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Farmers' Perceptions and Improving Agricultural Productivity in Saline Soils in Northern Ethiopia

Workineh Yenewa

Ethiopian Institute of Agricultural Research, Fogera National Rice Research and Training Center, Bahir Dar, Ethiopia

Email address:
wyenewa27@gmail.com

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Abstract: The aim of this study was to measure farmers' perceptions of the presence of salinity in their croplands 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 in Ethiopia. Farmers were selected using a random sample from a household list. Focus group interviews were conducted with farmers in each district to explore their perceptions of soil salinity, its impacts and their adaptation strategies. Data were collected using a semi-structured questionnaire and analyzed using SPSS descriptive statistics and chi-square test. Farmers' responses showed they were concerned about increasing problems with soil salinity and its impact on the productivity and well-being of their crops. The results showed that observing the white crust (91.4%)and dark brown color of the soil(5.5%) are the main indicators farmers use to determine the salinity in their fields. Irrigation water quality (97.4%) and poor irrigation practices (96.2%) are considered to be the main causes of salinity development. Farmers' perceptions of salinity should be used by various stakeholders as a starting point for developing Strategies for salt-affected areas.

Keywords: Soil Salinity, Food Security, Coping Strategies, Farmers' Perception

1. Introduction

Globally, saline soils in lowland irrigated areas are a serious problem due to inadequate irrigation practices and poor water quality. Globally, approximately 20% of irrigated areas are affected by salinity problems [1, 2]. The accumulation of soluble salt is the most important factor in the formation of saline soils in arid and semi-arid areas where evaporation exceeds precipitation. In dry regions, salts are introduced by streams flowing into the basins [1]. The world loses at least 10 hectares of farmland every minute; of this, 3 hectares are lost due to problems with salinity and sodium levels, particularly in irrigated lowland regions of the world. Soil salinization is a global environmental threat that alters land productivity and impacts agricultural production, environmental health, and economic well-being [3, 4]. The effect of soil salinization has been reported globally in almost all countries with variations in their extent [5]. Approximately 1 billion hectares of land are dominated by saline soils [6, 7].

Several researchers have reported the widespread occurrence of soil and water salinity in the irrigated lowland areas of Ethiopia [8]. Ethiopia ranks first in Africa when it comes to the extent of man-made and natural causes of salt degradation in soils. According to [1], 9% of the total landmass and 13% of the country's irrigated area are exposed to salinity. After Ethiopia, Chad, Egypt and Nigeria are countries with large land areas exposed to salinity [9, 10]. The extent of saline soils has been identified as one of the factors reducing land productivity and farmers' income, especially in lowland areas [11]. Ethiopia's agriculture relies primarily on rainfall and is therefore highly vulnerable to fluctuations in rainfall patterns and other negative impacts of climate change.

For the country's agricultural development, it is of utmost importance to reduce salinity in order to increase the productivity of existing saline soils and prevent the spread of salinity in newly developed areas. Nowadays, soil salinity is the most serious problem in the dry and semi-arid lowland areas of the country, resulting in lower crop yields, low agricultural incomes and increased rural poverty [12].

Insufficient understanding of salinity evolution and inadequate coping mechanisms are the primary causes of the nation's rapidly worsening salinity issues [13]. The food security of households may be impacted by farmers being forced to convert from grain production to salt-tolerant pulses and fodder crops [14]. Farm-level salinity management would involve educating farmers about the factors that contribute to salt development and the agricultural measures they should apply to solve the issue. Farmers who are aware of salinity levels, for instance, may choose to implement regional mitigation and adaptation strategies, better techniques for managing land and water, cultivating crops resistant to salt, varying cropping patterns, and altering investment choices [15]. It could be helpful to comprehend how farmers view salinity and develop adaption techniques to deal with this problem.

The purpose of this study was to find out how farmers felt about the salinity of the soil and how it affected agricultural output. The data produced by this project will assist researchers, farmers, and policymakers in developing suitable policies and recommendations for appropriate interventions to mitigate the effects of salt and enhance household food security in the nation's salt-affected areas.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted in Ethiopia, specifically in Raya-Alamata districts in northern Ethiopia. Based on the 2007 census conducted by the Central Statistics Authority of Ethiopia (CSA), this woreda has a total population of 85,403, an increase of 26.56% from the 1994 census, of which 42,483 are men and 42,920 are women; 4,563 or 5.34% are urban residents. 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 people per square kilometer. 80.27% of the population reported being Orthodox Christians and 19.68% were Muslims.

The region was selected because it showed promise for agricultural production and had sizable stretches of saline soil in the irrigated sections. The research area's topographical features span 1178 to 3148 m.a.s.l. The district's coordinates are 12°25'N and 39°33'E, respectively, for latitude and longitude. With an average monthly maximum and minimum temperature of 26.97°C and 14.8°C, respectively, the yearly mean rainfall falls between 299 and 1067 mm.

Mixed agriculture with predominantly crop cultivation is practiced in the district. The main food crops grown in the region are cereals (sorghum, teff and maize), legumes, oilseeds, vegetables and root crops. The district is characterized by a shallow groundwater table, 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 multistage sampling technique was used to select the sample kebeles and for this study, sample participants were drawn using systematic sampling. The selection was based on available information on soil salinity problems in these districts. A simple random sampling technique was used to select the sample participants. The on-site observation was part of validating the respondent's information and/or concerns were raised during the interviews.

2.3. Method of Data Collection

The study used both primary and secondary data sources to collect necessary information from farmers. To achieve the objectives of this study, quantitative primary data was collected. Interviews with individual farmers and field observations such as: B. Salt deposits on the ground surface were the key methods for collecting primary data. A carefully designed questionnaire was used to collect quantitative primary data. In addition, focus group discussions and key informant interviews were conducted to transform the research problem into a working hypothesis, prepare a draft survey questionnaire, and supplement the results with quantitative data. Before the final studies, a pre-test survey of a small sample population is always carried out. For this purpose, 5 households were randomly selected for the pretest survey. Accordingly, a draft questionnaire was modified based on the pre-test survey. In addition to primary data, secondary data was also collected from different sources on different characteristics. It is important to obtain basic information about the selected areas. During the actual survey, farmers' views on the causes and severity of salinity on their land were surveyed and collected.The questionnaires were intended to capture farmers' perception and knowledge about salt-affected soils, possible control practices for salt-affected soils and their coping strategies. Data collected included farmer demographics, crop production trends, land size, knowledge and perceptions of salinity issues, factors causing the occurrence of soil salinity, and management practices. Secondary data sources were collected from various sources such as Zone and Woreda Agricultural Office and previously conducted research.

2.4. Triangulation of Data

The subsequent discussion was conducted with key informants and advisors from each district to validate the information collected from the survey. To clarify the incomplete information, the key questions from the personal farmer interview and the FGDs were used. The use of the triangulation method increases the credibility and validity of research results [16]. By combining theories and observations in a research study, triangulation can help ensure that fundamental biases that arise during data collection, both qualitative and quantitative data, are overcome [16]. This exercise was productive in helping to identify circumstances surrounding the key concept of salt-affected soils and omitting unacceptable information to improve the trustworthiness of the results.

2.5. Method of Data Analysis

Statistical Analysis

The collected data was analyzed and reported based on percentage, frequency and mean. STATA version 15 software was used to perform statistical analyzes (coded and analyzed). Chi-square test was conducted to check the significant relationship between farmers' perceptions and its determinants.

3. Results and Discussion

Demographic and Socio-Economic Characteristics of Respondents of the Respondent

Demographic and socioeconomic characteristics of respondents include gender, family size, marital status, education level, land ownership, and livestock ownership. The survey result revealed that of the total number of respondents surveyed, about 73.1% were male, while the remaining 26.9% were female respondents. The maximum and minimum family composition of respondents was 1 (1.3%) and 13 (16.7%), respectively. Of all respondents, the majority, 56 (71.8%), were married. The result of chi-square test shows that the marital status of the household head and the salinity of the land had a statistically significant relationship at $p < 0.1$.

The educational level of the sample respondents was classified into those who can read and write as educated people and those who cannot read and write as illiterate. On this basis, illiterate people made up 51.3% of all respondents, while the literate group made up 48.7%. Of the total educated respondents, 20.5% can only read and write while the remaining 28.2% were educated in a formal education system.

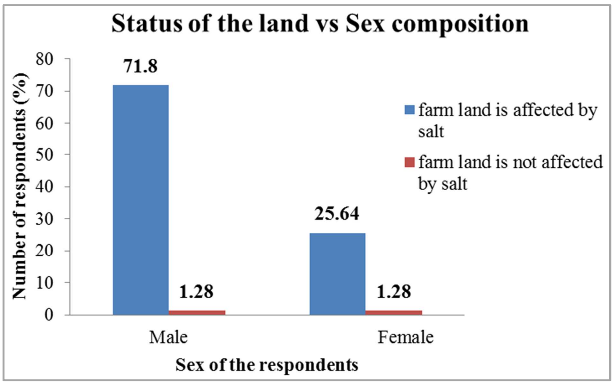

Figure 1. *Status of the land vs Sex composition.*

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

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

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

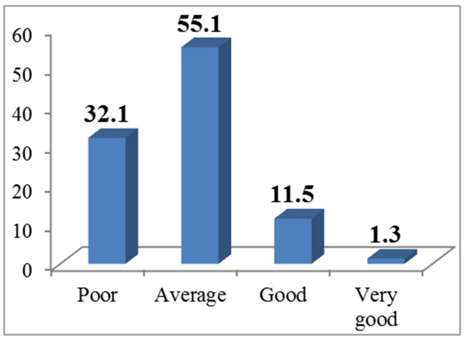

Figure 2. *Farmer's perception about the fertility status of the land.*

Regarding the continuous variables, it was found that the average age of the respondents was 51 years, with a minimum of 28 and a maximum of 95 years, and a standard deviation of 14. The average land ownership status of all respondents whose land was affected by salt was a Value of 0.87 with a minimum of 0.0625 and a maximum of 2 hectares and a standard deviation of 0.3994 were determined. Of all respondents on the country's fertility status, 32.1% of respondents said their country was poor, 55.1% of respondents said their country was average, 11.5% of respondents said their country was good, and 1.3% of respondents said their country was poor and their country was very good.

Irrigation accessibility and methods

Regarding irrigation accessibility, about 92.3% of the respondents have access to irrigation while 7.7% have no access to irrigation. Regarding the irrigation system in the region, all respondents used surface irrigation systems on their farms.

Major crops grown and cropping season of the area

According to the results of the survey carried out, sorghum, maize, teff and onions were mainly grown in the study area in the 2008/2009 growing season. Of these, 68% of respondents grow sorghum, 14.1% grow maize and teff and 3.8% grow onions. Regarding the growing season, the main growing season was July to September for 47% of respondents, April to June for 46.2% of respondents and January to March for 6.4% of respondents. According to the respondents' results, the source of seeds was own saved seeds (80.8%), purchased seeds (16.7%) and government seeds (2.6%), respectively.

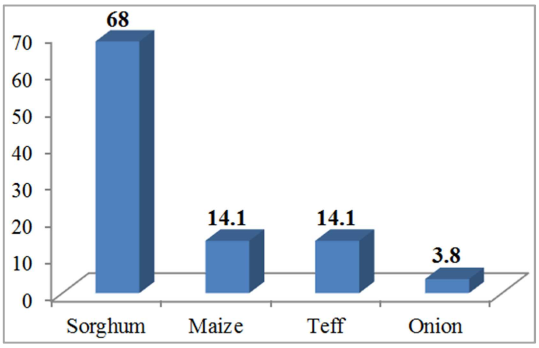

Figure 3. *The most important crops grown in the region.*

Factors affecting (hindering) crop production in the region

he main factors hindering crop production in the region include lack of arable land (100%), lack of technical know-how for crop production (100%), lack of rainwater (98.7%) and increase of salinity on arable land (100%), spread of invasive weeds (100%), lack of market information about crop prices (94.9%) and high costs of crop production (57.7%).

Farmers' perceptions about the existence and causes of salinity

Farmers were questioned in this study regarding the markers they employ to assess the salinity of their cropland. The survey's findings show that 91.4% of respondents identified themselves by pointing to a white crust on the soil's surface and the high compaction of the arable land, 3.1% by pointing to low water infiltration and 5.5% by pointing to the dark brown color of the farmland as a sign of the soil's salinity in their various 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 region

92.3% of all households in the region experienced a food deficit during the Ethiopian summer season. Households use different adaptation strategies to deal with food deficits. Traditionally, a system of mutual support has been the most common strategy used in communities. According to aggregated survey results, 57.7% of food-deficit households rely on food assistance programs of national and international organizations, and 21.8% of food-insecure households cope. They improve the situation by carrying out non-agricultural activities to generate income and even assets such as livestock and sell various household items. The remaining 11.5% of food-insecure households cope with shopping and 1.3% of food-insecure households cope with participation in food-for-work activities.

4. Conclusion and Recommendations

Comprehending the salinity of soil is essential for sustainable farming practices. In order to create suitable management plans for sustainable crop production in Ethiopia's salinity-affected regions, this project was started with the goal of evaluating the effects of soil salinity on crop productivity, food security, and the socioeconomic circumstances of agricultural communities. The findings of the study recommend that farmers assess the salinity of their soil using a variety of indicators. The primary markers that households can use to assess the salinity of their agricultural land are the white crust and the dark brown color of the soil. The majority of families stated that inadequate drainage systems and poor irrigation management were the primary reasons for the development of salinity in their farms. There are either no drainage systems or they are not operating correctly.

Salinity impacts household livelihoods either directly or indirectly. Reduced crop yields, declining farm incomes, and land abandonment are the direct effects. Food insecurity and a growing reliance on food assistance programs are the indirect effects. A lack of irrigation water, a lack of market information, a high involvement of brokers (middlemen), and a shortage of agricultural inputs like fertilizers and machinery are just a few of the production and marketing challenges that farmers face. Reduced household income drives male household members to migrate to neighboring cities in pursuit of non-agricultural jobs, further exacerbating poverty in the salt lands. The female members are under a great deal of strain because they have to shoulder the extra workload of housework.

According to the survey's findings, the majority of households with food insecurity depend on national and international organizations for food assistance programs. Farmers are being forced to sell their assets, such as livestock and household items, in order to pay for food and other supplies for their families, as a result of their increased reliance on food aid programs, which also reduces the ability of food aid organizations. As a result, the government needs to act quickly to alleviate poverty and food insecurity while also improving the situation in areas affected by salt.

Therefore, the following recommendations are crucial to increase productivity in saline areas:

1) A continuous assessment and monitoring system should be established to track the occurrence and increasing trend of soil salinization in the district.
2) Plant varieties that can grow in saline and humid conditions should be introduced.
3) A marketing mechanism needs to be created to purchase agricultural products from small farmers at true value. This will encourage farmers to increase their crop production and improve their income.
4) An effective extension program should be initiated to provide farmers with information on soil, water and salt management practices. Farmers should also be linked with national research and extension organizations to develop intervention programs to address increasing salinity problems.

ORCID

https://orcid.org/0000-0003-2155-6326

Conflicts of Interest

The author declares no conflicts of interest.

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