Farmer's Perception and Improving Agricultural Productivity on Salt –affected Soil in Northern Ethiopia

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Abstract
This study was designed to measure farmers' perceptions about the existence of salinity in their farmlands and its impact on agricultural production and household food security. The survey data was collected from a total of 101 farmers from Raya-Alamata district of Ethiopia. Farmers were selected using a random sampling from a household list. Focus Group Discussions were conducted with farmers in each district to investigate their perceptions of the soil salinity, its impacts and their adaptive strategies. Data were collected using a semi-structured questionnaire and analyzed using SPSS descriptive statistics and chi-square test. Farmers' responses showed that they were concerned about increasing soil salinity problems and its impact on their crop productivity and well-being. The results showed that observing white crust and dark brown color of the soil are the major indicators used by farmers to identify salinity on their fields. Irrigation water quality and Poor irrigation methods are perceived as the main causes for salinity development. Farmers' perceptions on salinity should be used as an entry point by different stakeholders to develop strategies for the salt-affected areas.
Keywords: Soil salinity, food security, coping strategies, farmers' perception.
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1. Introduction

Globally, salt-affected soils are a severe problem in lowland irrigated areas because of inappropriate irrigation practices and poor water quality. Globally, about 20% of the irrigated lands are affected by salinity problems (Ashenafi, Bobe, & Muktar, 2016). Accumulation of soluble salts is the single most important factor in the formation of salt-affected soils in the arid and semi-arid areas where evaporation exceeds precipitation. In arid regions, salts are brought in by streams draining into the basins (Ashenafi, Bobe, & Muktar, 2016). The world is losing at least 10 ha of arable land every minute; from this, 3 ha are lost due to salinity and sodicity problems, especially in lowland irrigated regions of the world. Soil salinization is a global environmental threat altering land productivity and bringing impacts to agricultural production, environmental health, and economic welfare (Butcher, Wick, DeSutter, Chatterjee, & Harmon, 2016). Approximately 1 billion ha of land is dominated by salt-affected soils (Zaman, Shahid, & Pharis, 2016); (Ivushkin et al., 2019).

Several researchers have reported the widespread occurrence of soil and water salinity in the lowland irrigated areas of Ethiopia (Sileshi, 2016). Ethiopia stands first in Africa in the extent of salt affected soils due to human-induced and natural causes. According to (Ashenafi, Bobe, & Muktar, 2016) 9% of the total landmass and 13% of irrigated area of the country is exposed to salinity. Following Ethiopia Chad, Egypt, and Nigeria, is countries with a large area of land exposed to salinity respectively (Gupta, R. K., & Abrol, I. P. (1990). The extent of salt-affected soils has been identified as one of the factors reducing land productivity and farmer incomes, particularly in lowland areas (Kashenge-Killenga, Tongoona, & Derera, 2013). Since agricultural production in Ethiopia is predominantly rain fed, it is extremely vulnerable to changes in precipitation patterns and other adverse impacts of climate changes.

Mitigating salinity to increase the productivity of existing salt-affected soils and preventing newly developed areas from the spread of salinity is of paramount importance for agricultural development in the country. Know a days, soil salinity is the most serious problem in the arid and semi-arid lowland areas of the country resulting in reduced crop yields, low farm incomes and increased rural poverty (Gebremeskel et al.,2018).

Poor knowledge about the salinity development and suitable coping strategies are the major reasons for rapidly increasing salinity problems in the country. This situation forces farmers to switch to salt-tolerant legume and forage crops instead of cultivating cereal crops, which has consequences for the household food security. Farmer's knowledge of the causes of salinity development and the farming practices they should use to overcome the problem would be some of the Salinity management at the farm level. For example, Farmers having knowledge of salinity might decide to employ local mitigation and adaptation practices such as improved land and water management practices, planting salt tolerant crops, diversify cropping patterns and change their investment decisions (Mamba et al., 2015). Understanding farmers' perceptions of salinity and adaptive strategies to cope with this problem could be a good entry point to suggest interventions that can help them tackle this problem (Wickham et al., 2006).

This study was conducted to establish farmers" perceptions of the soil salinity and its impact on agricultural production and the information generated through this study will help farmers, researchers and policy makers in setting appropriate policies and suggesting suitable interventions for the mitigation of salinity problems and improve household food security in the salt-affected areas of the country.

2. Materials and Methods

2.1 Description of the study area

The study was conducted in Ethiopia, particularly in Raya-Alamata districts of Northern Ethioia. Based on the 2007 national census conducted by the Central Statistical Agency of Ethiopia (CSA), this woreda has a total population of 85,403, an increase of 26.56% over the 1994 census, of whom 42,483 are men and 42,920 women; 4,563 or 5.34% are urban inhabitants. With an area of 1,952.14 square kilometers, Alamata has a population density of 43.75, which is less than the Zone average of 53.91 persons per square kilometer. 80.27% of the population said they were Orthodox Christians, and 19.68% were Muslim.

The area was selected based on the presence of large tracts of salt affected soils in the irrigated areas and the demonstrated Potential of crop production. Topography features of the study area range from 1178 to 3148 m.a.s.l. While the latitude and longitude of the district is 12°25'N and 39°33'E respectively. The annual mean rainfall ranges from 299 to 1067 mm, with a mean monthly maximum and minimum temperature of 26.97 C and 14.8 C, respectively.

A mixed farming system with the predominant of crop production is practiced in the district. The major food crops grown in the area are cereals (sorghum, teff, and maize), pulses, oilseeds, vegetables and root crops. The district is characterized by the shallow groundwater levels, which is the main cause of salinity development.

2.2 Sampling design and procedures

This study used a purposive sampling protocol to identify districts, salt expansion and farmers involved in the survey. The survey data was collected from a total of 101 respondents and interviewed using a semi-structured questionnaire. A multi-stage sampling technique was used to select sample kebeles and sample respondents were drawn using systematic sampling for this study. The selection was based on the available information regarding soil salinity problem in these districts. A simple random sampling technique was deployed to select sample respondents. Field observation was part of validating the respondents information and/or concerns was raised during the interviews.

2.3 Method of Data Collection

The study used both primary and secondary data sources to capture the necessary information from farmers. Quantitative primary data were gathered to address the objectives of this study. Interview with individual farmers and field observation such as salt deposition on the soil surface were the key methods for the collection of primary data. Carefully designed survey questionnaire was applied to collect quantitative primary data. In addition, focus group discussions and key informant interviews were conducted in order to revise the research problem into a working hypothesis, prepare a draft survey questionnaire and to supplement the results of quantitative data. A pretest survey of a small sample population is always conducted prior to the final studies. For this purpose, 5 households were selected at random for the pretest survey. Accordingly, a draft questionnaire was modified based on the pretest survey. In addition to primary data, secondary data from different sources regarding different characteristics was also collected. It is essential to get baseline information of the selected areas. During the actual survey, farmers" perceptions about the causes and severity of salinity on their land was asked and collected. The questionnaires were designed to capture farmers' perception and knowledge on salt-affected soils, possible controlling practices to salt-affected soils and their coping strategies. The data collected included farmers' demographics, crop production trends, land size, knowledge and perceptions of salinity problems, factors that causes soil salt occurrence, and management practices.

Secondary data sources were collected from different sources such as Zone and Woreda Agricultural office and previously conducted researches.

2.4 Triangulation of data

The follow-up discussion was made with key informants and extension officers of the respective districts to validate the information collected from the survey. The key questions used during the personal farmer's interview and FGDs were used to clarify the incomplete information. The use of the triangulation method increases the credibility and validity of research findings (Carter et al., 2014; Noble & Heale, 2019). Triangulation, by combining theories and observations in a research study, can help ensure that fundamental biases arising during data collection, both the qualitative and quantitative data are overcome (Noble & Heale, 2019). This exercise was productive, helping to identify circumstances surrounding the key concept of salt- affected soils and omitting unacceptable information to improve the trustworthiness of results.

2.5 Method of Data Analysis

2.5.1 Statistical analysis

The collected data was analyzed and reported using percentage, frequency, mean, and STATA Version 15 software was used to carry out statistical analysis (coded and analyze). The Chi square test was conducted to verify the significance level of association between farmers' perceptions and their determinants.

3 RESULTS AND DISCUSSION

3.1 Demographic and socio-economic characteristics of respondents of the respondent

The demographic and socio-economic characteristics of respondents include gender, family size, marital status, education level, land holding and livestock ownership.

The survey result indicated that from the total surveyed respondents about 73.1% were male respondents while the remaining 26.9% were female respondents. The maximum and minimum family composition of the respondent were 1(1.3%) and 13(16.7%) respectively. Of the total respondents, the majority or 56 (71.8%) were married. The result of chi-square test shows that marital status of household head and salinity status of the land had statistically significant association at $p< 0.1$.

The education level of the sample respondents was categorized in to those who can read and write as literate and those who cannot read and write as illiterate. Based on this, illiterate respondents constituted 51.3% of the total respondents and the literate groups constituted 48.7%. Out of the total literate respondents 20.5% can only read and write, whereas, the remaining 28.2% were educated in formal education system.

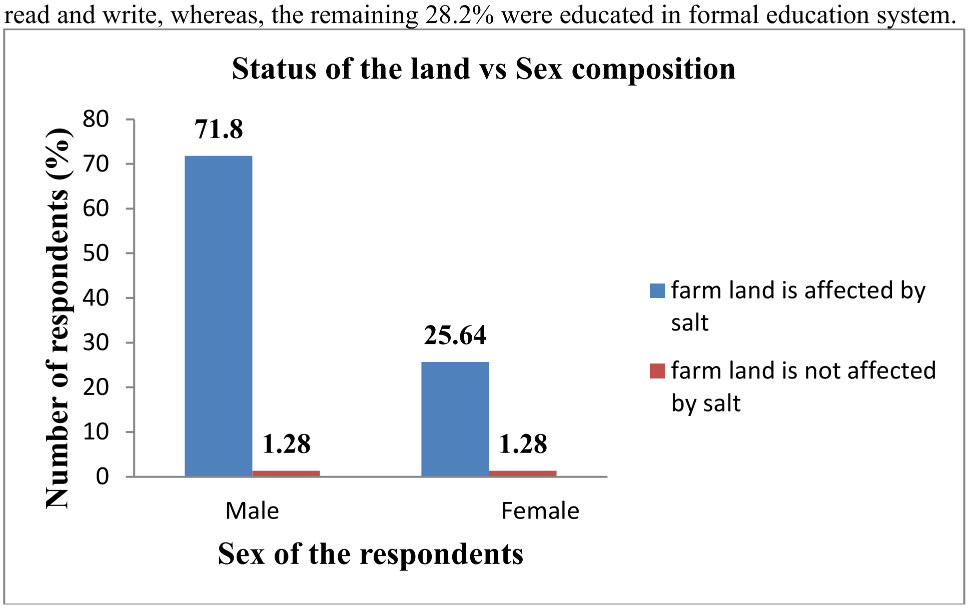

Fig1: Status of the land vs Sex composition

Table 1: Demographic and socio-economic characteristics of the respondents for dummy variables.

Variable	Category	farm land is affected by salt %	farm land not affected by salt %	Total %	Chi-square
SEHH	Male	71.80	1.28	73.08	
	Female	25.64	1.28	26.92	0.556
EDUC	illiterate	50.0	1.28	51.28	
	Literate	47.44	1.28	48.72	1.450
MRST	Married	71.79	1.28	73.07	
	Divorced	6.41	0	6.41	
	Widowed	3.85	1.28	5.13	8.669*
	Single	15.38	0	15.38	

* Significant at $P< 0.1$; Source: own survey, 2020

Regarding the continuous variables, the mean age of the respondent was found to be 51 with the minimum 28 and maximum of 95 years and with a standard deviation of 14. While the average land holding status of the total respondents whose land was affected by salt was found to be 0.87 with the minimum 0.0625 and maximum of 2 hectares and with a standard deviation of 0.3994.

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From the total respondents regarding the fertility status of the land 32.1% respondents said that their land was poor, 55.1% respondents said that their land was average, 11.5% respondents said that their land was good, and 1.3% respondents said that their land was very good.

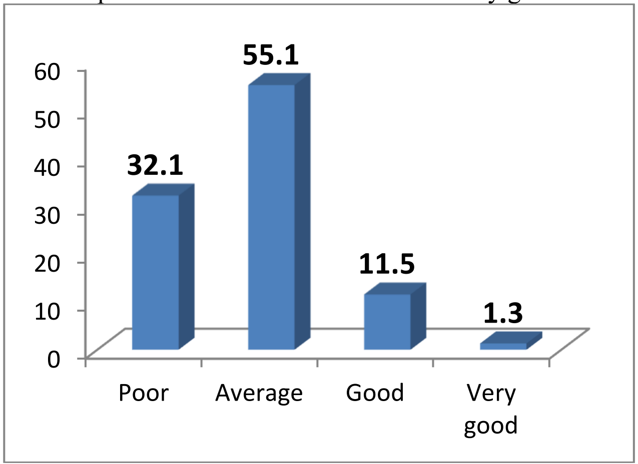

Fig 2: Farmer's perception about fertility status of the land

Irrigation accessibility and methods

Regarding to the irrigation accessibility about 92.3% respondents have access to irrigation, while 7.7% have no irrigation accessibility. About the irrigation system to the area, all the respondents used surface irrigation system to their farm.

Major crops grown and cropping season of the area

According to the results of the survey conducted the dominant crops grown in the study area during 2008/9 cropping season are Sorghum, Maize, Teff and Onion respectively. From this 68% respondent grow sorghum, 14.1% grow maize and teff and 3.8% grow onion. Regarding the cropping season, 47% respondents main cropping season was from July –September, 46.2% respondents cropping season was from April- June and 6.4% respondents cropping season was from January- March. According to the respondents result the source of the seed was own saved seed (80.8%), bought (16.7%) and government agency (2.6%) respectively.

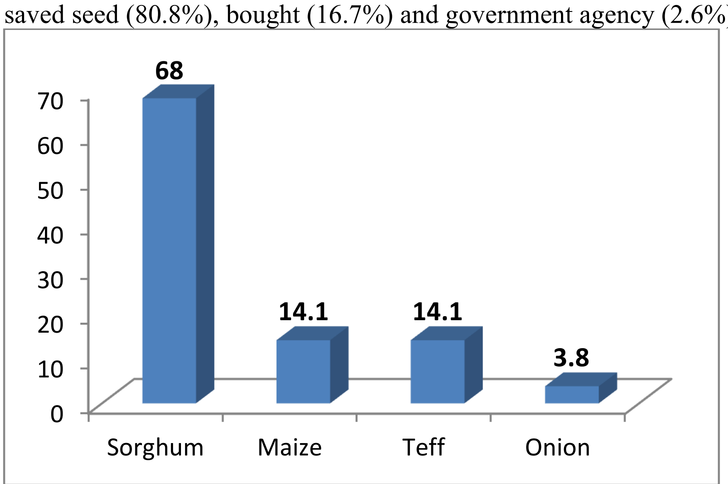

Fig 3: Major crops grown in the area

Factors affecting (hindering) crop production in the area

Of the major factors that hinder crop production to the area the major ones are: shortage of arable land (100%), lack of technical knowhow of crop production (100%), shortage of rain water (98.7%), expansion of salinity on farm lands (100%), expansion of invasive weeds (100%), lack of market information on crop price (94.9%) and high cost of crop production (57.7%) respectively.

Farmers' perception about the existence and causes of salinity

During this survey, farmers were asked about the indicators they use to identify salinity in their farmlands. According to survey results, 91.4% of the respondents identify through observing white crust on the soil surface and high compactness of the farm land, 3.1% respondents identify through low infiltration of water whereas 5.5%

of the respondents identify through observing dark brown color of the soil as an indicator to identify salinity in their fields.

Table 2: cause of farmland salinity

Parameter	No. of respondents	
	No	%
Classification of farmland salinity		
Low		7.7
Medium		34.6
High		30.8
Very high		26.9
Causes of salinity formation		
Parent material	13	16.7
Irrigation water quality	76	97.4
Irrigation methods	75	96.2
Climatic conditions	5	6.4
Land leveling problem	61	78.2
Irrigation frequency	68	87.2
Irrigation system	65	83.3

Source: Own survey

Farmers' food deficit and coping mechanisms in the area

Of the total households in the area, 92.3% were experienced food deficit during Ethiopian Summer season. Households use different adaptive strategies to cope up food deficit. Traditionally, mutual support system was the most commonly used strategy in the communities.

According to aggregate survey results, 57.7% of the food deficit households rely on food aid programs of national and international organizations, 21.8% food insecure households cope with this situation by doing off-farm income earning activities and even selling assets such as livestock and different household items. The remaining 11.5% food insecure households cope with purchasing and 1.3% food insecure households cope with take part in "*food for work activities*".

4. CONCLUSION AND RECOMMENDATIONS

Understanding salinity status of soils plays a vital role for sustainable agricultural production. This study was initiated to evaluate the impacts of soil salinity on crop productivity, food security and socio-economic conditions of the farming communities in order to develop suitable management strategies for sustainable crop production in the salt-affected areas of Ethiopia. The study results indicate that farmers use different indicators to identify salinity in their lands. Observing white crust and dark brown color of the soil are the major indicators used by households for the identification of salinity in their farmlands. Majority of the households alleged that poor irrigation management and absence of drainage systems are the major causes of salinity development in their fields. Drainage systems are either non-existing or malfunctioning.

Salinity affects directly or indirectly the livelihoods of the households. The direct impacts are related to abandoning of land, reduced crop production and declining farm incomes. The indirect impacts are linked to food insecurity and increased dependence on food aid programs.

Farmers face number of production and marketing constraints, which include lack of farm inputs including fertilizer and machinery, shortage of irrigation water, lack of market information and heavy involvement of brokers (middleman). The declined household income is increasing poverty in salt-affected areas, which has forced male members of the household to migrate to nearby towns and cities in search of off-farm jobs. This has put an enormous pressure on female members as they have to carry extra burden of household activities.

The survey results indicate that majority of the food deficit households rely on food aid programs of national and international organizations. Increasing dependence of farmers on food aid programs is declining the capacity of the food aid organizations, which is forcing farmers to sell their assets such as livestock and household items to buy food and other utilities for their families. Therefore, government needs to take immediate measures to improve situation in salt-affected areas to address food insecurity and poverty issues.

Therefore, the following recommendations are critical to increase productivity in salt-affected areas:

- ✓ A system of continuous assessment and monitoring should be established to keep an eye on the occurrence and increasing trend of soil salinity in the district.
- ✓ Crop varieties that have the capacity to grow under salinity and water logging conditions should be introduced.
- ✓ Marketing mechanism for buying the agricultural products of smallholder farmers at their true value needs to be established. This will encourage farmers to increase crop production and improve their incomes.

- ✓ Effective extension program should be initiated to disseminate information on soil, water and salinity management practices to farmers. Farmers should also be linked with national research and extension organizations for developing intervention programs for solving increasing salinity problems.

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