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Effects of Land Degradation on Sorghum Production among Farmers in Arabsiyo district in Somaliland

Author: Mustafe. Y. Osman
Co Author: Abdirisak Awil Mouse
Email: *Mustafeyasin575@gmail.com / Mobarikcawil@gmail.com*
Department of Agriculture and Veterinary Medicine, Faculty of Agriculture and Natural Resource Management, Gollis university, Hargeisa, Somaliland
Department of Humanitarian Arts of social science, Faculty of social work and community development , Gollis university, Hargeisa, Somaliland
Affiliation E-mail: *info@gollisuniversity.com.*

Keywords

Land Degradation
Sorghum production
Farmers

Abstract

This study determined the perceived effect of land degradation on Sorghum production among farmers in Arabsiyo district in Somaliland. The study used both Multiple Regression Analysis to find out the significance of land degradation on Sorghum production among farmers and Simple Linear Regression Analysis to and as well as to examine the effect of each objective on Sorghum production among farmers in Arabsiyo district in Somaliland. It used a questionnaire method as data collection method to garner data from sample size of 113 respondents by using stratified sampling method. The study found that land degradation affects sorghum production among farmers in Arabsiyo district, (R=.376a, R2 adj=.116p =. 002a) this study used three objectives; the soil erosion has a significant effect on sorghum production among farmers in Arabsiyo district, (R= .338a, R2 adj =.114, p=.001).). The second objective the study found that soil compaction has no significant perceived effect on sorghum production among farmers in Arabsiyo district, (R= -027a, R2 adj =-.009, p=.787). The third objective the study determined the perceived effect of soil salinization on sorghum production among farmers in Arabsiyo district and found that soil salinization has no significant perceived effect on sorghum production among farmers in Arabsiyo district, (R2=.052a, R2 adj. = .003, p = .600). Therefore, in this study as objective wise only the soil erosion

affects sorghum production among farmers in Arabsiyo district in Somaliland. Therefore, the study concluded that land degradation affects sorghum production among farmers in Arabsiyo district in Somaliland. Finally, the study recommends that Ministry of Environment and Ministry of Agriculture should develop and implement policies that encourage sustainable land use and management. NGOs should consider supporting scaling of soil and water conservation techniques to conserve soil and water in a degraded area.

1. Background of the Study

Globally, land degradation is wide spread affecting the agronomic productivity and the environment, though the exact magnitude and pace of land degradation at global scale is still to be determined, the land degradation has affected some 1900 million ha of land worldwide and the rate at which arable land is being lost is increasing and is currently 30-35 times higher than the historical rate united nation environmental program, 1999). In Africa, where agricultural production is critical to development and the livelihoods of the rural population depend on the primary sector (Barbier, 1998). Land degradation may pose a serious threat to crop production and rural livelihoods, particularly in the poor and densely populated areas of the developing world (Sara & Satya, 1997). In Somaliland, due to changes in climate, human, livestock population and changes national and global economy, the people have changed their land use patterns. The land degradation that exists in Somaliland includes loss of vegetation, gully erosion, loss of topsoil, siltation of surface dams and irrigation canals and loss of plant nutrients in the agricultural areas, the environmental and socio-economic characteristics of Somaliland are advancing land degradation, and it has affected pasture availability, crop production and pastoral production system (Somalia Water and Land Information Management, 2011).

This study was guided by the theory of collective goods written by economist Mancur Olson in 1965). This theory asserts that a pure collective goods has three properties: non excludability nobody can be excluded from consumption so anybody can benefit, non-rivalry in consumption one person's consumption does not impair that of another and externalities the possibility of free-riding because of non-excludability (Wachter, 1992). According to this theory, environmental problems such as land degradation emerge when users can exploit scarce environmental goods, such as grazing areas, without contributing to their maintenance or conservation (Wachter, 1992). This theory was adopted for this study because it relates to the land degradation factors to production which is the same variables to be addressed in this study.

Land degradation is generally defined as the reduction in the soil's ability to contribute to crop production and as a change to land that makes it less useful for human being (Blaikie & Brookfield, 2014). Land degradation generally is defined as the temporary or permanent decline in the productive capacity of the land (FAO, 1997). In same the line, World Bank defines land degradation as a reduction of resource potential, the loss of utility or potential utility resulting in temporary or permanent lowering of current or future productive capacity of land (2007).In this study land degradation is considered as the loss of actual or potential productivity of land resources; it is the decline of land quality. Land degradation was characterized climatic factors which relate to the amount and intensity of rainfall released on the land, soil erosion, soil compaction, soil salinization, population density, ignorance and reluctance to embrace technologies on land management. Human engagement activities that can cause land degradation are: agricultural activities, mining, deforestation (Eswaran and Reich, 2001).

Land degradation is conceptualized as Soil erosion, Soil compaction or Soil salinization. Soil Erosion can be defined as the removal of a field's topsoil by the natural physical forces of water,

wind or through forces associated with farming activities (Ritter & Eng., 2012). It is characterized by the loss of the topsoil formation of gullies and hallows fields by the natural physical forces of water, wind Balasubramanian (2017).

Soil compaction is defined as the densification and reduction in soil porosity (Arvidsson et al., 2000). Soil compaction is characterized as the reduction in soil pore volume and an increase in soil hard ban, bulk density (Barbier, 1998).Soil salinization is defined as one of the most common land degradation processes in arid and Semi-arid regions, where precipitation exceeds over evaporation (Marchanda, 1981),Soil salinization is characterized as the decreases of soil fertility, increase of soil salinity and is a significant component of desertification processes in the world's dryland (Thomas and Middleton, 1993).

Sorghum production is the amount of sorghum produced in a given country each calendar year, including both the quantities of the commodity sold in the market (Snowdon2010). Sorghum production is also defined as a way of growing o raising food in the required quantity at optimum time (Herren, 2014) Sorghum production is the process of propagating planting, growing, harvesting and processing of tall green leaf edible plant for source of food and income generation (Solomon, 2010). Sorghum production refers to yield of a crop, or to the cultivation of plants for food, animal food stuffs or other commercial uses (Cowell & Parkinson, 2003). In this study sorghum production is defined as the process of propagating planting, growing, harvesting and processing of tall green leafy edible plant for source of food and income generation. However in this study sorghum production is conceptualized quantity of sorghum produced in bags.

According the records of Food Security and Nutrition Analysis Unit (FSNAU 2011), crop productivity has continually declined in Somaliland over the years. The productivity of sorghum declined from 43760 tons to 20800 tons within the same period, reflecting a total fall of 8400 tons or (11.5%) per annum. This study was be carried out in Arabsiyo District which is called the bread basket of Somaliland because of its crop productivity level compared to other regions in the country. According to Ministry of Agriculture Development, (2016) reported Sorghum production declined by 35360 tons (48.5%) between 2014 and 2016.

1.2 Problem statement

The type and appearance of Land is directly related to the quality and quantity of crop production. Sorghum is one of the most important cereals growing in Somaliland. According to the ministry of Agriculture, the Sorghum production has been gradually decreasing from 2014 which was 43760 tons (60%), the Sorghum production reached by 20800 tons (28.5%) in 2015, and 8400 tons (11.5%) in 2016. Similarly, Sorghum production in 2016 has declined 48.5% between 2016 and 2014 year. The major reason for the decreased production is lowered yield, as the total sowing area in 2016 was almost identical to the one in 2014. The condition is so severe that it needs urgent measures yet the study on land degradation and Sorghum production in Arabsiyo district has not been carried out .

1.3 Research Objective

1.3.1 General research Objective

This study was guided by the general research objectives

To determine the perceived effect of land degradation on sorghum production in Arabsiyo District, Somaliland.

1.3.2 Specific research Objectives

The study was guided by the following specific objectives

1. To assesses the perceived effects of Soil erosion on sorghum production in Arabsiyo District, Somaliland

2. To examine the perceived effects of Soil compaction on sorghum production in Arabsio District, Somaliland.
3. To determine the perceived effects of soil salinization on sorghum production in Arabsiyo District, Somaliland.

1.4 Research Hypothesis

1.4.1 General Research Hypothesis

This study was guided by the general hypothesis There is a significant effects of land degradation on sorghum production in Arabsiyo District, Somaliland.

1.4.2 Specific Research Hypothesis

This study was guided by the following specific research hypothesis

1. There is a significant effects of Soil erosion on sorghum production in Arabsiyo District, Somaliland.
2. There is a significant effect of Soil Compaction on sorghum production in Arabsiyo District, Somaliland.
3. There is a significant effects of Soil salinization on sorghum production District, Somaliland.

1.5 Research Questions

1.5.1 General Research Question

The general research question answered in this study was be

- What is the perceived effect of land degradation on sorghum production in Arabsiyo District, Somaliland?

1.5.2 Specific Research Question

The study answered the following research questions:

1. What is the perceived effect of Soil erosion on sorghum production in Arabsiyo District, Somaliland?
2. What is the perceived effect of soil compaction on sorghum production in Arabsiyo District, Somaliland?
3. What is the perceived effect of Soil salinization on sorghum production in Arabsiyo District, Somaliland?

1.6 Significance of the Study

The findings of this study should benefit the different stakeholders farmers was the benefits from the finding of this study, by understanding the reasons why there is needed to preserve their land and how they can reduce land degradation and improve their sorghum production. The study is also useful to researchers was use the findings of this study as a secondary sources of data for their studies which may relate to land degradation. Therefore this study should be expected to provide necessary and up to data information concerned bodies or stakeholders such as local non-governmental organizations (LNGO), International non-governmental organization (INGO) also benefits the Government especially Ministry of Environment and Rural Development and Ministry of Agriculture that responsible for the community to improve land use system and to take intervention measures to reduce land degradation. The rationale for this study emanates from this recognition, and therefore seeks to incorporate the land use suitability and land management strategies to control land degradation.

2. Literature review

2.1 Introduction

This chapter reviews related studies in line with the study objectives. This mainly focuses on the effects of Soil erosion, Soil compaction and Soil salinization on Sorghum production.

2.2 Soil erosion and Sorghum Production

Soil Erosion can be defined as the removal of a field's topsoil by the natural physical forces of water, wind or through forces associated with

farming activities (Ritter & Eng., 2012). Further above description Soil erosion it is viewed as a world-wide challenge for sustainability of agriculture especially in tropical region. It is the process of detachment and transport of soil particles. Erosion can decrease rooting depth, soil fertility, organic matter in the soil and plant available water reserves (Lal, 1987).

According to Okoba and Sterk (2005), the effect of soil erosion on Sorghum production in Gikuuri catchment in central highland of Kenya generally leads to reduction of sorghum yield between seasons. The yield differences are due to inherited or in situ soil physical properties represented by different erosion indicators that fertilizers cannot eliminate. Soils prone to rill and sheet (splash-pedestals) are more productive than where red soils are observed. This can be attributed to efficient removal of nutrient-rich topsoil through the rill channels and surface runoff that enhance decline in soil–water and plant nutrients storage reserves in topsoil profiles required for crop development. Red soils tend to have coarse subsoil aggregates, which in effect reduced surface runoff to some extent though they are low in plant nutrients due to past loss of its dark topsoil profile. Farmers can lose over 50% of their sorghum yields due to observed past or current erosion phenomenon in agricultural lands.

Several studies have linked to Soil erosion and Sorghum production (Jaetzold, et al., (2006).investigated of Soil erosion on small holder Sorghum farms About 80% of the world's agricultural land suffers to Soil erosion, and 10% suffers slight to moderate erosion. Croplands are the most susceptible to erosion because their soil is repeatedly tilled and left without a protective cover of vegetation. In general, these studies suggested that Soil erosion affects Sorghum production and yielding efficiency during production stage.

2.3 Soil compaction and Sorghum Production

Soil compaction is defined as the densification and reduction in soil porosity (Arvidsson et al., 2000). Soil compaction it can also mean a serious and unnecessary form of land degradation that can result in increased soil erosion and decreased crop production (Munns, 2002).Soil compaction is viewed as one of the main problems for plant growth insorghum, especially in countries where crops should be irrigated (Ahloowalia et al., 2004). Soil Compaction has been considered a limiting factor to sorghum production in arid and semi-arid regionsof the world (Munns, 2002). Soil compaction causes problems in crop and forest recently reviewed the literature. Production worldwide (Soane and van Ouwerkerk, 1994).

Several studies have linked to Soil compaction and Sorghum production. (Botta et al., 2002) investigated the effect of Soil compaction on sorghum cultivation lands in Bangladesh on a sample of 580 farmers from 6 distinct areas. (Botta et al., 2002) has found that the compaction of soil was extremely and negatively affected sorghum production capacity as well as cultivation methods, so that, there is relationship between Soil compaction and sorghum production. In general the above studies suggested that Soil compaction affects Sorghum production while one study suggest that only extreme soil compaction effect Sorghum production.

2.4 Soil Salinization and Sorghum Production

Soil salinization is defined as one of the most common land degradation processes in arid and Semi-arid regions, where precipitation exceeds over evaporation (Marchanda, 1981). Furthermore Soil salinization is a complex phenomenon influenced by sorghum production and socio-economic factors. In many economic analyses, there is a tendency to attribute soil fertility decline only to soil erosion, Erosion is treated as the sole contributing factor to soil/land degradation and yield declines, as the impacts of nutrient depletion on crop yields were underestimated or completely neglected (Kerr and Pender, 2005).

Several studies have linked to soil salinization and sorghum production Soil Salinization in the form of nutrient depletion, is an important factor for the declining Sorghum production in Ethiopia (Sileshi Bekele and Holden, 1998). According to Getnet Dubale et al. (2009) soil Salinization induced

productivity losses are distinct in the Upper Blue Nile Basin. The cost of soil salinization to farmers is two-fold; loss of productivity due to loss of plant nutrients and economic cost of fertilizer in order to compensate the lost nutrients (Gruhn et al., 2000). The physical, chemical and biological effects of soil salinization on the ecosystems and Human populations have been researched to some degree, but little research has been done about the economic costs of soil salinization (Görlach et al., 2004), in particular sediment and nutrient loss by rivers from small catchment. Diga District where the two study catchments are found is located in the western Oromia, Ethiopia were low soil fertility and soil salinization are one of the major factors limiting sorghum production and productivity (WakeneNegassa, 2005).

3. Research Methodology

3.1 Introduction

This chapter describes the methods and techniques that was employed to solve the research problem. It describes the research design, population and sampling, and the data collection methods and analysis techniques that was be used in the study. It also describes the validity and reliability control techniques that was be used as well as ethical matters that was be considered in the study.

3.2 Research Area

This study was conducted in Arabsiyo district, Somaliland, among farmers. Arabsiyo district is located in Gebiley Region and is located 37km west of capital city of Somaliland. The community in the study area depend on farming about 70% are farmers while 20% of the community depend on livestock and remaining 10% are casual laborers who get their income on daily labor (HAVOYOCO,2018).

3.3 Research Design

This study was used a cross-sectional survey design, which constitutes collection of data from stratified population of farmers at a single point in-time (Oso&Onen, 2009). A crosssectional survey is the method of choice if you want to gather data at one point in time (Oso, 2013). The main purpose of using a cross-sectional survey design is that it can be used to test causal hypotheses in a number of ways because a cross-sectional study only happens once, you'll be able to analyze and act on your data immediately (Oso, 2013). Survey is mostly used when manipulation is not possible and to save time and cost which may be incurred in repeated data collection in longitudinal studies (Oso, 2013).

3.4 Study Population

3.4.1 Target Population

The part of the general population left after its refinement is termed target population, which is defined as the group of individuals or participants with the specific attributes of interest and relevance (Bartlett et al. 2001).The target populations of the study was consist of **320** farmers in Arabsiyo district two villages Agamsa, and Huluq (MOA, 2017). The smallholder farmers in Arabsiyo district was selected for the study because of the prevalence of land degradation in the area.

3.4.2 Accessible Population

The accessible populationis reached after taking out all individuals of the target population who was or may not participate or who cannot be accessed at the study period (Bartlett et al. 2001). The accessible population was **160** farmers since the researcher cannot easily access each all the farmers because they are largely distributed and time is limited.

3.5 Sample and Sampling

3.5.1 Sample Size

Sample is a further subset of the target population which we would like to include in the study. Thus a sample is a portion, piece, or segment that is representative of a whole (Prashant & Supriya,

2010). The sample was consist of **113** respondents from smallholder farmers in Arabsiyo District. The sample size was determined according to Krejcie and Morgan (as cited Oso, 2013). They recommend a sample of 160 for a population of 320 at 95% level of confidence, .05 level of significance and 5% margin of error, which has the same boundaries.

3.5.2 Sampling Techniques

Sampling is the act, process, or technique of selecting a suitable sample, or a representative part of a population for the purpose of determining parameters or characteristics of the whole population (Trochim, 2002). This study was used stratified sampling method. Stratified sampling is a method that identifies sub-groups in a population and then selects a sample proportionately from each sub-group (Atteye, 2015). It is mostly used where there are distinct and significant sub-groups in the population. The departments was district groups in this study and stratified sampling was used to help create a representative sample (Lewis & Elam, 2003). Stratified sampling was used to select farmers.

3.6.1 Data Collection Methods

Data was collected using questionnaire survey. It was used to collect data from the respondents who are farmers from in Arabisyo District. The questionnaire method is a research method consisting of a series of questions and other prompts for the purpose of gathering information from respondents (Passmore &Tysinger, 2002). It is suitable for studying where there is a logical and easy option as a way of collecting information from people (Feldman & March, 1981). It is selected because of the availability of, facility, time, personnel and the costs of the feasibility study (Navas&Halbrecht, 1999).

The questionnaire method was allowed the researcher to collect a lot of data in short time (Oso, 2013). The target population of this study is literate and was have no difficulty responding in writing (Oso, 2013).

3.6.2 Data Collection Instruments

Survey research may use a variety of data collection methods with the most common being questionnaires and interviews. This study was used a questionnaires to collect data. The questionnaire is the main instrument for collecting data in survey research. Basically, it is a set of standardized questions, often called items, which follow a fixed scheme in order to collect individual data about one or more specific topics (Paul, 2008). Questionnaires was employed in this study because it is less expensive and takes short time.

3.6.3 Research Procedure

The researcher was request the permission from the School of Postgraduate Studies and Research, and the Ministry of Agriculture. The permission when granted, the instrument of the study was be piloted in Caabudla, the researcher was sought further permission from the management of Arabsiyo district. All permits when obtained; the researcher was proceeded to collect data from 113 smallholder farmers using questionnaire.

3.7 Quality Control

3.7.1 Piloting

The instruments was piloted in Caabudla which has similar characteristic as farmers to the Arabsiyo district. The pilot study was enable the researcher to evaluate feasibility, time, cost, adverse events, and improve upon the study design prior to the full-scale research project (Van Teijlingen, 2001). Piloting was enabled the researcher to test the usefulness of the tools in providing the required information (Dominey, 2008). Caabudla was selected because it is the most important city and can provide a good base for piloting.

3.7.2 Validity of the Instruments

Validity is defined as the extent to which an instrument is accurately measured in a quantitative study (Robert 2015). This study was

employ content validity. Content Validity is the extent to which a research instrument accurately measures all aspects of a construct. The content validity of the research instrument was achieved through expert judgment and when the validity is near to 90% it is said to be valid.

3.7.3 Reliability of Instruments

Reliability is the consistency and stability of study results, or for a measuring device (Oso, 2016). This study was controlled by reliability of test-re-test method, this is the most reliable method to assess the reliability of instruments (Hendrickson, 2003). In the test-retest method, a researcher administers the same instrument twice to the same group at different points in time (Oso, 2013).

3.8 Data Analysis

Data analysis is a process of inspecting, cleansing, transforming and modeling data with the goal of discovering useful information, informing conclusion and supporting decision making (Xia & Gong, 2015). Data for this study was analyzed using simple linear regression. Regression is a technique for determining the statistical relationship between two or more variables where a change in a dependent variable is associated with, and depends on, a change in one or more independent variables (Kleinbaum, Kupper, & Rosenberg, 2013). The main purpose of a regression is to predict variable from unknown to known (Harrell, 2013). Simple linear regression was used to determine the relationship between land degradation and Sorghum production. It was be predicted that the maize production services was dependent on climate variability. The study was adopted a simple regression model of:

$Y = a + bX$. Where a is the coefficient of regression, and b is the constant term with Y and X.
Y is the Sorghum production, and X is the land degradation.

3.9 Ethical Considerations

The researcher was obtained a certificate of approval of research protocol from the school of postgraduate studies. The researcher was further obtained informed consent from each smallholder farmers and from each identified respondent before administering the instrument. To protect the respondents' identities data was reported as a block instead of highlighting individual cases. The researcher was also ensure that data collected was not forced to conform to a predetermined opinion.

4. Results and Findings

This chapter is guided by the objectives of the study. It reports on how data was compiled, analyzed and interpreted. The order of presentation of results is; demographic characteristics of respondents, description of the independent variables and lastly analysis on objectives. However, the background characteristics of respondents were presented first to provide a clear picture of the nature of respondents that participated in the study. A total of 113 questionnaires were given out to respondents, 104 of 113 were returned giving a response of 97%

Demographic Section

	Characteristics	Frequency	Percentage
Gender	• Male	• 74	• 71%
	• Female	• 30	• 29 %
Age	• 17-23	• 9	• 9%
	• 24-29	• 26	• 25%
	• 30-34	• 33	• 32%
	• 35-39	• 18	• 17%
	• 40-44	• 13	• 12%
	• above 45	• 5	• 5%
Level of Education	• None	• 17	• 16%
	• Primary	• 12	• 11%
	• Secondary	• 24	• 23%
	• University	• 48	• 46%
	• Others	• 3	• 4%
Marital status	• Single	• 17	• 16%
	• Married	• 70	• 67%
	• Divorce	• 9	• 10%
	• Widowed	• 4	• 7%

Data interpretation

The demographic analysis of respondents in Arabsiyo District reveals notable trends. The majority (71%) were male, highlighting gender disparities in farming and public administration. Age distribution shows that most respondents (32%) were between 30-34 years, with fewer younger (9%) and older (5%) participants. Education levels indicate that nearly half (49.5%) had no formal education, while only 10.3% attained university education, suggesting limited awareness of issues like land degradation. Marital status data shows that 67.1% were married, indicating that most farmers are family heads with responsibilities. These findings reflect the socio-economic structure of the farming community in the region.

4.3Land degradation and Sorghum Production

4.3.1 Measurement of Variables

After describing the demographic characteristics of the respondents, the researcher proceeded to determine the perceived effect of land degradation on Sorghum production in Arabsiyo district, Somaliland. Land degradation was the independent variable and was conceptualized as Soil Erosion, Soil compaction and Soil salinization. Soil erosion was operationalized into loss of top soil. Deeper and more frequent gullies and formation of hallows. Soil compaction was operationalized as formation of hard ban soils and reduction of soil pores. The third indicator which was Soil salinization was operationalized as Depletion of soil nutrients and increased salinity. Respondents were requested to react to several statements on these variables intended to assess the status of each subordinate variable by indicating Strongly Agree, Agree, No Comment, Disagree and Strongly Disagree. The responses were scored on an interval scale such that Strongly Agree was scored 5, Agree 4, No Comment 3, Disagree 2 and Strongly Disagree 1. The scores on each subordinate variable were added together to obtain overall score on the variable. There were minimum and maximum scores for variable depending on the issues raised on it. The total score of each respondent on each variable was obtained from the sum of the total scores from each subsidiary variable. The scores were converted in to percentages. The variables were scored, rated and coded as summarized in Table 1.

Table 1. ***Summaries of land degradation.***

Variable	Indicators	Score/Code	Scale	Analysis
Soil erosion	loss of topsoil Deeper and more gullies. formation of hallows	None	Interval	Regression
Soil compaction	- Formation of hard pan - Reduction soil pores.	None	Interval	Regression
Soil salinization	-Depletion of soil nutrients -increased salinity	None	Interval	Regression

Table 2 ***Variable Codes and Scores***

Elements of land	Scores	Weighted / Code	Decision on Variable degradation
Soil erosion	5 – 11	1	Low
	12 – 18	2	Moderate
	18 – 25	3	High
Soil compaction	8 – 17	1	Low
	18 – 27	2	Moderate
	28 – 38	3	High
Soil salinization	7 – 14	1	Low
	15 – 23	2	Moderate
	24 – 32	3	High

4.3.2 Soil erosion and Sorghum production

The first objective of this study was to assess the perceived effect of Soil erosion on Sorghum production among farmers in Arabsiyo District, Somaliland. Soil erosion was operationalized into loss of top soil. Deeper and more frequent gullies and formation of hallows. Respondents were provided to react statements on these variables intending to determine the status of Soil Erosion. Based on the responses provided by the respondents the recurrent drought was rated high, medium and low as described in Table 2. Soil erosion status of each respondent were compared Sorghum production and the obtained result were summarized in Table3.

Table 3 ***Summary of Regression analysis of Sorghum production with soil erosion***

Model	B	R	R2	R^2 adj.	Std. ε	F	T	Sig.
Constant	11.668				9.585		3.237	.010
Soil erosion	.536	.338a	.114	.105	3.73741	12.234	3.498	.001

In Table 3, it shows the effect of soil erosion on Sorghum production in Arabsiyo district. It showed that the **simple linear regression** between the soil Erosion and Sorghum production was (R= .338a, R^2 adj =.114, *p*=.001). This means that there is a very weak positive relationship between soil erosion and Sorghum production among farmers in Arabsiyo District, Somaliland. The significance value of *p*= .001of this objective is lower than *p* = .05 there by rejecting the null hypothesis of significant effect of Soil erosion on Sorghum production among farmers on Arabsiyo district, Somaliland.

The Simple Linear Regression model of this objective was:

SP = 11.668+ .536 SE (1)

Where SP = Sorghum production and SE = Soil erosion.

Table 4 ***Variation of Soil erosion and Sorghum production***

Soil erosion group	Mean	N	N – Percent	Standard Deviation
Moderate	24.0000	21	20.2%	4.24264
High	23.6145	83	79.8%	4.38354
Total	23.6923	104	100.0%	4.33786

Table 4 shows the descriptive statistics of the soil erosion and sorghum production of the farmers. It shows that the sorghum production with moderate soil erosion was lower (M = 24%, S = 4.24) than the sorghum production with high soil erosion (M = 23.61%,

S = 4.38) In addition, Table 3 shows that the average soil erosion of sorghum production (23.69%, S = 4.33). This was also analyzed using Simple linear regression represented in Table 5.

4.3.3 Soil compaction and Sorghum production

The second objective of this study was to examine the perceived effect of Soil compaction on Sorghum production among farmers in Arabsiyo District, Somaliland. Soil compaction was operationalized as Formation of hard pan Reduction soil pores.

This was achieved by ascertaining a linear regression as shown in Table 5.

Table 5 ***Summery soil compaction of Sorghum production with soil Compaction.***

Model	B	R	R2	R^2 adj. Std. ε	F	T	Sig.
Constant	19.962			10.472		5.709	.059
Soil compaction	-.090	-027a	.001	-.009 .332	.073	.619	.787

In Table 5, it shows the effect of soil Compaction on Sorghum production among farmers in Arabsiyo district. It showed that the **simple linear regression** between the soil compaction and Sorghum production was (R= -027a, R^2 adj =-.009, *p*=.787). This indicate that R value of -027a shows that there is weak positive association between soil compaction and sorghum production among production among farmers in Arabsiyo District, Somaliland. Its significance value of

p= .787is higher than the accepted significance value (p = .05) and for the sake, there is no significant effect of soil compaction on Sorghum production among farmers in Arabsiyo district, Somaliland. Therefore, the null hypothesis of no significant effect of soil compaction on sorghum production was accepted. Thus soil compaction does not have a significant effect on Sorghum production.

The Simple Linear Regression model of this objective was:

SP = 19.962 + -.090 SC (2)

Where SP =Sorghum production and SC = soil compaction

Table 6 ***Variation Soil compaction and sorghum production***

Soil compaction group	Mean	N	N – Percent	Standard Deviation
Moderate	23.3333	15	14.4%	3.97612
High	23.728	89	85.6%	4.41403
Total	23.6923	104	100.0%	4.33786

Table 6 shows the descriptive statistics of the soil compaction and sorghum production of the farmers. It shows that the sorghum production with moderate soil compaction lower (M = 23.3%, S =3.97) than the sorghum production with high soil compaction (M =23.75%, S = 4.41) In addition, Table 5 shows that the average soil compaction of sorghum production (23.69%, S = 4.33). This was also analyzed using Simple linear regression represented in Table 5.

4.3.4 Soil salinization and Sorghum Production

The third objective of this study was to determine the perceived effect of the Soil salinization on sorghum production among farmers in Arabsiyo District, Somaliland. Soil salinization was operationalized Depletion of soil nutrients increased salinity. This was achieved by ascertaining a linear regression as shown in Table 7.

Table 7 ***Variation of Sorghum production with soil salinization***

Soil Salinization group	Mean	N	N – Percent	Standard Deviation
Moderate	2.7500	8	7.8%	.46291
High	2.2947	95	92.2%	.50262
Total	2.3301	103	100.0%	.51236

Table 7 shows the descriptive statistics of the soil salinization and sorghum production of the farmers. It shows that the sorghum production with moderate soil salinization lower (M = 2.750%, S =4.62) than the sorghum production with high soil salinization (M =2.29%, S = 502) In addition, Table 8 shows that the average soil salinization of sorghum production (2.33%, S = 5.123). This was also analyzed using Simple linear regression represented in Table 8.

Table 8. ***Summary of Regression analysis of effect of Soil salinization on Sorghum production***

Model	B	R	R2	R^2 adj.	Std. ε	F	T	Sig.
Constant	9.855				13.937		.707	.481
Soil Salinization	.262	.052 a	.003	-.007	.499	.277	.526	.600

Table 8 shows us that the effect of soil salinization on Sorghum production among farmers in Arabsiyo district, Somaliland. The study shows that Soil salinization has a significant effect on Sorghum production in Arabsiyo district, (R2=.052a, R2 adj. = .003, p = .600) This indicate that R value of .052a shows that there is weak positive association between Soil salinization and sorghum production among farmers in Arabsiyo District, Somaliland. Its significance value of p= .600 is higher than the accepted significance value (p = .05) and for the sake, there is no significant effect soil salinization on sorghum production among farmers in Arabsiyo district, Somaliland. Therefore, the null hypothesis of no significant effect of soil salinization on Sorghum production was accepted. Thus soil salinization does not have a significant effect on sorghum production.

The Simple Linear Regression model of this objective was:

SP = 9.855+ .262 SS (3)

Where SP = Sorghum production and SS = soil salinization.

4.3.5 Multivariate Regression Model – Test of Three Objectives.

The general objective of this study was to determine the perceived effect of land degradation on Sorghum production among farmers in Arabsiyo district, Somaliland. This means that the fundamental part of the study was to examine the variation caused in the dependent variable (Sorghum production) by the independent variable (land degradation). However, all the analyses carried out in the proceeding parts of Chapter Four have mainly delved into Simple Linear Regression to test significance effect of land degradation on sorghum production among farmers. It was therefore, considered essential to run a regression analysis to establish whether in point of fact the independent variable causes variation in sorghum production of farmers. A multivariate regression model was used to determine the significance of land degradation on the sorghum production of farmers. This led to the adoption of a set of indicators to achieve the desired objectives.

The Multiple Regression Model for the study was:

Y=f(X)

Y=f(X1,X2,X3;

Y = +a1X1+a2X2+ a3X3

Where;

Y: Dependent Variable: Sorghum production
X1: IV1: Soil erosion
X2: IV2: Soil compaction
X3: IV3: soil salinization
= Constant a1, a2, and a3 are parameters for the variables X1, X2 and X3 respectively. Where the statistical
Where the statistical model to be used in the regression is:

Y= 0 +a1X1+ a2X2+ a3X3 + ε

I (i=0, 1, 2, 3) are parameters,
0 is the intercept (constant)
E represents the random errors

Table 9 Multiple Regression Model of soil erosion, soil compaction, soil salinization and sorghum production.

Model	B	R	R^2	R 2adj.	Std. ε	F	t	Sig.
Constant	12.231				5.983		2.044	.044
Soil erosion	.630				.157		4.012	.000
Soil compaction	.002				.102		.016	.987
Soil salinization	-.116				-704		.047	.451
					.154			
Model			.376a		.142	.116		.157
.002a								

a. Dependent Variable: Sorghum Production

Table 9 shows R which is the correlation between the observed and predicted values of the dependent variable to be .376[a], while R square which is the proportion of variation in the dependent variable is .142 the adjusted R square is .116 showing a relationship between the observed and predicted values of the dependent variable. The model illustrates that Sorghum production is manipulated by the sum of the combined outcome of soil erosion, soil compaction and soil salinization as confirmed by the R^2. The regression analysis has pointed out that the land degradation explains 16% variation in the sorghum production of the farmers.

The subsequent empirical model was generated using the beta coefficients:

SP = 12.231+ .630 SE +.002 SC -.116 SS

Where SP = Sorghum production, SC = Soil compaction, SS = soil salinization SE= soil Erosion.

More so, in the model in Table 7 illustrates that a unit change in Soil erosion causes 63.1% variation in Sorghum production. While Soil compaction and soil salinization demonstrated an in significant variation in the Sorghum production, soil erosion exhibited a positive and significant variation in the Sorghum production in Arabsiyo district. Therefore, this study suggested that Soil erosion is the factor that is responsible for the poor sorghum production in farmers in Arabsiyo district in Somaliland. More so, in The model in Table 7 reveals that for every unit change in Soil compaction 2% change in the Sorghum production in farmers in Arabsiyo district and it is not significant, (p=.987).

This suggests that Soil compaction is not a significant predictor of soil production.

The model also reveals that a unit change in Soil salinization causes 11.6 % change Sorghum production in farmers in Arabsiyo district in Somaliland though it is not significant (p = .451). This implies that Soil salinization is not an important factor to explain Sorghum production in farmers in Arabsiyo district in Somaliland.

Recommendations

Based on the finding and conclusion draw above, the researcher has shown in this report the perceived effects of land degradation among farmers in Arabsiyo district. The researcher makes the following recommendations, first study recommends.

- The Ministry of Environment and Rural Development should develop and implement policies that encourage sustainable land use and management.
- The Agricultural land use planning and management should be informed by smallholder farmer's knowledge of landscape structure and local micro-environments hence informed decision making.

- Educating farmers on soil and water conservation measures and proper land management techniques as a prerequisite for adoption of SWC and improvement in crop yields.
- The Ministry of Agriculture should come up with developing programs such as agricultural extension and then should implement then in the district in order to improve the knowledge of the smallholder farmers about how to enhance land productivity through reducing land degradation effect.
- The Government line ministers together with other stakeholders (NGO's and UN agencies) should consider and support for up scaling of soil and water conservation techniques to conserve soil and water at a degraded area.

Finally, I recommend that the ministry of environment and rural development should come up with developing programs such as agricultural extension and then should implement in the district in order to improve crop yield.

Recommendations for further studies

The researcher recommended that a study under taken to assess of land degradation and quantification and matching with agricultural production. And also recommend conducting effect of land degradation on crop production

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