meters above mean sea level (WWDSE, 2004). The mean minimum and maximum temperatures are 23° C and 49° C, respectively. The average annual rainfall is 222 mm compared to mean annual evapotranspiration of 2854 mm, which makes irrigation necessary to support crop production (Sileshi et al., 2015). The soils belong to five main soil units; Solonetz (39%), Calcisols (28%), Solonchak (15%), Vertisols (14%) and Fluvisols (4%). The soils are characterized by massive soil structure which can be attributed to the dominance of exchangeable sodium (WWDSE, 2004; Sileshi et al., 2015). Groundwater flow has also a key importance in the Awash Basin since the highland's fractured volcanic cover is substantial for the favorable groundwater recharge process (Ayenew et al., 2008). All the proposed initial development of Dubti/-Tendaho area is not used for farming due to its high salinity problems.

2.1.3 Raya-Alamata district

The Raya Alamata district is in the southern zone of the Tigray region with an elevation of 1520 meters above mean sea level (REST, 1998). The climate is semi-arid and arid with mean annual rainfall of 663 mm, and minimum and maximum temperatures of 15° C and 28° C, respectively. The Raya valley is one of the most productive areas in the Tigray region. Teff and sorghum crops are grown on 75 percent of the area, whereas cereals and vegetables are grown on the other 25 percent. The major soil types in the district are Cambisols, Fluvisols, Leptosols and Vertisols, with each covering about 20 percent of the area (Amanuel et al., 2015). The shallow groundwater table equals to 130 cm due to lack of drainage and poor irrigation practices.

2.1.4 Kewet district

Kewet district is in the North Shoa zone of the Amhara region within the Awash River basin in the Rift valley system, 235 km northeast of Addis Ababa. The district is classified as hot to warm moist agro-ecological zone with a mean annual rainfall of 1000 mm and temperatures ranges from 17° C to 32° C (Tilaye and Mekonen, 2001). The parent rock materials of this basin are basalt and some other volcanic formation and alluvial and colluvial deposits (FAO, 1965). The soil of the Robi River valley is

typically dark gray when dry and very dark gray brown when moist with a clay texture. The clay is montmorillonite type, which have high shrinkage capacity when dry and high swelling when wet (Murphy, 1968). The district is widely irrigated through springs, the river Jeweha and its tributaries. The area is mainly cropped with teff, sorghum, onion, maize and tobacco. With increased irrigation activity in the area after the establishment of the tobacco industry, signs of soil salinization are becoming prevalent in many areas.

2.1.5 Zeway-Dugda district

Zeway-Dugda district is a part of the Central Rift Valley in the Oromia region, about 145 km south of Addis Ababa, with an elevation of 1520 meters above mean sea level. The climate of the area is arid in nature with mean annual rainfall of 760 mm (MoWR, 2006). The highest temperatures occur between March and June prior to the start of the main rains, though seasonal variation in daily temperature is relatively slight. The mean annual temperature of the area is within the range of 16–25° C (MoWR, 2006). The areas around Lake Zeway are composed of volcanic rocks, with alkaline lavas, ashes and ignimbrites, mainly of Tertiary and younger age. The sediments covering the volcanic rocks in the area are, generally mixed deposits of sandstone, limestone and silts, with frequent occurrences of evaporite minerals (BGS, 2001). In Zeway, area gentle levees are formed of sandy clay loams.

2.2 South Sudan

South Sudan is located in East Africa extending over an area of 640,000 km2. It borders with Ethiopia, Kenya, Uganda, and Democratic Republic of Congo in the south and Central African Republic in the west. The rainfall patterns are zone dependent ranging from 500–2000 mm, which provides 130–300 days of growing season. The performance of agriculture sector varies with time and location. The temperatures are variable and range from 25 to 35°C. The dry hot conditions trigger human and livestock migrations to more permanent water sources, which serve as dry season grazing and fishing areas.

The major water resources of South Sudan are the Nile, its tributaries, and groundwater. The low lands of the White Nile Valley have great potential for irrigation due to availability of fresh water from the Nile river, but these soils have hardly been utilized for agricultural production. Despite abundant water resources, only 5 percent of the total area is irrigated due to lack of irrigation infrastructure. Surface irrigation methods such as basin and/or flooding are commonly used, which results in water use efficiencies as low as 30–35 percent.

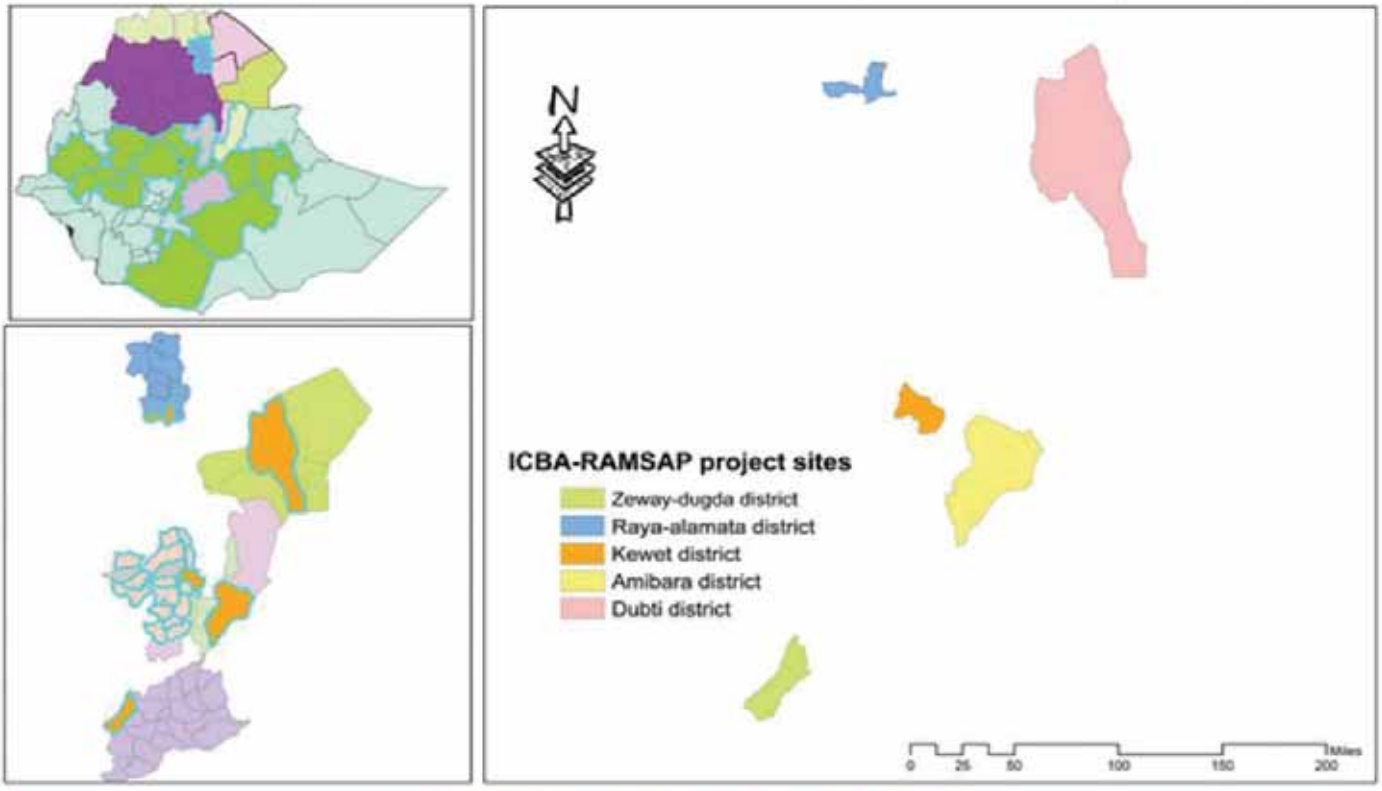

Figure 1. Location of the selected sites in Ethiopia

About 95 percent of the land is suitable for agriculture, out of which 50 percent is prime land with high suitability to grow all sorts of crops. South Sudan has highest per capita livestock holding in Africa and livestock sector accounts for 15 percent of the total GDP. Forest cover is about 30 percent of the total area. Land productivity is generally low due to lack of agricultural inputs such as seeds, fertilizer, pesticides, agricultural machinery and higher labor costs. Nearly all farmers in South Sudan depend on traditional methods for seed and grain storage. These methods increase post-harvest losses and the quality of seeds is compromised, which affects crop yields as well as nutritional value of the produce. Most of the farmers are not aware and do not have access to modern irrigation technologies. The major reasons for lower land and water productivities include:

- Poor agronomic and irrigation practices resulting in land degradation;
- Costly land reclamation;
- Deforestation because of logging and charcoal burning;
- Overgrazing and bush burning;
- Lack of adequate quality seeds and improved farm technologies, etc.;
- Climate variability e.g. rampant floods and drought;
- Lack of infrastructure/equipped central soil and water laboratory.

Figure 2. Location of the selected sites in South Sudan.

For South Sudan, five states were selected for conducting baseline socio-economic survey. The selected states include: Jubiek, Jongule, Aweil, Nayamurnang, and East Nile state. These locations were selected after consultation with the representatives of the Ministry of Agriculture and Food Security, research organizations and research scientists. For each selected state there are number of sites as listed below:

- Jubeik State (Juba) - Juba, Luri, and Rajaf
- Jongule state (Bor) - Bor town, Panliet and Cuei Nyok)
- Aweil State (Aweil) - Nyalith, Awulic, Rice Scheme Nogwe, and Kuom
- Namurnang state (Kapoeta) - Kapoeta, Katico, Lomilmil and Kotomo
- East Nile state (Renk) - Renk, Rumeila, Mangara, Khor Ajais, Abu Khadra and Feyuer

These sites were selected using the following criteria:

- Marginal degraded lands with low productivity due to poor agronomic and water management practices;
- Large number of poor resourced farm-households including women and youth with mainly rare cattle and small ruminants;
- Availability of local partners and state government staff on ground;
- Shallow groundwater levels and poor quality in Jonglei (Bor) and Unity (Bentiu) states. The general characteristics of the selected sites are given in Table 1.

S/N	Site	Zone	Type of Crops
1.	Aweil	Western Flood Plains	(Agro-pastoralism): livestock and agriculture predominant. Main crops are sorghum, pearl millet vegetables, cow peas
2.	Bentiu	Nile-Sobat Rivers	(Agro-pastoralism and fishing): prone to seasonal flooding. Major crops sorghum, beans and vegetables.
3.	Bor	Nile-Sobat Rivers	(Agro-pastoralism and fishing): prone to seasonal flooding. Major crops include sorghum, beans and vegetables.
4.	Torit	Hills & Mountains	Agriculture and livestock husbandry. Crops include cassava, sweet potatoes, sorghum, maize, finger, pearl millet.
5.	Juba	Hills & Mountains	Agriculture and livestock husbandry. Crops include cassava, sweet potatoes, sorghum, maize, finger, pearl millet.

3. METHODOLOGY

The baseline socio-economic survey was conducted to document socio-economic conditions of the farming communities living in the selected project sites. It was anticipated that the results of this survey will provide useful information in understanding the status of salt-affected lands in both countries and their impact on the livelihood of farming communities. The information about the causes of salinity development and the way irrigation water management is done by farmers was also part of this survey. The survey also identified limita- tions and constraints in the adoption of innovative technologies and approaches for managing saline soils and improving agricultural productivity. The role of women in performing different agricultural tasks was highlighted and the problems faced by them in maintaining household food security and livelihood were addressed.

Multi stage random sampling techniques were used for the selection of study sites and sample respondents. The study districts were selected based on the prevalence of salinity problems due to long term mechanized irrigated state farms and commercial agricultural practices. In this study, both primary and secondary data were used. Secondary data were also collected from different sources like districts offices of agriculture and pastoral development, published and unpublished documents and others.

During the study, both qualitative and quantitative information was collected using different survey tools like structured questionnaire, key informant interview and focus group discussions. Discussions were also conducted with the government representatives and farmers to understand the socio-economic constraints of the farmers in diversifying their cropping patterns and increasing agricultural productivity through the adoption of new and promising technologies. In addition, information on socio-economic aspects was also collected from both countries.

The survey was conducted using a socio-economic questionnaire, which was developed by the socio-economic teams of ICBA, South Sudan and Ethiopia. As a survey tool, focus group discussions and key informant interviews were also conducted. Before conducting the actual field survey, this questionnaire was tested in the field. The field teams of both countries underwent a training before the start of the project. The training was conducted by the agricultural economist of ICBA. Information on socio-economic aspects was also collected from both countries. Discussions were also held with the government representatives and farmers to understand the socio-economic constraints of the farmers in diversifying their cropping patterns and increasing agricultural productivity through the adoption of new and promising technologies.

Besides, focus group discussions, key informant interviews were also held with selected individuals including both men and women household heads. Before conducting survey, following steps were followed:

- A well-structured questionnaire was developed by the socio-economic teams of ICBA, and partners in South Sudan and Ethiopia for the collection of first-hand data and information to quantify the effects of salinity on livelihoods of smallholders in salt-affected areas.
- The questionnaire was thoroughly reviewed by professionals including soil scientists, irrigation expertise, social scientists and extension workers.
- The developed questionnaire was pre-tested in the field by trained enumerators to obtain necessary feedback and make corrections accordingly.
- All enumerators including translators were trained in an orientation session. The field teams of both countries were trained before the start of the project. The training was conducted by the agricultural economist of ICBA. The questionnaire used for this study is given in Appendix 3.

The survey was conducted at regional and household levels. From each selected site, 25–30 respondents with a mix of big and small farmers were selected. Consideration were also given to owner and tenant farmers (50/50, wherever possible). Focal persons in both countries developed the strategy for the survey in limited possible time

and resources. Local staff of collaborating organizations was mobilized to conduct this survey, entering the data and perform analysis. The focal persons in Ethiopia and South Sudan developed a detailed plan for conducting the surveys, which included areas of surveys, resources needed, timeline, data analysis and report writing.

During the survey, in addition to parameters on agricultural productivity and socio-economic constraints, infor- mation on age, marital status, income, and other household characteristics were also collected. The farming system of the selected areas were characterized as mixed crop-livestock systems. Thus, the livelihood of most of the respondents is based on both farming and livestock rearing.

From the four regions of Ethiopia, sample respondents were selected with randomly purposive sampling techniques. Here pastoralists/agro-pastoralists with farmlands were taken as a population and from them only farmlands with salinity problem were considered and sampled randomly. Generally, the number of inter- viewees equaled to 67 and 35 from Amibara and Dubti districts of Afar Regional states, 88 from Raya-Alamata district of Tigray Regional states, 45 from Kewet district of Amhara Regional states and 65 from Zeway-dugda district of Oromia Regional states. A total 300 respondents were selected from five selected districts from four regions of Ethiopia.

From South Sudan, 40 respondents were interviewed from each of the five selected sites i.e. Juba, Kapoeta, Bor, Aweil and Renk, making the total sample size to 200. The qualitative and quantitative data collected through structured questionnaires, key informant interviews and focus group discussions were analyzed by using mean, percentage, frequency and ANOVA. SPSS Version 20 software was used to carry out statistical analysis.

Figure 3. Baseline survey and group discussions in South Sudan and Ethiopia.

4. Results of socio-economic baseline survey in Ethiopia

4.1 Results of Amibara and Dubti districts of the Afar Region

4.1.1 Demographic characteristics of sample respondents

The demographic characteristics of the respondents included gender, age, family size and composition, and marital status of the households. From the total (120) sample respondents, 67 (65.69%) were from Amibara district and the remaining 35 (34.31%) were from Dubti district. About the gender distribution of the sample households, only 10 (9.8%) were female while the remaining 92 (90.2%) were male-headed. About 60 percent of the female-headed households were from Amibara and 40 percent were from Dubti. Within the district, 11.43 percent of the Dubti and 8.96 percent of the Amibara respondents were female-headed while 88.57 percent and 91.04 percent of the Dubti and Amibara respondents were male-headed households.

Table 1. Distribution of respondents by gender and districts

Gender of Respondents	Amibara	Dubti	Total (%)
Female	6	4	9.80
Male	61	31	90.20
Total	67	35	100

The mean age of the respondent household was 39.5 years with a maximum of 82 years and a minimum of 20 years. The mean age of household head of Amibara was about 40 years and 38.6 years for Dubti. However, there was no statistically significant mean age difference in the respondent of the two districts.

Table 2. Age of household heads by districts

District	Amibara	Dubti	Total (%)
Female	6	40.0	11.52
Male	35	38.6	12.66
Total	102	39.5	11.88

This survey considers the size of a household as the sum of an agro-pastoralist, his/her spouse, offspring and dependents. The family size of the sample respondents varies between 1 and 20 with an average value of 7, which matches with the regional average. The household members with less than 15 years of age and those with more than 64 years of age ranges from 0 to 6; while those household members aged between 15 and 64 ranges from 0 to 8. On average, family size and productive family members of the survey areas were, 6.67 and 0.84, respectively, with dependency ratio calculated as the proportion of household members less than 14 years of age and older 64 years of age from active population.

Table 3. Household size and dependency ratio of the study areas by age group

Households	Amibara		Dubti		Total (%)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
< 14 years	2.65	1.96	2.06	1.76	2.43	1.91
< 64 years	0.05	0.21	0.09	0.28	0.06	0.24
>14 and <65	4.16	2.31	3.43	2.40	3.91	2.36
Total family	7.15	3.38	5.74	3.64	6.70	3.52

Non-availability of labor is the major factor for low productivity in pastoral household members. In this case, average dependency ratio is approximately equal to one. This implies that 50 percent of the population is economically dependent on a family size with 1 to 20 members.

Table 4. Marital status of respondents by districts (%).

Households	District		Total
	Amibara	Dubti	
Single	4.40	5.71	4.90
Married (one)	77.60	74.29	76.47
Married (more than one)	13.40	8.57	11.76
Divorced	3.00	5.71	3.92
Widowed	1.50	5.71	2.94

Socio-economic characteristics of respondents

The socio-economic characteristics included the level of education of the household heads, livestock size (holding), farmland size (hectare), livelihood (income) sources and others. As far as level of education is considered, almost 50 percent of the households in the study areas were, illiterate (cannot read and write) and 36.28 percent were at least able to read and write while only 13.73 percent of the respondents had access to secondary education.

Table 5. Marital status of respondents by districts (%).

Level of Education	District		Total
	Amibara	Dubti	
Illiterate	50.75	48.57	50.00
Adult education	16.42	20.00	17.65
Formal education	16.42	22.86	18.63
Secondary education	16.42	8.57	13.73

Livestock ownership is a proxy for wealth in Ethiopia. Among Afar pastoralists, livestock asset holdings and the type of species determine wealth of a family. This is because livestock is the source of food, income, prestige and security in times of hardship for pastoral communities. Therefore, in this study the number of livestock measured by tropical livestock unit (TLU) was used to estimate the livestock asset of an individual household. This was done because households have different composition of livestock; hence, a unit of measurement for livestock was needed to use livestock as an indicator variable to compare households.

Table 6 shows that the different livestock species kept by respondent households were cattle, camel, goat and sheep with average holding of 9.09, 2.75, 2.42, 0.91 TLU, respectively, while donkey, horse and poultry were not common. The per capita livestock holding was found to be 3.64 TLU on average, which is lower than (4.5 TLU) what was considered the minimum level to sustain traditional pastoral households in East Africa (Davies and Bennett, 2007). This shows that households in the study areas followed different livelihood strategies to complement livestock and livestock related income.

The different means of livings reported by the sample households include livestock herding, crop cultivation, off-farm wage employment, petty trade, permanent employment, food aid, and others. The survey results show that although livestock and livestock related income sources were the dominant means of living in pastoral and agro-pastoral livelihood systems, farming (crop sale), off-farm employment and permanent employment also contributed by 96.08 percent, 37.25 percent and 27.45 percent to the incomes of the respondents, respectively.

Table 6. Livestock ownership of sample households (TLU)

Livestock Species	Amibara		Dubti		Total	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Cattle	9.99	10.61	7.34	8.52	9.09	9.98
Camel	2.25	5.88	3.69	15.25	2.75	10.07
Goat	2.10	2.67	3.03	2.94	2.42	2.79
Sheep	0.92	0.98	0.89	1.04	0.91	0.99
Total Livestock	15.27	16.84	14.95	21.86	15.16	18.61

The average annual income that households earn from off-farm activities have shown that crop sale (farming) contributed the largest share (18,600 Ethiopian Birr, ETB) followed by livestock and permanent employment with 5,000 ETB and 3,200 ETB, respectively. Causal wage employment has also contributed considerable amount of income (2,900 ETB) annually. Petty trade and other income sources (food aid and clan land rent) were also helpful to fetch income for households. This clearly shows that the households need to engage themselves in multiple activities to earn their living and meet their daily food requirements. For practical reasons, these tasks are divided among male and female members of the family.

Table 7. Sources of households' income

Income sources	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Livestock	56	83.6	28	80	84	82.4
Farming	67	100	31	88.5	98	96.1
Off-farm wage	31	46.3	7	20.0	38	37.3
Permanent employment	19	28.4	9	25.7	28	27.5
Petty trade	2	3.0	3	8.57	5	4.90
Food aid	2	3.0	0	0.00	2	2.00
Others (clan land rent)	11	16.4	0	0.00	11	10.8

As far as the proportion of income is considered, farming or sale of crops took nearly 49 percent of the total annual income whereas sale livestock and livestock products, off-farm wage employment and permanent employment contributed about 24 percent, 13 percent and 11 percent of the total annual households' income, respectively.

Table 8. Households' annual income from different sources (in ETB)

Income Sources	Amibara		Dubti		Total	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Livestock	4940	4784	5202	3954	9.09	4489
Farming	18400	21999	18959	15.25	25158	23039
Permanent employment	3420	6969	2754	2.94	5017	6329
Causal employment	3122	4313	2460	1.04	5312.30	4674
Petty trade	437	2480	285	21.86	957.06	2068
Other sources	242	541	0.00	21.86	0.00	449

The survey results indicate that average landholding in the study areas is about 1.5 hectare with a minimum and maximum of 0.15 and 6.5 hectares, respectively. The result of the t-statistics test showed that there is significant mean difference (P< 0.01) in farmland size among households of the study districts. Households at Dubti district have larger farmland than households of Amibara district. Similarly, the number of parcels that the household had differ significantly (P< 0.1) between districts with a combined mean of 1.25 and a minimum and maximum of 1 and 3 parcels, respectively. A household at Dubti has 1.37 parcels of farmland on average whereas at Amibara a household has 1.19 parcels of farmland.

The distance fromthe residences to the farmlandalsovaried-significantly. The average distance of the farmlandfrom the residence house was 2.64 kilometers at Dubti district while itwas 1.5 kilometers at Amibara district with acombined mean distance of 1.89 kilometers and a minimum and maximum distance of 0.1 and 12 kilometers, respectively.

Table 9. Farm size, number of plots and distance of farmland to home of respondents

Farm size	Amibara		Dubti		Total	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Farmland size (ha)	1.21	1.23	1.97	1.48	1.47	1.37
Number of plots/parcels	1.19	.43	1.37	.59	1.25	.50
Distance from farmland (km)	1.49	2.24	2.64	3.15	1.89	2.63

Farmlands vary with fertility status due to various reasons and respondents were asked to categorize their own farmlands in terms of fertility status as poor (infertile), average and good (fertile) by themselves. Accordingly,
43.28 percent of the Amibara respondents and 57.14 percent of the Dubti respondents ranked their farmland as poor (infertile) while 50.75 percent of the Amibara and 37.14 percent of the Dubti respondents categorized their farmland as average and nearly 6 percent of respondents from both districts grouped their farmland as good (fertile). Generally, the result showed that most of the farmlands possessed by respondents are poor in terms of fertility.

Table 10. Fertility status of farmlands of respondents

Fertility status of the farmlands	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Poor	29	43.28	20	57.14	49	48.04
Average	34	50.75	13	37.14	47	46.08
Good	4	5.97	2	5.71	6	5.88

Agricultural activities and crop production in the study areas of Amibara and Dubti districts are fully operated using irrigation water sourced mainly/entirely from Awash River. As described earlier, irrigated agriculture has been dated in the late 1960s at both districts thanks to the expansion of state owned commercial farms.

Table 11. Major crops produced by respondent households

Descriptions	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Maize producers	22	80.00	28	32.84	50	49.02
Cotton producers	31	46.27	0	0.00	31	30.39
Onion producers	22	32.84	9	25.71	31	30.39
Tomato producers	16	23.88	12	34.29	28	27.45

Table 11 shows that there are significant statistical differences ($P < 0.01$) between maize and cotton producers of Amibara and Dubti districts. Large number of Amibara respondents produced maize and cotton. Although not statistically significant, 34 percent of the Dubti respondents produced tomato whereas only 24 percent did the same at Amibara. Many smallholder farms have been established along with large-scale state farms and private commercial farms in the study districts. The major crops grown in these districts are cotton, maize, onion, tomato and other vegetables. Until recently, cotton was the most popular crop in Dubti and Amibara regions. However, presently it has been substituted by sugarcane.

According to the survey results, almost all producers of the study districts have access to irrigation water. Due to this access to irrigation water, 49 percent of the total respondents cultivate maize as a staple food crop, 30 percent respondents (all from Amibara) produce cotton, while onion and tomato is cultivated by 30 percent and 27 percent of the total respondents, respectively.

Average productivities of crops grown in the areas vary due to number of constraints faced by producers. Soil salinity, lack of improved inputs best suited for the environment, expansion of invasive weeds and lack of technical knowledge are the major production constraints in order of importance both at Amibara and Dubti districts (Table 12). The second in importance are shortage of arable land and irrigation water constraints reported by 63.73 percent and 35.29 percent of the household respondents, respectively.

Table 12. Production constraints faced by household respondents

Production constraints	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Lack of inputs	64	95.52	27	77.14	91	89.22
Shortage of arable land	57	74.63	15	42.86	65	63.73
Lack of tech. knowledge	51	76.12	25	71.43	76	74.51
Shortage of water	30	44.78	6	17.14	36	35.29
Soil salinity	67	100	34	97.14	101	99.02
Growth of invasive weeds	52	77.61	25	71.43	77	75.49

Similarly, producers were faced with marketing constraints, as most of the produces are cash crops. With the same token, the marketing constraints were also ranked by respondents of the two districts. Subsequently, small quantity of produce, lack of market information and infrastructure and high transaction cost were the major marketing constraints with their respective orders reported by more than 50 percent of respondents. Additionally, low bargaining power and high involvement of brokers (middle men) were the final marketing constraints faced by 40.20 percent and 23.53 percent of the respondents, respectively.

Table 13. Marketing constraints faced by household respondents

Marketing constraints	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Lack of information	53	79.1	29	82.8	82	80.4
Small quantity of produce	57	58.1	28	80.0	85	83.3
High transaction cost	35	53.3	19	54.3	54	53.5
Lack of infrastructure	38	56.7	19	54.3	57	55.9
High broker involvement	18	26.8	6	17.1	24	23.5
Low bargaining power	23	34.3	18	51.4	41	40.2

The survey results indicate that 46 percent of the respondents, mostly located in Amibara and Dubti districts, were not food secured. However, the difference was not statistically significant. The deficit period is distributed all over the year, but most commonly reported food deficit months were March through June. This can be attributed to the fact that these months are the driest and hottest months and livestock have been traced for long distance in search of feed and water so that households couldn't get milk for immediate consumption.

Table 14. Food security status of sample respondents

Food security status	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Food insecure	30	44.78	17	48.57	47	46.08

Households use different strategies to tackle food shortages within the communities. In the study areas, as a tradition of pastoral and agro-pastoral communities, mutual support system was the most common strategy applied among the households at the time of shocks and risks. However, with the weakening of the pastoral traditional system this mutual support strategy is not working very efficiently. Therefore, other strategies have been adopted by the communities either through themselves or by governmental and non-governmental organizations (NGOs). About 44.68 percent of the total food deficit households used food for work activities as a copping strategy while 13 percent of them used donors' food aid as additional strategy. Food purchase and selling assets is also a copping strategy for food deficit among households of the study areas.

4.1.2 Analysis of salinity and salinity related factors

Salinity is a problem attached with agricultural production activities. For proper plant growth, special remedial measures and unique management practices are required to minimize the effects of soil salinity. These measures and management practices need to be disseminated to places and producers where the salinity problems are prevalent. During this survey, questions were asked by local communities regarding awareness of communities to salinity, status of salinity in the areas, effects caused by salinity and possible solutions suggested to mitigate the effects and expansion of salinity in the study areas.

Table 15 shows the results of the survey regarding access to agricultural information. More than half of the respondents do not have any information regarding their soils and other agricultural activities. This is the main reason that they are not able to take necessary measures at the right time to avoid salinity and low productivity problems. The result of the chi-square analysis showed that there is a significant difference between two districts in terms of access to agricultural information. The respondents from Dubti district have relatively better access than their counterparts in Amibara.

Table 15. Access to agricultural information by sample respondents

Access to agricultural information	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Lack of information	23	34.33	22	62.86	45	44.12
Small quantity of produce	44	65.67	13	37.14	57	55.88

Agricultural information can be accessed from different sources and methods by households in the study areas. The major information sources in the areas were government extension system, research institutes, non-gov- ernmental organizations and others.

Table 16. Sources of agricultural information to sample respondents

Sources of agricultural information	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Government extension	19	82.61	22	100	41	91.11
Research institute	3	13.04	0	0.00	3	6.67
Others	1	4.35	0	0.00	1	2.22

Table 16 shows that most of the information has been provided by the government extension system through the development agents at local kebele levels. However, due to the proximity of Werer Agricultural Research Center (WARC), 13 percent of the respondents from Amibara district obtained agricultural information from this research center.

Households obtained agricultural information through different channels such as, television, extension manual, training, friends and others. In conservative societies, like Afar pastoral and agro-pastoral, traditional means of information exchange have greater impacts as of other means. In this region, people prefer to have information from the village elders, friends and/or relatives rather than waiting for formal government or non-governmental organizations.

According to the survey result, nearly 50 percent of the respondents have obtained information from direct trainings given to them by different organizations while 44 percent of them obtained information from other sources like friends and local visits. Due to the low level of educational status and shortage of extension manuals, only 4 percent of the respondents obtained information from the extension manual (Table 17).

Table 17. Means of acquiring information by sample respondents

Means of Obtaining Information	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
TV	1	4.35	0	0.00	1	2.22
Extension manual	1	4.35	1	4.55	2	4.44
Training	13	56.52	9	40.91	22	48.89
Others	8	34.78	12	54.55	20	44.44

Table 18 shows that information about the soil salinization was available to 24 percent respondents only and the remaining 76 percent were unaware of any such information.

Table 18. Information obtained by households on salinity

Information on salinity	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Yes	6	26.09	5	22.73	11	24.44
No	17	73.91	17	77.27	34	75.56

Status of existence of salinity

Almost all respondents have reported that their farmland was affected by salinity even though the degree and its extent vary among households and districts. Producers were asked how they identified whether their farmland was affected by salinity. About 21 percent of the respondents used white crust on the soil surface

as an indicator of the salinity, 19 percent consider dark brown color of the soil whereas 43 percent used both white crust and dark brown color at the surface of the farmland as a witness for the presence of salinity. The trend at which salinity exists in the localities of the study areas has showed different results according to the survey results. Subsequently, 91 percent of the total respondents thought that salinity is increasing, about 6 percent consider no change in salinity whereas 3 percent believe that salinity is decreasing in their lands and localities (Table 19).

Table 19. Trends of salinity in the study areas

Trends of salinity	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Increasing	64	95.52	29	82.86	93	91.18
Decreasing	2	2.99	1	2.86	3	2.94
No change	1	1.49	5	14.29	6	5.88

The results show that there is no significant statistical difference between respondents and trends of salinity. The severity of salinity was rated as low, medium, high and very high at the time of survey. The results showed that 40.2 percent of the respondents consider extent of salinity as medium, 37 percent as high, 13.73 percent as low while 8.8 percent rated as very high severity.

Table 20. Severity of farmland salinity of sample respondents

Severity of salinity	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Low	10	14.93	4	11.43	14	13.73
Medium	28	41.79	13	37.14	41	40.20
High	23	34.33	15	42.86	38	37.25
Very high	6	8.96	3	8.57	9	8.82

More than 86 percent of the respondents consider quality of irrigation water as the major cause of soil salini- zation followed by poor land levelling (46%), poor irrigation practices (45%), drainage problem (41%), parent material (26%) and amount of irrigation water (25%). Table 21 shows that the problems of irrigation water quality and quantity, land levelling and introduction of improved irrigation methods need immediate attention to increase agricultural productivity.

Table 21. Perception of household respondents about causes of salinity

Causes of salinity	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Parent material	12	17.91	17	42.86	27	26.47
Irrigation water quality	59	88.06	29	82.86	88	86.27
Irrigation methods	23	34.33	23	65.71	46	45.10
Climatic conditions	5	7.46	9	25.71	14	13.73
Land levelling problem	32	47.76	15	42.86	47	46.08
Irrigation frequency	5	7.46	4	11.43	9	8.82
Irrigation water quantity	14	20.90	11	31.43	25	24.51
Drainage problem	34	50.75	8	22.86	42	41.18

Assessing the impacts of soil salinity

Salinity has exerted both direct and indirect effects on the livelihoods of producers in the study areas. The direct effects are related to abandoning of farmland (29.41%), declining farm productivity (52.94%), and decreasing household income (8.82%) as shown in the Table 22.

Table 22. Direct effects of salinity on sample respondents

Direct effects	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Abandoning farm land	14	20.90	16	45.71	30	29.41
Declining farm productivity	40	59.70	14	40.00	54	52.94
Decreased income	8	11.94	1	2.86	9	8.82
All above	3	4.48	3	8.58	6	5.88

The indirect impacts create socio-economic and livelihood problems for the communities living in these areas. These include increasing food insecurity (29.4%), decreasing employment opportunities (3.9%), increasing landlessness (45%), and increasing dependency (5.88%) on food aid programs. These factors have forced male members of the household to migrate to cities in search of off-farm jobs causing many social problems. Increasing salinity and food insecurity also create health issues especially for the women and children. Food deficiency leave more and more households at the mercy of food aid programs of the national and international organizations. With increasing demand, the capacity of these organizations is also squeezing adding more to food insecurity and malnutrition.

Table 23. Indirect effects of salinity on sample respondents

Indirect effects	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Increasing food insecurity	22	32.84	8	22.86	30	29.41
Decreasing employment	3	4.48	1	2.86	4	3.92
Increasing landlessness	27	40.30	19	54.23	46	45.10
Increasing dependency	6	8.96	0	0.00	6	5.88

The productivity loss caused by salinity ranges from complete loss to less than 10 percent loss. The 44.12 percent of respondents reported 50 percent loss in their productivity due to salinity while nearly 14 percent reported a complete loss of crop production. About 32 percent of the respondents reported 25 percent loss in their productivity due to soil salinization whereas 44 percent reported more than 50 percent loss in their agricultural productivity whereas about 13 percent of the respondents completely lost their crops due to soil salinization (Table 24). The yield losses in Dubti were higher than Amibara because Dubti area is more saline and dry due to shortage of irrigation water and low rainfall.

Table 24. Productivity losses caused by salinity on sample respondents

Productivity losses	Amibara		Dubti		Total	
	Frequency	%	Frequency	%	Frequency	%
Complete loss	10	14.93	4	11.43	14	13.73
50% loss	26	38.81	19	54.29	45	44.12
25% loss	24	35.82	9	25.71	33	32.35
10% loss	6	8.96	2	5.71	8	7.84
Less than 10% loss	1	1.49	1	2.86	2	1.96

Figure 4. Focus group discussion at Aseboda kebele (Keyafer) of Dubti district

4.1.3 Focus Group Discussion at Dubti and Amibara Districts

Focus group discussions and key informant interviews were held at Aseboda kebele (Kayaker) and Debel kebele (Burtale) in Dubti district. In Amibara, the discussions were held at Ambash kebele (Bonta) and at Kedigadora. Both male and female household heads participated in the discussions and shared their experiences and perceptions about salinity problems. At the same time, key informant interviews were conducted with selected individuals who have a very long experience of the localities and a reputation of their clans.

The result of the focal group discussion and key informant interview of the two districts have clearly reflected the impact of salinization on the livelihood of the producers to the extent of complete abandoning of farming lands. According to the discussant at Dubti district, the trend of salinization has been increasing in the last six years since Tendaho dam has become functional. They relate these increasing trends of salinization with the deterioration of quality of irrigation water, which emanates from the dam.

The group discussant at Dubti district also stated that they are becoming dependent on food aids from governmental and non-governmental organizations because their land and water resources have deteriorated because of soil salinization. For this reason, they put salinity at the top of lack of technical support, shortage/absence of input supply, flooding and shortage of irrigation water supply as agricultural production problems in their locality.

Farmers in Dubti (Burtale and Keyafer) are trying different approaches to cope with the salinity problems based on their indigenous knowledge. For example, allowing their farmland to grow Prosopis for a year or two and applying cow dung. They also explained that adding goat/sheep dung had no effect on salinity. However, they have observed that forage crops are better to tolerate salinity than cereals and vegetables. Therefore, they are interested to grow these crops if they have access to good quality seeds. Farmers are also practicing land levelling by reducing the plot size, which they call as duga, to reduce salinity at their farmland.

A key informant at Burtale kebele of Dubti district explained the condition as *"we are losing our livestock due to drought & diseases, our land due to expansion of state owned commercial farms & salinity, and we are unable to nourish our family and we are entirely dependent on food aid for more than six months in ayear. Our remaining cattle are hundreds of kilometers away from us in search of feed, our land productivity is low, our livelihood deteriorates fromtime to time, andour vulnerability is increasing. We are tired of talking about our problems without havingany solution. Our people are ready to do everything possible and to accept a technology that could mitigate salinity and increase the productivity of our farmland."*

Figure 5. Focus group discussions at Debel kebele (Burtale) of Dubti district

In Amibara district, increasing salinization problem has been caused due to the deterioration of quality of irrigation water as the result of mixing of Lake Beseka and Deho hot spring water to Awash River in the last five years along with expansion of sugarcane plantation. The group discussant at Amibara district stated that the closing and malfunctioning of the decade old drainage system is another cause of salinity increase in their farmlands.

Due to increasing salinity problems, cost of production is increasing while land productivity is decreasing. This result in reduced income, food insecurity and surge in poverty. Therefore, more and more people are becoming dependent on the food aid programs of government and non-governmental organizations. They also prioritize their agricultural production constraints as salinity, lack of marketing information (for both cotton & vegetable crops), shortage of improved input availability, and lack of technical support with their respective order.

A key informant at Sidaha fagie kebele of Amibara district explains the situation as;"we have been cultivating this land for the last 40 years with acotton mono-cropping farming practice. Now the soil has been compacted with machineries and with the start of sugarcane farming, the land is irrigated with the poor quality of Lake Beseka and Deho hot spring water throughout the year. Therefore, our farmland is becoming saline from time to time and our farming work is a futile exercise. We have invested what we had but the result is bankruptcy. We are wasting our money, energy and time by producing nothing and the situation is worsening with every passing day. We need urgent intervention and solution to our problems from the government and other concerned bodies. Drought and salinity problems are making our livelihoods difficult. Our animals and land are no more considered as an asset. We are dependent on government food aid for about 10 months in ayear. Even our social support system has been destroyed and nobody cares about others but the government."

Figure 6. Key informant at Sidahafagie kebele of Amibara district

4.2 Analysis of Raya-Alamata district of Tigray Region

4.2.1 Household and farm characteristics

The survey results show that 55 percent of the households were from Tumuga kebele, while the rest 45 percent were from Waja-Tumuga kebele of the Raya Alamata district, southern zone of Tigray, northern Ethiopia. About 97 percent of the respondents were household heads, whereas the rest were spouses. Among the household respondents, about 70 percent were male and 30 percent were female household heads. Most of the house- holds (72.40%) were married. In terms of educational level, about 51 percent were illiterate and 22 percent were formally educated (Table 25).

Following Storck et al. (1991), types and heads of livestock owned by the sample households was converted into tropical livestock unit (TLU) to facilitate comparison among the households (Appendix 1). Accordingly, the analysis of the household of the study area shows that the livestock holding varied from 0 to 10 TLU among respondents. The average livestock holding of the household respondents was 2.45 TLU (Table 26).

Table 25. Household information of the district (n= 87)

Gender of Respondents	Amibara	Dubti	Total (%)
Sex	Male	61	70.10
	Female	26	29.90
	Total	87	100
Marital status	Single	10	11.50
	Married	63	72.40
	Divorced	10	11.50
	Widowed	4	4.60
Educational level	Illiterate	45	51.70
	Adult education	18	20.70
	Formal education	19	21.80
	Secondary school	3	3.40
	University/higher	2	2.30
Fertility status of farm land	Poor	27	31.00
	Average	44	50.60
	Good	15	17.20
	Very go	1	1.10

The age of the respondents ranged from 28 to 95 years with an average value of about 51 years. The family size of the respondents of the district varied from 1.0 to 15 with an average family size of 5.40 (5 members per household). The household size of the respondents was higher than that of the regional family size, which is 4.30 per household and the national family size, which is 4.70 per household (CSA, 2007). This indicates that, the average family size of the district was closest to the regional and national average family size of the households (Table 26). Family composition of the district was converted into adult equivalent ratio using conversion factor (Appendix 2). The mean area owned by households was 0.91 ha, out of which about 0.81 ha is cultivated. The mean area irrigated per household is 0.23 ha, whereas the same size of area is salt-affected per household. The livestock ownership was around 2.5 TLU per household.

Table 26. Household information and farm characteristics of the Raya-Alamata district

Variable description	Minimum	Maximum	Mean	SD
Age	28	95	51	14.25
Family size	1.00	15	5.40	2.30
Total family	0.90	13.60	4.46	1.94
Dependency Ratio	0	3.67	0.60	0.64
Adult male (15–64)	0	6.00	1.54	1.09
Adult female (15–64)	0	5.40	1.53	1.04
Male children (<15)	0	3.00	0.63	0.65
Female children (<15)	0	1.80	0.51	0.55
Male above (>65)	0	1.00	0.15	0.36
Female above (>65)	0	0.90	0.09	0.28
Total area owned by the HH (ha)	0.06	2.13	0.91	0.45
Area under cultivation (ha)	0	2.00	0.81	0.43
Area under irrigation (ha)	0	1.00	0.23	0.19
Area affected by salinity (ha)	0	1.00	0.23	0.17
Farm d/s from residence (km/m)	0.50	10.00	2.74	1.66
Livestock size (TLU)	0	10.10	2.45	2.41

TLU=Tropical Livestock Unit: SD = standard deviation

The average landholding of the total respondents was 0.81 hectare. This indicated that the cultivable land size of the respondents was smaller than the national average of 1.14 ha per household (CSA, 2015). About 50 percent of the households rated the fertility status of their soils as 'average' whereas 31 percent consider it 'poor'. Most of the household respondents (42.50%) used their own seed and 29.90 percent used seed donated by the local NGOs.

The two selected kebeles of the district have mixed farming system in which farmers practice both livestock and crop production. However, farmers give more emphasis to crop production to pursue different crop enter- prises to secure their family food supply and satisfy various cash needs. The dominant crops grown in the area were mostly cereals in rain-fed and irrigated areas. Different horticultural crops are also produced using surface water and groundwater.

The analysis of the survey data reveals that 97 percent of the farming system was the major source of the household income as more than 60 percent of their income was coming from the farming system. Indeed, among the households, 62 percent benefited from the source of livestock income and comprising their total income of 21 percent which was the amount of maximum income earned from livestock performed both by men and women whereas, the rest hadn't benefit from livestock as a source of income. Similarly, aids, employment (temporary and permanent), trade and horse cart (gari- rent) were among the income sources with different proportions of the household respondents in the district (Figure 7). The maximum amount of income in all income sources were earned from both by men and women. However, the income proportion earned by men and women were 44 percent and 56 percent, respectively.

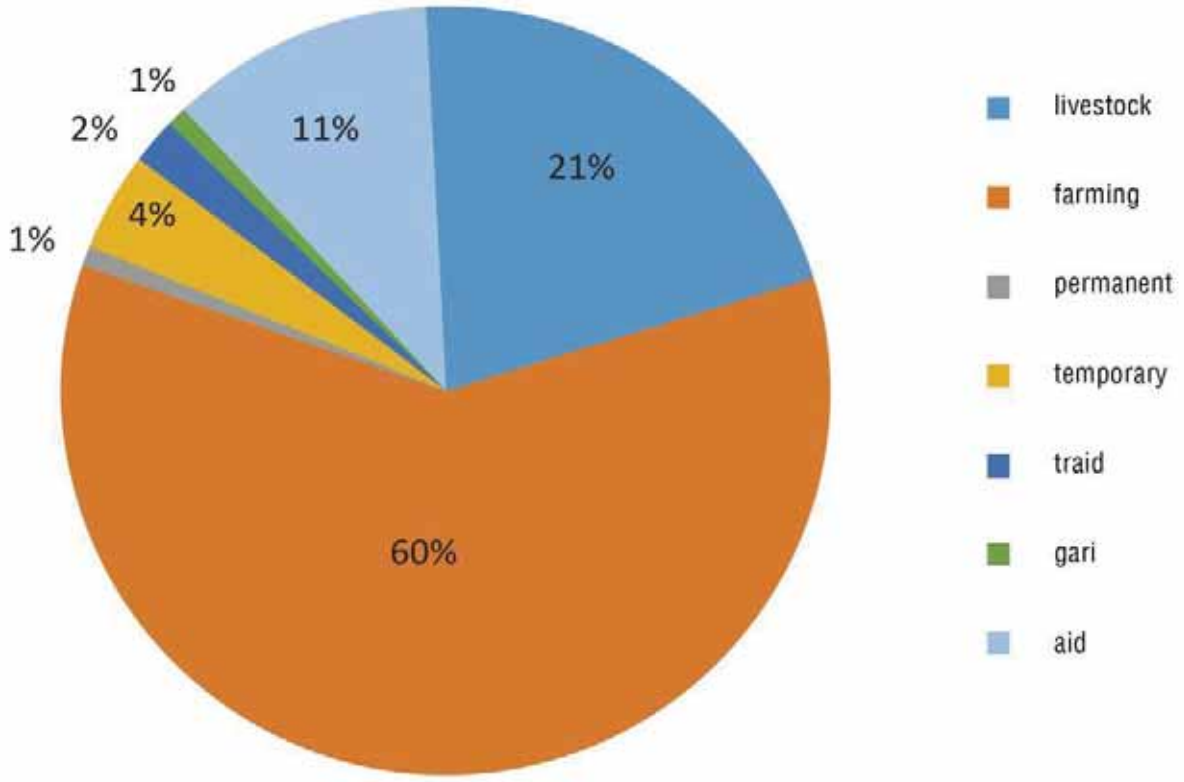

Figure 7. Sources of household income in the Raya-Alamata district

About the production costs in ETB, the three major crops (Maize, Teff and Sorghum) which are widely utilized in the district were selected. Accordingly, the total average cost of Teff was the highest whereas; the total average cost for sorghum was the lowest. Among the production constraints associated with crop production that the households encounter, lack of improved inputs and shortage of arable land were the dominant that comprises 98.90 percent of each household respondents. Similarly, lack of market information (88.50% of households) and small quantity of produces (67.80% of households) were the major marketing constraints of the households in the district (Table 27).

Table 27. Production and marketing constraints of the households (n=87)

No	Production constraints	N	%	Marketing constraints	N	%
1	Lack of improved inputs	86	98.9	Lack of market information	77	88.5
2	Shortage of arable land	86	98.9	Small quantity of produces	59	67.8
3	Lack of technical knowhow	85	97.7	High transaction costs	43	49.4
4	Lack of irrigation water	82	94.3	Lack of infrastructures	32	36.8
5	Soil salinity in farms	83	95.4	Involvement of brokers	27	31.0
6	Spread of invasive weeds	70	80.5	Low bargaining power	23	26.4
7	Poor irrigation management	9	10.3	Far from market	9	10.3

The results show that men performed most of the farm activities (land cleaning, plowing, sowing, irrigating harvesting and threshing). This indicates that, men perform most of the agricultural labor activities than women of the district. However, agricultural activities (weeding, bagging and transporting) are shared among male and female members of the household (Figure 8).

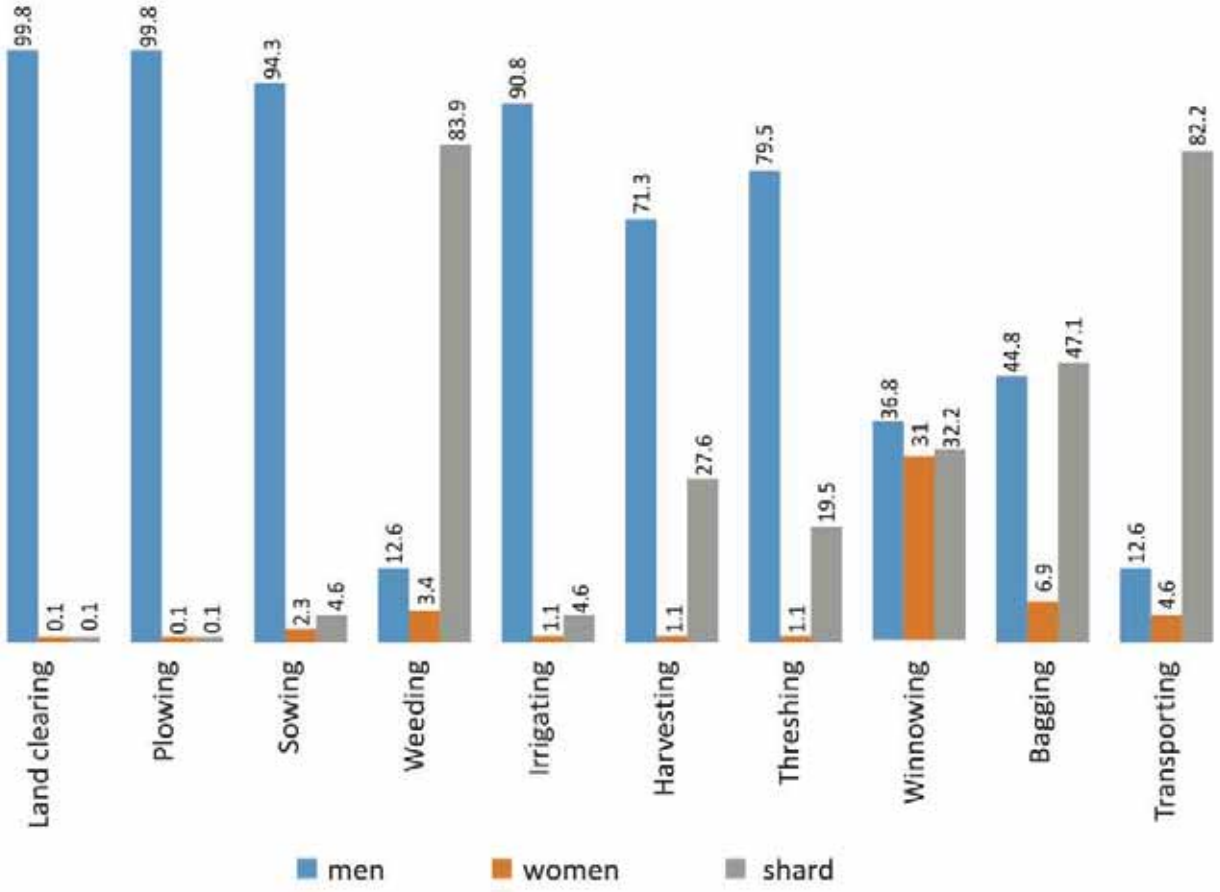

Figure 8. Farm labor tasks for women, men or shared tasks of the district

The peak hour of wage per day was in the months of April, September and October for both women and men. There is no difference in working hours and the amount of wage per day in ETB among men and women in the district (Table 28).

Table 28. Production and marketing constraints in Raya-Alamata district.

Month	Man			Woman		
	N	Hour	Wage per day	N	Hour	Wage per day
January	22	8–9	50–80	22	8–9	50–80
Feb	7	7–10	60–80	5	7–10	50–80
March	63	7–10	50–80	60	6–10	40–80
Aril	82	8–10	50–90	80	8–10	40–100
May	72	8–10	50–100	70	7–10	45–100
June	30	6–10	50–100	27	8–10	35–100
July	64	8–10	50–100	60	8–10	40–100
August	65	8–10	50–100	57	8–10	50–100
September	85	8–10	55–100	85	8–10	55–100
October	86	8–11	70–100	84	6–10	70–100
November	73	8–10	60–100	74	6–10	60–100
December	63	8–10	70–100	58	6–10	70–100

4.2.2 Household food security and agricultural information

The results of the household survey showed that, about 93.10 percent of the sample households are food insecure within different months of the year, while the rest 6.90 percent households were food secured in all months of the year. Those households with food insecure in some months of the year cope the food deficit mainly through food aid programs (10.30% of households) and others like food for work, selling assets and food purchase. The households with food insecurity mainly cope with this situation by doing off-farm income earning activities and selling assets such as livestock and different households items.

The agricultural information analysis result in the last one year of the households revealed that 97.70 percent of the households accessed information about agriculture, while the rest 2.30 percent did not. Most of the household respondents (69%) obtained the agricultural information from the government extension officer whereas 14.90 percent got it from the government extension officer and farmers association together. Among the 59.80 percent of the household respondents who get training about salinity, 47.10 percent gets training from the Government office of agriculture and only 8 percent gets from research centers. The training about salinity that the households get was reclamation methods of salinity (23.50% of the households) and 12.60 percent of household respondents got about farmyard manure application methods.

Table 29. Household food security and agricultural information (n= 87)

Variable description	Frequency (n)	%
Households food deficit	81	93.10
Access of agricultural information in the last one year	85	97.70
Information that the HH talk about salinity	64	73.60
Training that the household get about salinity	52	59.80
The HH that applied information got from the training	30	34.50
Farm land affected by salinity	83	95.40

4.2.3 Awareness of farmers on soil salinity

Salinity problems and identification methods

The survey results indicate that about 95.5 percent of the district landholdings are affected by salinity with different levels of severity. According to 42.50 percent of the households, their productivity was lost by 50 percent

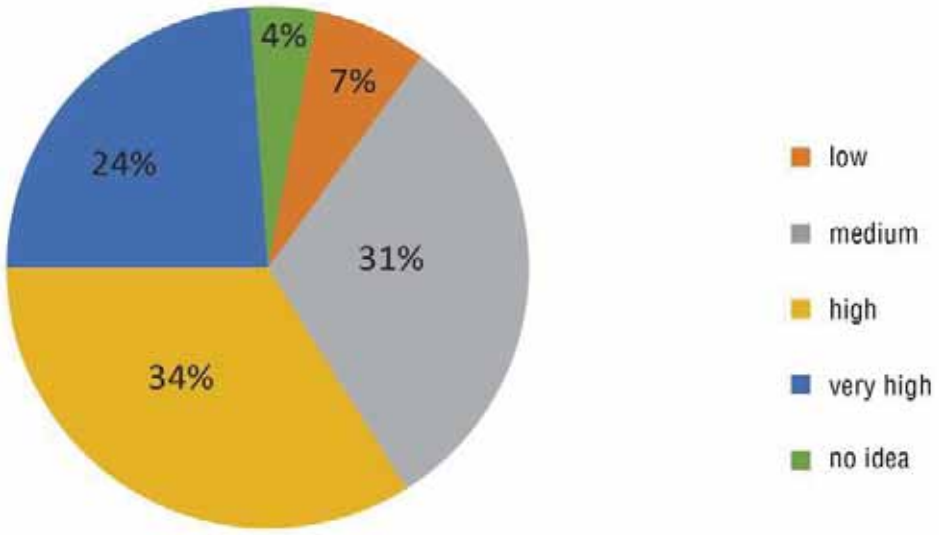

Figure 9. Severity of soil salinity at farm land level

due to salinity. Observing white crust at the top of the surface farmland is the most common way used by the households to identify whether their farmland is affected by salinity. In addition, observing a dark brown color of the soil in the farmland and the shallow ground water table is also reported as the second and third major indication of the presence of salinity at their farm.

Most of the respondents (34%) believe that their farmlands have high severity of salinity, whereas 24 percent and 31 percent of the households consider land severity of salinity as very high and medium, respectively (Figure 11). The salinity trend of the district looks like increasing from time to time and hence 93.10 percent of the household respondents revealed that salinity of the farmlands was increasing at an alarming rate with the probable cause of increasing irrigation farming practices, deteriorating irrigation water quality and decreasing irrigation water availability. Most of the households (74.70%) used groundwater as a source of irrigation water for agricultural production. Similarly, 14.90 percent of the households used river water as a source of irrigation water.

Most of the household respondents revealed that the main cause for salinization of the farm lands in the district were poor irrigation method, irrigation water quality, amount of irrigation, frequency of irrigation and drainage problem. Interestingly, some household respondents believed that, parent material, climate change and land levelling problems were not the major causes for the salinity status of the farming communities (Figure 10).

Effects of soil salinity on livelihood and socio-economic conditions

Most of the farmlands are affected by salinity, which is increasing at an alarming rate. Salinity affects directly or indirectly the livelihoods of the households. The level of salinity brings with the main direct effect of abandoning the farmland, decreasing farm productivity and decreasing household income. The indirect effects of salinity are increasing food insecurity, increasing landlessness and increasing dependency of the farming communities. Generally, salinity in the district was the main problem for the livelihood and socio-economic conditions of the households. Farming system was the major source of the households (97.70%) income in the district. However, this farming system faces soil salinity stress that affects the production and productivity of crops.

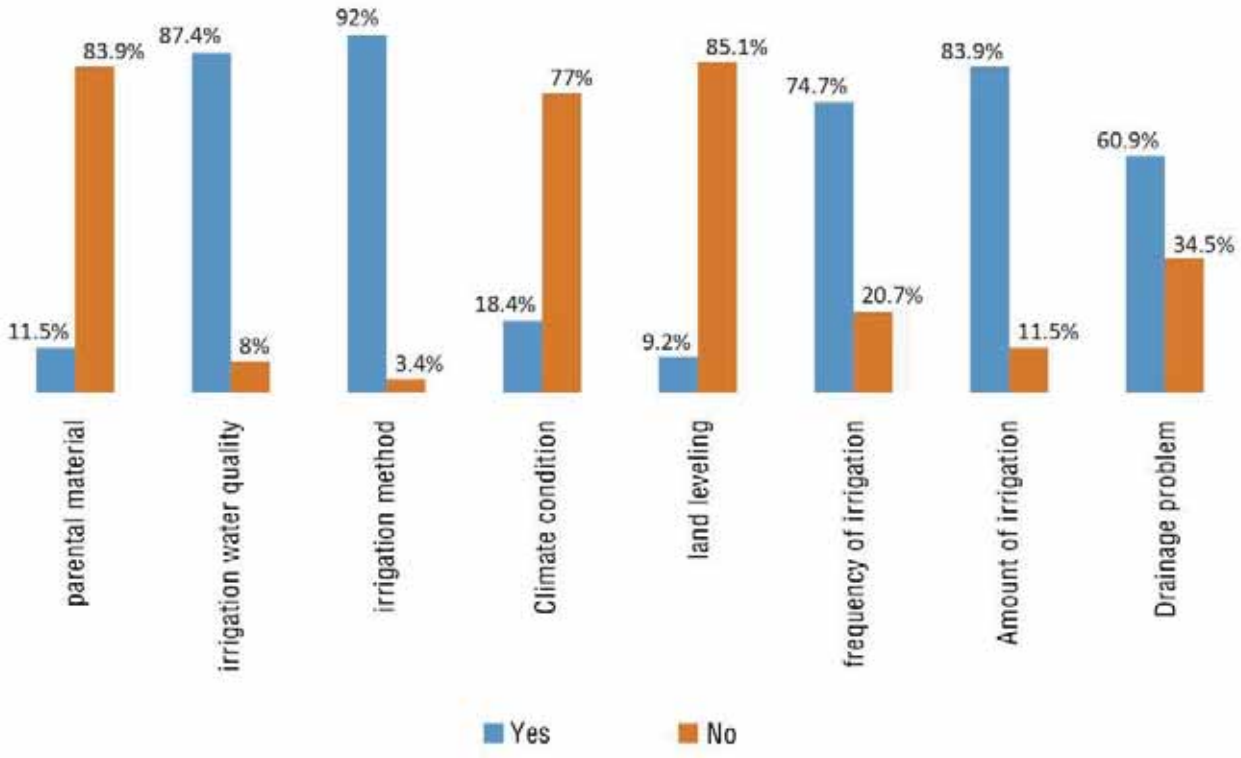

Figure 10. Causes of soil salinization in farm lands of the district

Figure 11. Focal group discussion at Raya-Alamata district

4.2.4 Focus Group Discussion Results of the District

After baseline survey, focus group discussions (FGD) with model farmers and development agents were conducted to understand the general observations of the people. Other than the structured questionnaire prepared for the baseline survey, some additional points were also included in the focus group discussions. The major issues discussed include constraints to agricultural production, causes, and identification of soil salinity, direct/in direct effects of salinity on the livelihoods of the households were the major ones. Accordingly, the key participants mentioned that the main constraints of agricultural production in the district were soil salinity, waterlogging, poor soil fertility and shortage of rainfall/drought. Among these agricultural production constraints waterlogging, caused by shallow ground water table and sodic nature of soils (drainage problem), is the major issue that abandoned large tracts of agricultural lands of the farming communities.

Most of the focus group discussion members revealed that, the main cause for salinization of the farm lands in the district were irrigation water related and drainage problems. White color on the dried surface of land and observing a dark brown color of the soil (oil like thing) were the most common way the households identifi ed salinity on their farmland. The participants fi nally revealed salinity directly/ indirectly aff ected both their livestock and crop production. Destroying animal feeds, decreasing crop production, dependence to government aid, lack of work opportunity, land degradation and water logging induced problems were among the eff ects of soil salinity in the district.

4.3 Results of Ziway-Dugda district of Oromia state

4.3.1 Household and farm characteristics

The demographic characteristics of the respondents included gender of the household heads, age of household heads, family size and composition, and marital status of the household heads. The analysis result of the household survey, 96.9 percent of the respondents were household heads, whereas the rest (3.10%) were spouse respondents for Zeway-dugda district of Oromia regional states of Ethiopia. With regard to the gender distribution of the sample households, only 8 (12.3%) were female and 57 (87.70%) were male-headed. Most of the households (96.9%) were married. In terms of educational level, most of the respondents have taken formal education (35.4%) followed by secondary (Table 30).

Table 30. Household information of the district (n= 65)

Variables	Description	Frequency (n)	Percent (%)
Sex	Male	57	87.7
	Female	8	12.3
	Total	65	100
Marital status	Married	63	96.90
	Divorced	2	3.10
Educational level	Illiterate	11	16.9
	Adult education	10	15.4
	Formal education	23	35.4
	Secondary school	19	29.2
	University/higher	2	3.1

The age of the respondents ranged from 25 to 80 years with an average value of about 44.83 years. The family size of the respondents of the district varied from 1.9 to 16.10 with an average of 5.97 percent (6 members per household). The household size of the respondents was higher than that of the regional family size, which is 5.10 percent per household and the national family size, which is 4.70 percent per household (CSA, 2013). Family composition of the district was converted in to adult equivalent ratio using conversion factor (Appendix Table 2).

Table 31. Household information and farm characteristics of the district

Variables	N	Minimum	Maximum	Mean	SD
Age	65	25	80	44.83	12.85
Adult male (15–64)	65	0	8.00	2.18	1.61
Adult female (15–64)	65	0	4.50	1.78	1.03
Male children (<15)	65	0	4.80	1.03	0.85
Female children (<15)	65	.00	3.00	0.97	0.76
Male above (>65)	65	0	0	0	0
Female above (>65)	65	0	0	0	0
Total family	65	1.90	16.10	5.97	2.58
Dependency Ratio	64	0	4.00	0.68	0.67
Total area owned by the HH (ha)	65	0.25	4.75	1.62	0.90
Area under cultivation (ha)	65	0	4.75	1.43	0.90
Area under irrigation (ha)	39	0.13	2.00	0.50	0.36
Area affected by salinity (ha)	60	1	6	2.75	1.95
Livestock size (TLU)	65	0	12.82	3.70	2.92

TLU=Tropical Livestock Unit: SD = standard deviation

Following Storck et al. (1991), types and heads of livestock owned by the sample households was converted into tropical livestock unit (TLU) to facilitate comparison among the households (Appendix Table 1). Accordingly, the analysis of the household of the study area shows that the livestock holding varied from 0 to 12.82 TLU among respondents. The average livestock holding was 3.70 TLU (Table 31). The average landholding in target areas is 1.62 ha. The agricultural system of the district was mixed farming system in which farmers practice both livestock and crop production. However, farmers give more emphasis to crop production to pursue different crop enterprises to secure their family food supply and satisfy cash needs.

The analysis revealed that more than 92 percent of the households received aid from different organizations, 56.9 percent earn their income from the livestock production. Indeed, among the households, only 21.5 percent benefited from the source of farming system. Similarly, employment (temporary and permanent), remittances and small trade were among other income sources for household respondents in the district.

Table 32. Sources of household income and proportion of the district

Variables	Frequency	%
Livestock	37	56.9
Farming source	14	21.5
Permanent employment	4	6.2
Temporary employment	13	20
Trade source	9	13.8
Remittance source	3	4.6
Aid source	60	92.3

The main crops grown in these areas include maize, teff, barley and sorghum, which are widely utilized in the district. Among the production constraints associated with crop production that the households encounter, shortage of irrigation water/rain and expansion of salinity in farms were more prominent, followed by lack of infrastructures (49.20% of households) and lack of market information (6.20% of households).

Table 33. Production and marketing constraints of the households (n=65)

No	Production constraints	N	%	Marketing constraints	N	%
1	Lack of improved inputs	13	20	Lack of market information	4	6.2
2	Lack of technical know-how	1	1.5	Lack of infrastructures	32	49.2
3	Lack of irrigation water/rain	62	92.3	Involvement of brokers	2	3.1
4	Increasing salinity on farms	43	66.2			

Most of the farm labor activities (land cleaning, plowing, and irrigating) are performed by men. However, agricultural activities (sowing, weeding, bagging, winnowing and transporting) were shared among male and female members of the household (Table 34).

Table 34. Farm labor tasks for women, men or shared tasks of the district

Farm labor tasks	Amibara		Dubti		Total	
	N	%	N	%	N	%
Land clearing	35	53.8	2	3.1	28	43.1
Land ploughing	51	78.5	2	3.1	11	16.9
Sowing	19	29.2	2	3.1	44	67.7
Weeding	5	7.7	3	4.6	57	87.7
Irrigating	31	47.7	1	1.5	29	44.6
Harvesting	13	20.0	3	4.6	50	76.9
Winnowing	15	23.1	5	7.7	44	67.7
Bagging	9	13.8	1	1.5	55	84.6
Transporting	7	10.8	8	12.3	18	27.7

4.3.2 Household Food Security and Agricultural Information

The results of the household survey showed that about 98.5 percent of the sample households are food insecure within different deficit months, whereas 35.4 percent are food insecure in all months of the year (Table 35). The households with food insecurity in some months of the year (49.2%) cope with their food deficit by donor food aid and others through food purchase and food for work.

The agricultural information analysis result in the last one year of the households revealed that 67.7 percent of the households have access to information about agriculture. Only 18.5 percent had information about salinity whereas 64.6 percent did not have any information about salinity of their lands. Similarly, only 8 percent of the households got training about salinity whereas most of the households (69.2%) did not get any training on salinity management (Table 35). The training and information about salinity management were provided by the government extension officers and farmers' associations.

Table 35. Household food security and agricultural information of Ziway-Dugda district

Variable description	Frequency	%
Households food deficit	64	98.50
Access of agricultural information in the last one year	44	67.70
Information that the HH talk about salinity	12	18.50
Training that the household got about salinity	8	12.50
The HH that applied information got from the training	5	7.70

4.3.3 Farmers' awareness and understanding of soil salinization

The analysis of the survey showed that about 89.2 percent of the districts landholdings are affected by salinity. About 84.6 percent of the respondents revealed that parental material was the primary cause of salinity in their farmland and 44.6 percent blame poor irrigation water quality as the secondary cause of salinity in the farm lands (Table 36). Observing white crust and dark brown color of the soil on the farmland are the most common indicators to identify soil salinity.

Most of the household respondents (44.6%) consider their farmlands under severe salinity, whereas 27.7 percent and 15.4 percent of the households consider salinity levels of their farms as high and medium, respectively (Table 37). More than 87 percent of the households think that the salinity of the farmlands is increasing with the probable major cause of deteriorating irrigation water quality and increasing irrigation farming practices. Salinity affects directly or indirectly the livelihoods of the households. Major direct effects are abandoning of farmlands, decreasing farm productivity and household incomes, which, in turn, effect food security and increase dependence of rural communities on food aid programs.

Table 36. Farmers' awareness and cause of soil salinization (n= 65)

Variable description	Frequency	%
Farm land affected by salinity (households)	58	89.20
Parental material as the primary cause of salinity	55	84.60
Irrigation water quality as the secondary cause of salinity	29	44.60
Irrigation method as the secondary cause of salinity	4	6.20

Table 37. Severity and trend of soil salinity in the farmlands

Variable description		Frequency	%
Severity of salinity at farmlands	Low	2	3.10
	Medium	10	15.40
	High	18	27.70
	V. high	29	44.60
Trend of Salinity	Increasing	57	87.7
	Decreasing	2	3.1
	No change	1	1.5

4.4 Analysis of Kewet district of Amhara State

4.4.1 Household and Farm Characteristics

The demographic characteristics of the respondents included gender of the household heads, age of household heads, family size and composition, and marital status of the household heads. All respondents were household heads for Kewet district of Amhara regional states of Ethiopia. Most of the households (97.8%) were married, whereas 35.6 were were illiterate followed by 24.4 percent having adult education and 22.2 percent secondary school education.

Table 38. Household information of the district (n= 45)

Variables	Description	Frequency (n)	Percent (%)
Sex	Male	45	100
	Female	0	0
	Total	45	100
Marital status	Single	1	2.2
	Married	44	97.8
Educational level	Illiterate	16	35.6
	Adult education	11	24.4
	Formal education	6	13.3
	Secondary school	10	22.2

The age of the respondents ranged from 26 to 66 years with an average of 41 years. The family size of the respondents varied from 1 to 7 with an average of 4.18 (4 members per household). Family composition of the district was converted in to adult equivalent ratio using conversion factor (Appendix Table 2). Following Storck et al. (1991), types and heads of livestock owned by the sample households was converted into tropical livestock unit (TLU) to facilitate comparison among the households (Appendix Table 1). The result indicates that the livestock holding varied from 0 to 11 TLU with an average of 3.7 TLU (Table 39).

The average landholding under cultivation of respondents was 1.11 ha whereas the average area under irrigation was 1.12 per household. The analysis shows that the farming system was the major source of income for 66.7 percent of the households whereas 64.4 percent earn their income from livestock production and only 13.3 percent took help from different aid organizations. Other sources of income for households include livestock production, employment, farming, and trade (Table 40).

Table 39. Household information and farm characteristics of the district

Variable description	N	Minimum	Maximum	Mean	SD
Age	43	26	66	41.02	9.83
Adult male (15–64)	45	1.00	5.00	1.77	1.02
Adult female (15–64)	45	0	3.60	1.34	0.76
Male children (<15)	45	0	1.80	0.56	0.55
Female children (<15)	45	0	1.80	0.51	0.48
Male above (>65)	45	0	0	0	0
Female above (>65)	45	0	0.60	0.01	0.09
Total family	45	1.00	7.70	4.18	1.57
Dependency Ratio	45	0	1.26	0.42	0.35
Total area owned by the HH (ha)	45	0	5.00	1.0	1.05
Area under cultivation (ha)	45	0	7.00	1.11	1.38
Area under irrigation (ha)	41	0.25	5.00	1.12	1.27
Livestock size (TLU)	45	0	11.01	3.64	2.22

TLU=Tropical Livestock Unit: SD = standard deviation

Table 40. Sources of household income and proportion of the district (n= 45)

Variables	Frequency	Percentage
Livestock	29	64.4
Farming source	30	66.7
Permanent employment	2	4.4
Temporary employment	1	2.2
Trade source	4	8.9
Remittance source	0	0
Aid source	6	13.3

The major crops grown in the district are vegetables, teff, tobacco and maize. Among the production constraints, lack of irrigation water/rain (69%) and on-farm salinity (67%) were eminent in the district. Similarly, high involvement of brokers (53%) and lack of infrastructures (11%) were the major marketing constraints of the households in the district (Table 41).

Table 41. Production and marketing constraints of the households.

No	Production constraints	N	%	Marketing constraints	N	%
1	Lack of improved inputs	2.0	4.4	Lack of market information	3.0	6.7
2	Shortage of arable land	1.0	2.2	High transaction costs	7.0	15.6
3	Lack of irrigation water/rain	31	68.9	Lack of infrastructures	5.0	11.1
4	Increasing salinity on farms	30	66.7	Involvement of brokers	24	53.3

4.4.2 Household food security and agricultural information

The results of the household survey showed that most of the sample households were food secure. However, about 42 percent of the households were food insecure mainly during August and September months of the year. These households cope with the food deficit mainly by donor food aid, food purchase and selling assets. Over 75 percent of the households have access to agricultural information, of which 80 percent got this information from government extension officers through trainings. Only 26.7 percent have information about salinity, whereas only 8 percent got training about salinity management. The training was mainly given by the office of agriculture with a focus on soil reclamation methods, alternative crops and improved irrigation water management for salt-affected soils. Majority of the households did not apply this information as they consider it expensive (Table 42).

Table 42. Household food security and agricultural information of Kewet district

Variable description	Frequency	Percentage
Households food deficit	19	42.2
Access of agricultural information in the last one year	34	75.60
Information that the HH talk about salinity	12	26.70
Training that the household got about salinity	10	22.20
The HH that applied information got from the training	8	17.80

4.4.3 Farmers' awareness and understanding of soil salinization

About 82.2 percent of the land in this district is affected by salinity. More than 66 percent respondents consider parent material as the primary cause of salinity in their farmland whereas 31 percent of the house- holds blamed poor irrigation water quality as the secondary cause of salinity in their farm lands (Table 43). The average farmland affected by salinity in the district was 0.47 ha per household. Observing white crust at the top of the surface and dark brown color of the soil on the farmland are the most common ways of identifying salinity.

Most of the household respondents (35.6%) think that their farmlands have medium level of salinity, whereas 28.9 percent consider salinity levels as high (Table 43). Most of the households in the district use river water and groundwater as a source of irrigation for crop production. According to the dominant household respondents (77.8%), salinity increases from time to time mainly due to deteriorating irrigation water quality and increased irrigated farming.

Table 43. Farmers' awareness and cause of soil salinization

Variable description		Frequency	Percentage
Farm land affected by salinity (households)		37	82.2
Parental material as a primary cause of salinity		30	66.7
Irrigation water quality as a secondary cause of salinity		14	31.1
Irrigation method as a secondary cause of salinity		8	17.8
Severity level of salinity	Low	3	6.70
	Medium	16	35.6
	High	13	28.9
	V. high	6	13.3

Salinity affects directly or indirectly the livelihoods of the households (Table 44). The level of salinity brings with the main direct effect of decreasing farm productivity and household income, decreasing household income and decreasing farm productivity, respectively and with indirect effect of increasing food insecurity and increasing food insecurity and increasing dependency, respectively of the farming communities.

Table 44. Direct and in direct effects of soil salinity

Direct effects	N	%	Indirect effects	N	%
Abandoning farm land	2	4.4	Increasing food insecurity	19	42.2
Decreasing farm productivity	9	20	Increasing food insecurity and Increasing dependency	6	13.3
Decreasing household income	10	22	Increasing food insecurity and Increasing landlessness	3	6.7
Abandoning farmland and decreasing farm productivity	2	4.4	Increasing landlessness	2	2.2
Decreasing farm productivity & household income	5	11	Increasing food insecurity, Increasing dependency and landlessness	3	6.7

Soil salinity causes land degradation and hence loss of productivity in farmlands. The 28.9 percent households reported productivity loss of 50 percent, 15.6 percent reported 60–90 percent whereas 13.3 percent reported productivity loss of 25 percent due to salinization of their lands (Table 45).

Table 45. Productivity losses caused by soil salinity

Variables	Frequency	Percentage
Complete loss	3	6.70
50% loss	13	28.90
25% loss	6	13.30
10% loss	4	8.90
Less than 10% loss	3	6.70
More than 60%-90%loss	7	15.60

5. Conclusions and Recommendations - Ethiopia

The systematic appraisal of soil resources with respect to their characteristics is very important for developing an effective land use system for agricultural production. Understanding of salinity status of soils plays a vital role for proper management of agricultural fields that can serve for sustainable agricultural production. Accordingly, this study was initiated to assess the impacts of salinity on livelihoods and socio-economic condi- tions of farming communities and to generate relevant information that can serve as an input for designing appropriate management options for sustainable agricultural production in five selected districts from four regions of Ethiopia. The sites are Amibara and Dubti districts from Afar regional states, Zeway-Dugda district from Oromia regional states, Kewet (Shoa robit) district Amhara regional states, and Raya-Alameta district from Tigray regional states.

The project contains five project outputs; one of the outputs was baseline survey on assessment of impact of salt-affected soils on livelihood and socio-economic conditions of the farming communities within the affected areas. After multi-stage sampling, 299 respondents (67 from Amibara district, 35 from Dubti district, 87 from Raya-Alamata district, 45 from Kewet district and 65 from Zeway-dugda district) respondents were sampled. Structured questionnaire, focal group discussion and key informant interviews were used to collect the data from the households. Based on the prepared structured questionnaire, socio-economic character- istics, food security, farmers' awareness on salinity problems and their effect on livelihood of the households were collected.

The analysis result of the household survey showed that about 91.04 percent, 88.30 percent, 70.10 percent and 87.70 percent of the male respondents were from Amibara, Dubti, Raya-Alamata and Zeway-Dugda districts, respectively, whereas female respondents of Amibara, Dubti, Raya-Alamata and Zeway-Dugda districts were recorded at 8.96 percent, 11.30 percent, 29.9 percent and 12.30 percent, respectively. However, 100 percent of the respondents in Kewet district were males.

Most of the households were married. The age of the respondents ranged from 25 to 95 years in all districts. The family size of the respondents of the district varied from 1.0 to 20. The average areas of land holding size under cultivation of the total respondents 1.21, 1.97, 0.91, 1.01, and 0.90 ha were recorded at Amibara, Dubti, Raya-Alamata, Zeway-Dugda and Kewet districts.

Farming systems followed by livestock income was the major source of the households' income. The maximum amount of income from all income sources were earned by both men and women. Production and marketing constraints were the major problems of the households. Most of the farm labor activities were performed by men. Among the households, lack of access to agricultural information, poor extension services from government and NGOs, and access to irrigation/rain water for agricultural production were set as production constraints.

Most of the landholdings are salt-affected with different percent of production loss. Observing white crust and dark brown color of the soil in the farmland are the major salinity identification indicators used by households. Majority of the households revealed that the main causes for salinization are poor irrigation management and drainage related problems. Salinity affects directly or indirectly the livelihoods of the households. Almost all members of the focus group discussion were of the view that soil salinity directly or indirectly effects their livelihood.

This study presents important findings concerning baseline survey on impacts of soil salinity in livelihood and socio-economic conditions of the farming communities at in targeted five selected districts from four regions of Ethiopia. The sited are Amibara and Dubti districts from Afar regional states, Zeway-Dugda district from Oromia regional states, Kewet (Shoa robit) district Amhara regional states, and Raya-Alameta district from Tigray

regional states. From the analysis result of the baseline household and visual field reconnaissance survey, the following recommendations can be forwarded:

- Continuous assessment and monitoring should be implemented to avoid the occurrence and increasing trend of soil salinity in the district.

- Surface and subsurface drainage systems should be installed in the waterlogged areas since more farmlands are abandoned from time to time.

- Selection of suitable plant varieties that can deeply extract the amount of perched water near the surface to lower the shallow ground water table, which is main factor for the cause of salinity and waterlogging.

- Marketing of produce at reasonable prices is the major issue of households. Therefore, there is a need to develop a marketing mechanism for buying the agricultural products of smallholder farmers at their true value. This will encourage them to increase their crop production and improve their incomes.

6. Results of Socio - Economic Baseline Survey in South Sudan

The analysis of the survey data reveals that household poverty is very pervasive in the selected areas because the household income of more than 60 percent of the farmers is less than $1 USD per day. The land holdings are generally small and not all land is cultivated due to shortage of water and other agricultural inputs. Majority of the farmers (44%) cultivate sorghum, followed by maize (17%) and sesame (12%). Other crops are grown in small quantities and include groundnuts, vegetables and cassava (Figure 12). Generally, farmers lack knowledge about irrigation management and they are totally unaware of problems related to salinity. They relate low productivity to insects and diseases.

The age of 32 percent of respondents was in the range of 31–40 years, 27 percent were between 21–30 years whereas 40 percent were between 40–60 years and only 2 percent were above 60 years. The sample shows a balanced combination of experienced and young emerging farmers. The findings of this survey therefore reflect different opinions especially about adoption of innovative irrigation techniques to improve water use efficiency and increase crop production.

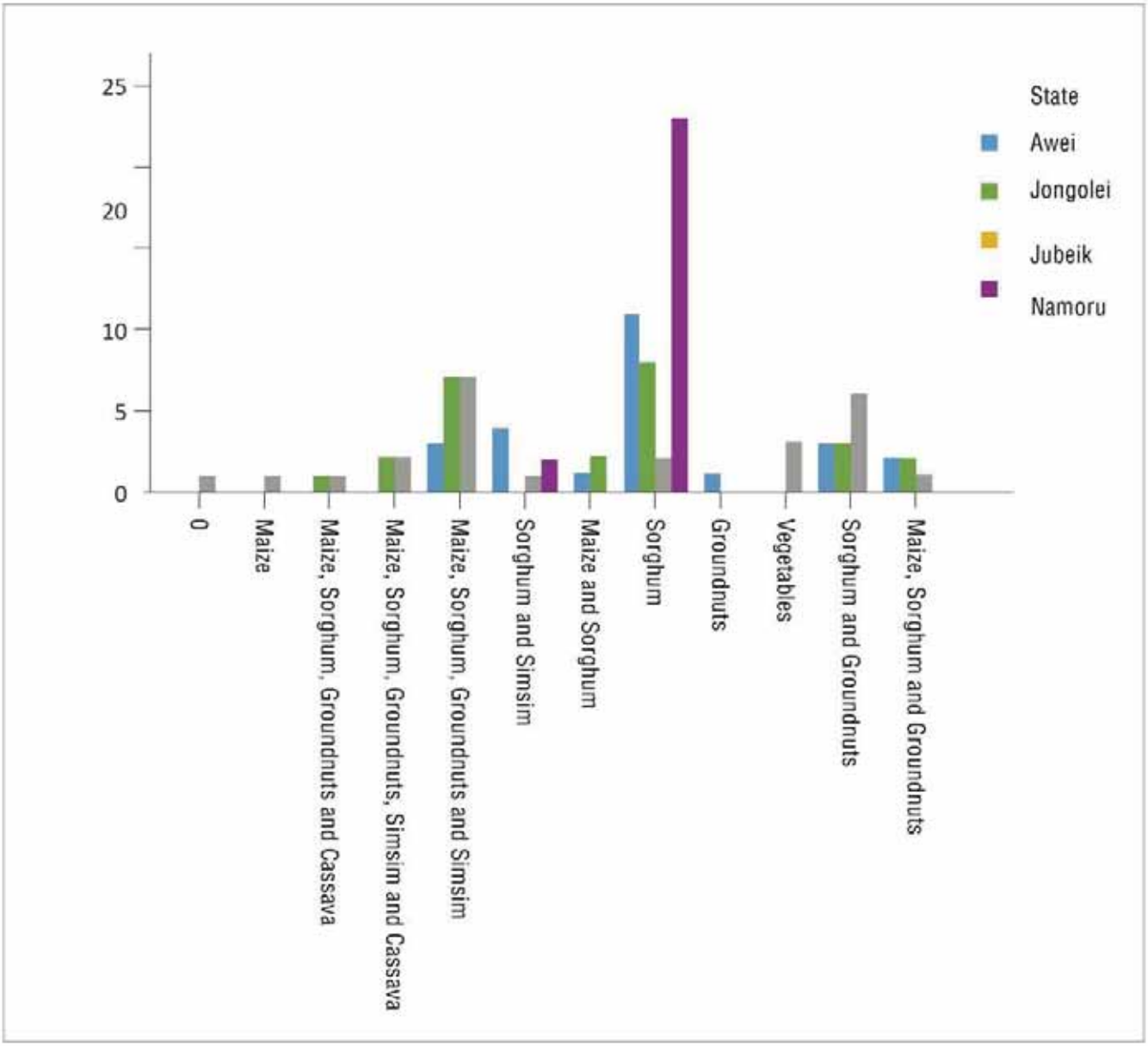

Figure 12. Major crops grown in the selected regions.

Table 46. Age distribution of respondents

Age range (years)	Number of respondents	Percentages
20- 30	15	27.3
31- 40	18	32.7
41- 50	11	20.0
51- 60	10	18.2
61 and above	1	1.8
Total	55	100

Table 47. Gender of the respondents

Gender	Number of respondents	Percentages
Male	37	67.27
Female	18	32.73
Total	55	100

Most of the respondents (67%) were male while only 18 percent consisted of females. This disparity was due to the following reasons:

- Male respondents were readily and easily accessible compared to their counterparts. The nature of the household duties females do could be reasons explaining disparity.
- The male practicing irrigation or farming are comparatively higher and hence easy for them to respond and answer the questionnaires.

Table 48. Marital status of the respondents

Marital status	Number of respondents	Percentages
Single	10	18.18
Married	30	54.55
Widowed	9	16.36
Divorced	6	10.91
Total	55	100

About 55 percent of the respondents were married. They are practicing irrigated farming to earn their living to educate their children and maintain their living standards. This was followed by 18 percent of single, 16 percent widowed and about 11 percent of divorced respondents. This shows that getting good income from the irrigated farming is a top priority because they do not have enough means to support their family needs. More than 49 percent of the respondents have high school education followed by 27 percent with primary school educated whereas about 24 percent are illiterate.

Table 49. Educational level or qualification of the respondents

Qualification	Number of respondents	Percentages
No formal education	15	23.64
Primary education	18	27.27
Secondary education	11	49.09
Tertiary institution	10	0
Post graduate	1	0
Total	55	100

Table 50 shows that large number of respondents (45%) are unemployed whereas about 40 percent have some sort of employment in the private sector whereas 14 percent are engaged with the public sector. The earnings of these farmers are far below than their daily needs therefore for some part of the year, they must depend on different relief organizations to meet their food needs. The low income and higher unemployment rate is the major cause of poverty in these areas, which has resulted in social problems such as migration to cities, diseases, malnutrition and increasing rate of crime.

Table 50. Source of livelihood of farmers in South Sudan

Source of livelihood	Number of respondents	Percentages
Unemployed	25	45.45
Private sector	22	40
NGOs	0	0
Public sector	8	14.55
Total	55	100

Farmers consider irrigation necessary for sustainable agricultural production as the rainfall is neither reliable nor sufficient. More than 85 percent of the respondents believe that the irrigation systems need further deve- lopment whereas 15 percent believe that first the current system should be rehabilitation. Most of the farmers (87%) have sufficient knowledge of irrigation. About 73 percent of respondents use surface irrigation system whereas only 9 percent have simple drip system. About 18 percent of the farmers use none of these systems and they reply on traditional flooding systems.

Table 51. Type of irrigation farmers practice in South Sudan

Types of Irrigation	Number of respondents	Percentages
Surface irrigation	40	73
Drip irrigation	5	9
Sprinkler irrigation	0	0
All types of irrigation	0	0
None	10	18
Total	55	100

Table 52 indicates that most farmers cultivate vegetables and legume crops to meet their household needs and to earn small amounts by selling the excess in local markets. Cereals and oil crops are also grown by any farmers. Table 53 shows that land ownership is very small because farmers lack farming equipment and human power to cultivate large areas. Nearly 70 percent of farmers own less than a feddan (one feddan is 0.42 ha).

Table 52: Crops commonly grown by farmers

Types of crops	Respondents	Percentages
Cereals	9	16.4
Oil crops	7	12.7
Vegetables	23	41.8
Legumes	16	29.1
Tree crops	0	0
Total	55	100

Table 53: Size of land cultivated

Area in Fadden	Respondents	Percentages
0.5	21	38.2
1.0	17	30.9
3.5	9	16.4
4 and above	8	14.5
Total	55	100

Farmers prefer surface irrigation methods because of their lower energy and operational costs. They see surface irrigation as an income source because it improves their livelihoods through increased crop yield and cultivation of cash crops such as vegetables and fruits both during rainy and dry seasons for the local Juba market. Most of the farmers (87%) prefer lift irrigation because it is reliable and easy to access water from surface canals and ground-water wells. In addition, it is less expensive and have minimum operational and maintenance requirements. Many respondents use mechanical pump engine, hand pump and water-cans to lift water from river and small dug wells for irrigating their fields.

Table 54. Pumping methods used by farmers

Pumping method	Respondents	Percentage
Lift	48	87
Flow	5	9
None	0	0
Total	55	100

Farmers in South Sudan do not have exact knowledge of crop water demands. Their irrigation applications largely depend on the availability of water and visual plant stress indicators. Most of the farmers apply irrigation when the soil surface becomes dry and the crops start showing signs of stress (e.g., dry leaves, changed color of leaves etc.). Since they are unaware of actual crop water require-ments, irrigation applica- tions are usually far higher than the actual demand. The excess water is wasted through surface runoff that damages neighboring fields. During the survey, about 80 percent of the respondents admit that irrigation applications generate surface runoff whereas the rest 20 percent believe that it is not a big issue. To prevent runoff, farmers are using different methods, which include land levelling, widening of channels and raising the bunds of their fields.

Figure 13. Farmer interviews in Juba, South Sudan

About 76 percent of respondents have one or more irrigation equipment such as pipes, pumps, diesel generators and watering cans. Other 24 percent do not have any irrigation equipment because of low purchasing power and they usually borrow these equipment from their fellow farmers. Most farmers (36%) use "rotodynamic" type of pumps. This pump is preferred by farmers due to its low cost, high efficiency and ease of installation. However, the drawback of this pump is that it needs regular maintenance and skilled labor for better operation. The poor farmers look to government and other donor agencies for financial assistance to buy these pumps.

In the absence of any scientific irrigation scheduling information, farmers are compelled to apply irrigations based on their local experience and the availability of water as discussed above. The survey results indicate that majority of the farmers (53%) irrigate twice a day because usually discharges are lower, and temperatures are high, which make soil dry very quickly. These are farmers, who own pumps and have sufficient access to irrigation water. About 17 percent irrigate daily, 11 percent twice a week whereas 19 percent can only afford irrigation three times a week. These unscheduled irrigation applications produce low water use efficiency and crop yields. Farmers usually use basin method irrigation because they consider is better to control surface runoff. Excessive irrigation applications also deplete soil nutrients, which exacerbate existing poor soil fertility problems. Farmers complain that they do not get any information from the extension workers or irrigation technicians regarding timing and amount of irrigation water application for different crops.

Table 55. Irrigation scheduling adopted by farmers in South Sudan

Scheduling	Respondents	Percentage
Once a day	10	17
Twice a day	29	53
Twice a week	6	11
Three times a week	3	19
Total	55	100

6.1 Farmer perceptions about the challenges in irrigation management

Farmers in South Sudan commonly practice basin method of irrigation because they consider it as the best method to prevent overflow and uniform water application in the field. The major challenges faced by farmers for irrigation management includes the following:

Land levelling - farmers must hire the services of companies and the skilled laborers.
Lack of irrigation equipment.
Irrigation time management.
Loss of valuable land due to salinity.
Low water use efficiency due to seepage and runoff losses.

Most of the farmers hire annual laborers for land preparation, planting, weeding and harvesting purposes. The cost of hiring labor ranges from 100–200ssp, 200–500ssp, and 1000ssp per day. Meanwhile the daily income of the respondents from the sale of their farm products ranges from 1500–5000ssp per day. This shows that farmers earn good income from irrigation farming to cover these costs. However, without irrigation, income levels are low and it becomes hard for them to cover these expenses. Farmers' first preference is to use surface water for irrigation because of its low cost and better quality. However, in case of non-availability of surface water, their ultimate choice is groundwater for irrigation. Some farmers prefer to use groundwater because of its on-farm availability since surface water is far from their farming site.

Farmers demanded training to increase their level of awareness about irrigation management, crop water requirements and soil management. They suggest that government and/or other concerned agencies should arrange these trainings on a regular basis. According to survey results, farmers think that the government, farming communities and the NGOs have the main responsibility to take appropriate steps for improving irrigation management in South Sudan.

6.2 Farmers' suggestions for the optimization of irrigation management

Farmers of South Sudan gave the following suggestions for optimizing irrigation management:

- Training of farmers on the management of on-farm irrigation systems.
- Provision of irrigation equipment to farmers at subsidized rates.
- Credit facilities for farmers to assist them to start their small-scale farming.
- Supply of healthy seed and fertilizer for smallholder farmers by government agencies.
- Strengthening of extension services to provide useful information to farmers.
- Solving drainage and waterlogging problems.
  Assist farmers in the designing of appropriate irrigation systems.

6.3 Challenges to the Agricultural Productivity

- Availability of irrigation water is the most challenging factor in the selected areas as well as the entire South Sudan. In the absence of irrigation water, farmers depend on seasonal rain, which results in serious food shortages during most part of a year. Therefore, alternative techniques such as access to groundwater, rainwater harvesting need to be introduced to solve ongoing food shortages. The cost-effective small-scale irrigation system introduced through RAMSAP project in the selected sites could be an effective way to solve shortage of irrigation water. These irrigation systems were construction using local materials to keep the cost affordable for smallholder farmers.
- Most of the farmers at the selected sites depend on locally produced seed obtained from their harvested crops. These seeds are poorly stored and infected, which results into low crop productivity. Therefore, farmers suggest including provision of healthy seed production and training on storage techniques in the project activities.
- Lack of agricultural machinery is also reported as one of the major causes of low crop productivity in the five selected areas of the project. Farmers suggest that government should provide machinery such as tillage equipment, planters, chemical sprayers, ridges, levelers, ditchers, harvesters, threshers and

transporting trailers. In areas like Renk, there are enormous number of tractors owned by individual farmers, but they lack agricultural machineries. Most of the farmers use wide level disc planters for land preparation, which uses lots of fuel and the soil structure is damaged due to excessive moment of tractor and the machinery on the soil. In other areas, only tractors and tillage equipment (i.e. planting, spraying, harvesting and threshing) are available. The maintenance of this machinery and spare parts is a major problem in South Sudan.

- The recent socio-economic survey data shows that there is a big gap between the farmer at the five selected areas and the existing agricultural technology. Majority of the farmers rely on traditional methods of cultivation, which results in low crop productivity. This situation has forced farmers to look for off-farm income generation activities in nearby towns and cities. Therefore, intensive extension services are needed to keep farmers informed of the improved agricultural techniques for better production.
- Most of the farmers cultivate crops for domestic consumption due to financial problems. Therefore, it is important to encourage farmers to increase their cultivated area and produce crops for local marketing. This can be done by creating marketing awareness of the farmers.

7. Conclusions and Recommendations – South Sudan

- Generally, farmers are aware of irrigation development and its importance and are well informed about the necessity of irrigation development in South Sudan to improve crop production and agricultural productivity.
- Most farmers use surface irrigation system and recognize the needs for training and provision of appropriate design system to optimize irrigation water use efficiency and crop production in South Sudan.
- The availability of appropriate and low-cost irrigation system using local materials in South Sudan received attention of farmers. They were attracted to this system because of its low-cost and ease of installation especially for low-income smallholder farmers. The locally produced drip and furrow irrigation systems may help local smallholder farmers due to its affordability.
- These systems produced high water use efficiency because plants were supplied with precise amount of water and water applications was made directly to the plant root zone for drip system and through the furrow for furrow system. Non-beneficial use of water was reduced to minimum.
- Establishment of agriculture extension services to the farmers should be one of the priorities for the government and stakeholders.
- Training of local vegetable growing farmers on modern irrigation methods such as drip and sprinkler irrigation system and provision of irrigation equipment to the farmers.
- The state and national governments who are concerned with agriculture development should provide seeds and loans to the vegetable growers to enable them to improve their crop production and cultivation of crop during dry period.
- Benefits of drip irrigation system can be maximized when they are properly designed, managed, and maintained. Farmers should be provided the consultancy services to properly design drip irrigation system since the drip design is complex. Different manuals produced by different manufacturers on different design factors may also help farmers to ensure properly designed drip irrigation system.

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Brief about the RAMSAP Project

Background

Increasing salinity remains a challenge to sustainability of irrigated agriculture in Ethiopia and South Sudan as it reduces natural biodiversity as well as farm and livestock productivity. Agriculture sector in Ethiopia supports 85 percent of the work force. About 85 percent of the population living in rural areas is directly dependent on agriculture for their livelihood. There are 7 million smallholder farmers, which produces more than 95 percent of the total agricultural outputs including food crops, cereals, oil seed and pulses. Cotton and sugar are produced on state-owned large-scale enterprises. Ethiopia also has large livestock resources including cattle, sheep, goats and camels. Despite this high biodiversity and distinctive ecosystems, Ethiopia is one of the poorest countries of the world and known as a country of famine. Food shortages are widespread and since 1970s there have been severe famines almost once per decade.

Land degradation is considered one of the major causes of low and in many places declining agricultural productivity and continuing food insecurity and rural poverty in Ethiopia. Today, Ethiopia stands first in Africa in the extent of area of salt-affected soils due to human-induced and natural causes. Current estimates suggest that about 11 million ha (Mha) land in Ethiopia is exposed to salinity and sodicity, out of which 8 Mha have combined salinity and alkalinity problems whereas the rest 3 Mha have alkalinity problems. About 9 percent of the population lives in the salt-affected areas. The saline areas in Ethiopia are in the Tigray region, and Awash River basin and the situation is expected to exacerbate in future due to climate change induced factors. For sustainable development and food security to produce enough food for the rising population, there is an urgent need that salt-affected soils are restored to their production potential.

In South Sudan, agriculture accounts for 36 percent of the non-oil GDP with 80 percent of the population living in rural areas largely dependent on subsistence farming, and 75 percent of the households consuming cereals as a main part of their daily diet. Despite abundant water supplies, only 5 percent of total 30 million ha arable land is cultivated. Crop yields are low, which negatively affect incomes and livelihood of poor farmers. Lack of agricultural inputs such as seed and fertilizer, poor advisory services and inefficient irrigation management are considered as the major barriers. Although South Sudan has highest livestock per capita in the world, with 23 million head of cattle, sheep, and goats, there is little use of improved varieties of seed or breeds of livestock. For increasing livestock productivity, there is a need to introduce improved forage varieties that are resistant to common diseases. The salt-affected lands in South Sudan are in the White Nile irrigation schemes. These areas have hardly been utilized for agricultural production despite having great potential due to fresh water availability from Nile. Therefore, bringing back these degraded lands into acceptable production levels is essential to ensure food security and social stability.

With a 3 percent average population growth in these countries, future food security as well as the livelihood source for a considerable portion of the population remains a challenge to the governments. Increasing the productivity of existing salt-affected lands and protecting newly developed areas from the spread of salinity is therefore of paramount importance. The smallholder farmers in both countries have the potential to increase their agricultural productivity and farm incomes if their technical and financial capacity is enhanced. They need guidance on the improved irrigation and salinity management strategies and access to modified salinity-tol- erant seeds for crops and forages. Therefore, for millions of farm families in these countries, access to improved knowledge and inputs will be a dividing line between poverty and well-being.

The areas of low to moderate salinity levels can be restored by improving irrigation and crop management practices. However, in areas where increased salinity levels have restricted the growth of normal field crops, use of Biosaline Approach1 could be a potential solution. This approach is based on adaptable technology packages

1 The Biosaline approach was developed by ICBA, in partnership with NARS of at least eight African countries and support of international donors including IFAD, OFID and IDB

composed of salt-tolerant fodders and halophytes integrated with livestock and appropriate management systems. These integrated crop and forage-livestock feeding systems have the capacity to increase resilience of smallscale crop-livestock farms, particularly in Ethiopia and South Sudan where livelihood of smallholder farmers is largely dependent on the development of livestock sector.

This project will devise a strategy to improve productivity of saline soils to an economically feasible level and to minimize future salinity development in these areas. The project will draw on the successful experiences of past work to identify most productive alternative crop and forage production systems, test them for local conditions and devise a strategy for scaling up these production packages to improve livelihood of rural communities especially women in the target areas of both countries. Through improved crop yields and reduced loss of land to degradation, the project will improve the resilience of farmers thereby reducing both migration to cities and health problems due to stress on families suffering from the impact of salinity on their livelihoods.

Project Goals and Objectives

The overall goal of the project is to attain higher agricultural productivity, food security and income for smallholder farmers, agropastoral/pastoral communities through rehabilitation and sustainable management of irrigated salt-affected farming areas of Ethiopia and South Sudan. The main objective of this project is to introduce, test and promote appropriate technologies and practices for rehabilitation and sustainable management of irrigated salt-affected farming systems and in Ethiopia and South Sudan and draw lessons for scaling up.

The Target Group

The project will directly target 5,000 smallholder farmers in selected areas in Ethiopia and South Sudan who are facing high food insecurity due to their high dependency on marginal water and land resources. The indirect beneficiaries will be about 50,000 farmers (40,000 farmer in Ethiopia and 10,000 farmers in South Sudan) that are dependent on forage production in both countries with an estimated total area of about 200,000 ha (150,000 ha in Ethiopia and 50,000 in South Sudan). These targets will be achieved through the production and distribution of tested crop and forage seeds, dissemination of improved soil and water management practices, training of farmers and extension workers in the target areas.

The rehabilitation of degraded lands will improve the livelihood of 9 percent of the population of Ethiopia which lives in salt-affected areas. In South Sudan where only 7 percent of 30 million ha of land is being culti- vated, rehabilitation and management strategies developed under this project will open a window of oppor- tunity for thousands of rural farmers to improve productivity of their degraded lands and increase their farm incomes. The outcomes of this project will especially benefit women, as they will have better access to food and health facilities. Transformation of degraded lands into productive lands will also create direct and indirect job opportunities for the large segment of young population. This will help in reducing the migration trends of unemployed youth from rural areas to urban areas.

The project will target Ethiopian highlands (Tigray, Amhara and Afar) and lowlands (Omara and Somali) which produce 87 percent of Ethiopia's cattle and 5 percent of its sheep and goats, however, land degradation has reduced farm and livestock productivity of these areas resulting in extreme rural poverty. The developed crop-livestock value chain system will benefit Ethiopia because this is the largest livestock producer in Africa.

The project will target the White Nile irrigation schemes (about 50,000 ha area) in the South Sudan. These soils have a large potential due to availability of fresh water from White Nile River and its tributaries, which run through 7 out of 10 states, providing ready access to an abundant water supply and river transport access for agriculture producers. However, these soils are not being cultivated for decades due to low soil fertility and non-availability of good quality seeds for crops and forages. It is estimated that about 18 percent of the land is

not cultivated due to shortage of seed and another 9 percent due to low soil fertility. Increasing productivity of these lands will be crucial to ensure food security for the smallholder farmers of the area.

Strategy, Approach and Methodology

This project will adopt an integrated soil and water management approach to tackle the salinity problems in irrigated areas of both countries. The project strategy would be to first diagnose the issues and then to develop long term mitigation, management and rehabilitation strategies at farm and regional level relevant to the problem using proven and high level international salinity science and management. Since the rehabilitation of saline soils through engineering (drainage systems) or chemical amendments is an expensive and time-consuming process, this project will work on adaptive and mitigation approaches for the rehabilitation of salt-affected soils.

This project will adopt a participatory approach to conduct field trials in different parts of both countries to test the suitability of local and imported crop and forage species for the rehabilitation of salt-affected soils. Adaptation trials will be conducted at the Farmers Training Centers (FTCs) and volunteer farmers' plots in collab- oration with the national partners. These trials will also be used for demonstration purposes before scaling up. The project team will jointly implement the best management practices for salinity control at farm level. Smallholder farmers (especially women and young farmers) will be trained to establish seed/gene banks at the community level. ICBA has successfully applied this approach in SSA.

The project will generate and disseminate sustainable integrated crop-livestock technology packages to diversify incomes of farmers through the sale of animal products and forages to local markets, thus making the production systems economically sustainable. However, salt tolerant forage plants are variable in biomass production and nutritive value. The available salt-tolerant forages have not been selected or managed for improved livestock production. For this reason, they need to be tested locally for their (a) edible biomass production (kg/ha/year);

(b) nutritive value of edible biomass (i.e. the response in animal production per unit of voluntary feeding intake), and (c) the use of micronutrients and nutraceutical properties.

The project will address gender equality and social issues as crosscutting themes in each area. The project will include most vulnerable groups of the society, to ensure that the interventions benefit very poor men and women farmers and households. Since rural women play key role in undertaking agricultural and livestock activities, enhancing their knowledge and capacity will be one of the main targets of this project.

Project Outcomes and Impacts

The immediate outcome will be full implementation of new salt-affected management strategies within the pilot sites with related benefits to farming communities and land management organizations. The longer-term outcome will be new thinking and awareness of the gains possible from new salinity management approaches and both support and implementation of overall system reform. This, in turn, will lead to out-scaling of alter- native production packages beyond the project area through project partners including key government organizations. The successful implementation of above activities will increase the productivity of salt-affected lands, which will contribute positively to country's economy and reducing rural poverty. The overall impact of the project will be a revitalized agriculture in Ethiopia and South Sudan.

Scaling up Pathways

The key element of this project is to pilot test innovative strategies and approaches for the rehabilitation and management of salt-affected soils and then "scale up" recommended technologies to reach up to a greater number of rural poor. As discussed before, all activities of this project will be carried out with the involvement of local rural communities. Once convinced, these communities will act as the champions of change and critical

drivers in the process of scaling up. For successful scaling up, policy support and institutional infrastructure is very crucial. During the pilot stage, opportunities and constraints that may affect the scaling up process will be critically evaluated. For long-term sustainability, the overall impact of the alternative production systems on the lives of the rural poor, natural resources and environment will also be reviewed.

Socio-Economic and Environmental Impacts

The project will develop modified approaches to improve water management for salinity control and demon- strate best soil management practices for different salt tolerant crops and forages. Adoption of alternative crop and forage production systems will reduce the area lost to salinity degradation, bring income to farmers and improve livelihood of poor rural communities especially women. Transformation of salt-affected lands into productive lands will also contribute directly to poverty reduction by increasing the availability of fuel wood, construction materials, wild foods, and medicinal plants.

Appendix I. Conversion factor of Tropical Livestock Unit (TLU)

Livestock category	TLU	Livestock category	TLU	Livestock category	TLU
Camel	1.25	Heifer	0.75	Sheep/Goat (adult)	0.13
Ox / Cow	1.00	Calf	0.25	Sheep/Goat (young)	0.06
Bull	0.34	Donkey	0.70	Hen	0.013
Donkey (young)	0.35	Horse	1.10		

Source: Storcket al. (1991)

Appendix 2. Conversion factor for adult equivalent ratio of the households

Age	Adult equivalent ratio
Adult men 15–64	1
Adult female 15–64	0.9
Men % Female children	0.6
Men >65	

Appendix 3. RAMSAP Baseline Survey - Questionnaire

Section A: - General information

Region: _____ Zone: _____ District: _____ Kebele: _____

Village name/settlement site: _____ Clan: _____

Enumerator Name: _____ Signature: _____ Date: _____

Section B: - Household information

2. Name of respondent _____

3. Relationship to household 1. Head 2. Spouse 3. Child 4. Relative

4. Sex of respondent 1. Male 0. Female

5. Age of respondent _____ years

6. Marital status of the respondent 1. Single 2. Married (one) 3. Married (Number of spouse _____)

4. Divorced 5. Widowed

7. Level of education of the respondent 1. Illiterate 2. Read and write (adult/religious school) 3. Read/write (formal education) 4. Secondary School 5. University or higher

8. Family composition

Family composition	Family members	
	Male	Female
Below age of 14		
Between age of 15 & 64		
Above age of 65		

9. Sources and amounts of Household income per year in ETB

S. No	Possible livelihood source/s	Yes (1) No (0)	Total income	Amount earned/year			Proportion of income
				Men	Women	Both	
1	Livestock						
2	Farming						
3	Employment/ permanent						
4	Employment/ temporary						
5	Trade						
6	Remittance						
7	Aids						
8	Other						

10. Livestock ownership of the household

S. No.	Types of livestock	No. owned	No. of livestock consumed last year	No. of livestock dead last year	No. of livestock sold last year	Average price of livestock sold	Who manages the livestock (1= adult men; 2= adult women; 3= male children; 4= female children; 5= all equally)
1	Ox						
2	Bull						
3	Cow						
4	Calves						
5	Heifer						
6	Goat						
7	Sheep						
8	Camel						
9	Chickens						
10	Donkey						
11	Others						

Section C: - Farm characteristics

11. Total area of land owned by the household _____ha/ timad (1 timad= 0.25 ha)
12. Area of land under cultivation _____ ha/timad
13. Number of farm plots/parcel_____
14. Distance from the house to farm land _____ km/m
15. Fertility status of your farm land 1. Poor 2. Average 3. Good 4. V. good
16. How much land do you rent-out?_____ha
17. How much is the rental cost per hectare?_____ Birr/ha
18. Do you share your farm land? 1. Yes_____0. No
19. Do you have access to irrigation? 1. Yes_____0. No
20. If yes, total area of irrigated land_____ha/timad

S. No.	Types of crop planted	Irrigated area (ha)	Rainfed area (ha)	Amount produced (qt)	Amount consumed (qt)	sold	Cropping calendar (code*)	Amount lost (qt)
1	Maize							
2	Wheat							
3	Sorghum							
4	Rice							
5	Soy bean							
6	Mung bean							
7	Groundnut							
8	Cotton							
9	Tomato							
10	Banana							
11	Mango							

Code Cropping calendar 1. Jan.–Mar.; 2. 3. Apr.–Jun.; Jul.–Sept.; 4. Oct.–Dec.*

22. Seed sources 1. Own farm saved 2. Bought from market 3. NGOs 4. Government agency 5. Others (specify)

23. Please the production and marketing costs on the crops specified in question (6) above

Production and marketing activity/input	Crop 1 (specify)	Crop 2 (specify)	Crop 3 (specify)	Crop 4 (specify)
Seed				
First ploughing				
Second ploughing				
Third ploughing				
First weeding				
Second weeding				
Third weeding				
Irrigation water application				
Pesticides				
Fertilizers				
Harvesting				
Threshing				
Winnowing				
Drying and bagging				
Storage				
Transport				
Broker				
Others (specify)				

24. State any production constraints associated with crop production and marketing that you encounter

S. no.	Production constraints (1= yes; 0= no)	Marketing constraints (1= yes; 0= no)
1	Lack of improved inputs	Lack of market information
2	Shortage of arable land	Small quantity of produces
3	Lack of technical knowhow	High transaction costs
4	Shortage of irrigation water/rain	Lack of infrastructures
5	Expansion of salinity on farm lands	High involvement of brokers
6	Expansion of invasive weeds on farm lands	Low bargaining power
7	Others (specify)	Others (specify)

25. Easiness to hire land in the community 1. Easy 2. Difficult 3. Not applicable

26. Farm equipment owned/rented

26.1 Primary tillage implements

Implement	Owned (1= yes 0= no)	Rented (1= yes 0= no)	quantity
Hoes			
Indigenous tools			
Moldboard			
Disc			
Chisel			
Rotary			
Other			

26.2 Secondary tillage implements

Implement	Owned (1= yes 0= no)	Rented (1= yes 0= no)	quantity
Harrow			
Disc harrow			
Blade harrow			
Indigenous blade			
Ridge plough			

26.3 Sowing implements

Implement	Owned (1= yes 0= no)	Rented (1= yes 0= no)	quantity
Seed drill			
Mechanical seed drill			

26.4 Harvesters

Implement	Owned (1= yes 0= no)	Rented (1= yes 0= no)	quantity
Combine harvester			
Harvester			
Threshers			

26.5 Irrigation methods

Irrigation methods	Tick ☒	Combined/specify
Surface irrigation		
Localized irrigation		
Drip		
Sprinkler		
Center pivot		
Sub-surface irrigation		

27. List of farm labor tasks for women, men or shared tasks

S. No.	List of tasks	Who usually performs the task		
		Men	Women	Shared
1	Land clearing			
2	Ploughing			
3	Sowing			
4	Weeding			
5	Irrigating			
6	Harvesting			
7	Threshing			
8	Winnowing			
9	Bagging			
10	Transporting			
11	Others (specify)			

28. Farm labor

Month	Male Hours	Wages (/day?)	Women hours	Wages /day
Jan				
Feb				
March				
April				
May				
June				
July				
Aug				
Sept				
Oct				
Nov				
Dec				

29. Average monthly costs for the below and who usually makes the decisions

Activity	Av. Monthly Cost	Men decide	Women decide	Either/both decide
Food purchases				
School expenses				
Household repairs				
Farm equipment				
Seeds				
Other ag. Inputs				
Household expenses				
Other				

Section D: - Household food security

1. Does the family experience food deficit? 1. Yes 0. No
2. If yes, please indicate, which months the household experiences food deficit?

January 2. February 3. March 4. April 5. May 6. June 7. July

8. August 9. September 10. October 11. November 12. December

3. How does the household cope with food deficits? 1. Food purchase 2. Donor food aid 3. Selling assets 4. Food for work 5. Support from relatives 6. Skip without meal 7. Others (specify)

Section D: - Household food security

1. In the past one year, has the household had access to agricultural information? 1. Yes 0. No
2. If yes, who provides agricultural information? 1. Government extension officer 2. Research institutions
3. NGOs 4. Farmer association 5. Others (specify)
3. If yes, what was the means of getting agricultural information? 1. Radio 2. TV 3. Extension manual 4. Training
5. NGO manual 6. Others/specify
4. Is any of the agricultural information you obtained from the above sources talk about salinity? 1. Yes 0. No
5. Have you ever got any training about salinity management practices? 1. Yes 0. No
6. If yes, who provides the training? 1. Research centers 2. NGOs 3. Government office of agriculture 4. Others/specify
7. If you get any training about salinity, what information do you get? 1. Reclamation methods 2. Alternative crops to be grown on salt affected soils 3. Improved methods of irrigation water application 4. Others/ specify
8. Did you use any of the information you obtain at your farmland to reduce the effect of salinization? 1. Yes 0. No
9. If not, why? 1. Expensiveness 2. Not accessible 3. Complexity of the methods 4. No interest of using 5. Others/ specify

Section F: - Farmers' awareness and understanding of soil salinization

5. Do you think that your farmland is affected by salinization? 1. Yes 2. No 3. Not sure
6. If yes, how much of your farmland is being affected by salinity? ha
7. If yes, how sever is the salinization at your farmland? 1. Low 2. Medium 3. High 4. Very high
4. If yes, how do you know the salinity problem at your farmland? 1. Observing white crust at the top surface of the land 2. High compactness of the farm land 3. Low infiltration of water at the farmland 4. Observing dark brown color of the soil at the farmland 5. Others/specify
5. If yes, what do you think are the causes for the salinization of your farmland?

S. No.	Causes	Yes= 1, No= 0	Effects	Proposed interventions
1.	Primary			
	Parent material			
2.	Secondary			
	Irrigation water quality			
	Irrigation methods			
	Climatic condition (arid/semi-arid)			
	Land levelling problem			
	Irrigation practice			
	Frequency			
	Amount			
	Drainage system			

Section D: - Household food security

6. If irrigation is assumed to be the cause of salinization, how long do you practice using irrigation water for agricultural production at your farm land? years
7. What is your source of irrigation water? 1. River water 2. Manmade dam 3. Well 4. Lake water 5. other
8. What is the trend of salinization at your locality in the last five years? 1. Increasing 2. Decreasing 3. No change
9. If increasing, what are the probable causes? 1. Increasing irrigation farming practices 2. Deteriorating irrigation water quality 3. Decreasing irrigation water availability 4. Others/ specify
10. What direct effect does salinity cause on your livelihoods? 1. Abandoning farmland 2. Decreasing farm productivity 3. Decreasing household income 4. Increasing desertification 5. Others/specify
11. What indirect effect does salinity cause on your livelihood? 1. Increasing food insecurity 2. Decreasing employment opportunity 3. Increasing landlessness 4. Increasing dependency 5. Others/ specify
12. If decreasing agricultural productivity is caused by salinity, how much is the decreasing in productivity of your farmland since you observe salinization? 1. Complete loss 2. 5% loss 3. 25% loss 4. 10% loss 5. Less than 10% loss 6. Others/ specify

Thank you!

For Notes

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