Original Research Article

Impact of Drought on Sorghum Production and Its Adaptation Strategies in Baki district, Awdal region, Somaliland

ABSTRACT

The main objective of the study was to determine the impact of the drought on sorghum production and its adaptation strategies to overcome the impacts. The sorghum farmers of the Baki and Ruqi villages under the Baki districts were the respondents of the study. the study was conducted from 16 February 2022 – 1 January 2023, from the population, the study selected 109 sample sizes to represent the population by using the Slovin formula with the maximum acceptable error of 5 %. The sampling procedure was non-probability particularly purposive sampling. fifteen major drought impacts faced by sorghum farmers were identified in the study. A four-point rating scale was used to measure the extent of drought impact, and based on the scale score, the farmers were categorized. Moreover, Drought Impact Index (DII) was calculated to rank the selected impacts. the highest proportion of sorghum farmers (78 percent) faced high drought impacts on the production of sorghum. Among the 15 selected drought impact the highest drought impact index (DII) was found for 'Crop failure' which is (DII 327) and the lowest was "increase the unemployment" with a score of (DII 279). The most prioritized suggestion adaptation strategies regarding the solution of the drought impacts were "Drought-tolerant crop varieties" followed by "Use of short-duration crop varieties" "water harvest for irrigation use", and "weather forecasts and early warnings system". The study recommends the adaptation of drought-resistant crop varieties, short-duration crops, the establishment of weather forecasts and early warning systems, and water harvesting for irrigation use to adapt the climatic shocks.

Keywords: Drought, Impact, Farmers, Adaptation strategies, Sorghum, Somaliland.

1. INTRODUCTION

"Sorghum is the fifth most important cereal grain after maize, rice, wheat, and barley in the world" [1]. "It has been cultivated for centuries as a staple food crop in much of sub-Saharan Africa and Asia. It has remarkably wide adaptation and tolerates high temperatures and drought stress. It grows under high radiation, inadequate and erratic rainfall, and in soils of poor structure, low fertility, and low water holding capacity. Somaliland is a Sub-Saharan country located in the Horn of Africa, sharing boundaries with the Gulf of Aden in the north, Somalia in the east, the Federal Republic of Ethiopia in the southwest, and the Republic of Djibouti in the northwest It has a total surface area of about 176,119.2 squared kilometers Somaliland, the agriculture sector contributes to 25% of the country's

livelihoods and is dominated by subsistence farmers, who practice rain-fed farming and grow mainly sorghum" [2]. But more importantly, sorghum production has been gradually decreasing since 2017 which was 3000 tons (54%), the sorghum production reached 1722 tons (31%) in 2018, and 833 tons (15%) in 2019 [3]. "Sorghum is an important source of food and feed, particularly in arid and semi-arid regions where other cereal crops such as maize and wheat fail to grow" [4], [5]. "Considering recent climate changes, sorghum production could reduce the expected food shortages" [6]. "In developing countries, including Somaliland, more than 500 million people consume sorghum as their principal food source" [7].

According to [8] "Somalia is recurrently vulnerable to drought, with moderate drought occurring every 3-4 years and severe drought occurring every 7-9 years". "Droughts have disastrous effects on Somali communities and have been tagged severe droughts with unforgettable names, e.g., "Xaarama-cune, Harga-Cuna, Dabadheer" In the recent past, severe droughts occurred in Somalia in 1964, 1969, 1974, 1987, 1988, 2000, 2001, 2004, 2008, 2011, 2016/ 2017, as a result, millions of people experienced famine, malnutrition, displacement, and death" [9]. "During the drought, Somalia suffered over $1.6 billion in agricultural losses and damages, accounting for nearly half of total drought damage and losses" [10]. "Severe or prolonged droughts result in greatly reduced river flow and reduced harvestable crop yields in the Juba and Shebelle regions. A drought had the biggest effect on rain-fed food crops (sorghum, cowpea, and sesame). Total production volume loss in Somalia was 50% in sorghum, 34% in corn, 83% in sesame, and 59% in cowpea" [11]. "Drought reduces crop production by decreasing the amount of cultivated land, resulting in harvest failures. Droughts throughout 2017 cost Somalia $71 million for the four main crops planted, including $35 million for maize and sorghum, $9 million for cowpea, and $28 million for sesame" [11]. Generally, Somaliland's current climate is hot and dry, with uneven rainfall and regular droughts [12]. In Somaliland, the Somaliland Development Plan I (2016) showcasing of best practices in the adaptation strategy to climatic events was also run in parallel development [13]. According to [14], the adaptation strategy is the ability of households or communities to respond to climate impacts and pursue adaptation strategies so strong, forward-looking decision-making. Adaptation strategies are advances made by people to accustom themselves to the adverse effect of climate change such as drought [15].

"A community's coping and adopting capacities in the face of climate change and extremes are used as a proxy for its level of coping and adaptive capacity for future climate change" [16]. According to [17], "climate change adaptation strategies include the development of new irrigation infrastructure, transport or storage infrastructure, land use arrangements and property rights, and watershed management". [18] asserts that adaptation strategies include improving crop seeds, shifting crop calendars, changing irrigation systems, and soil and water conservation. These authors generally characterize adaptation strategies more or less the same way. Keeping in view the above matters, this study concentrates on finding the impact of the drought on sorghum production and its adaptation strategies to overcome these impacts. Therefore, this study was undertaken to (i) determine the extent of drought impact faced by farmers in the production of sorghum, and (ii) identify the adaptation strategies to overcome the impacts. For this reason, the researcher conducted a study entitled the impact of drought on sorghum production and its adaptation strategies in Baki district, Awdal region, Somaliland.

2. METHODS AND MATERIALS

The study was carried out in Baki District, Awdal region, Somaliland. The area is located about 107 kilometers from the capital city of Hargeisa, it has an area of 3,420 km² Area with an estimated population of 148,702, this locality was chosen because it constitutes an essential agricultural pole of sorghum production and has been affected by the recurrent. the study was conducted from 16 February 2022 – 10 January 2023. Different descriptive statistical measures such as frequency, number, percentage, mean, standard deviation, and rank order were used for categorization and describing the variables. The sampling procedure was non-probability particularly purposive sampling. Primary data were collected using a structured interview schedule by face-to-face interview method. The collected data were coded, compiled, tabulated, and analyzed for interpretation. The analysis was performed using Statistical Package for Social Science (SPSS) 22.0 computer package. The estimated target population was 150 farmers who came from Ruqi and Baki villages farmers, from the population, the study selected 109 sample sizes to represent the population by using the Slovin formula with the maximum acceptable error of 5%.

$$n = \frac{N}{1+Ne^2}$$

N: Stands for the population

n: Stands for the sample

e. Stands for acceptable error

$n = \frac{150}{1+150(0.05)^2}$ $\frac{150}{1.375}$ = 109 So the sample was109

The drought impact on the sorghum farmers was constructed to measure the impacts faced by the sorghum farmers in their production by using closed-form questions. Fifteen most important impacts of drought on sorghum faces of the study were finalized in the scale base on the pre-test experience. The farmers were asked to give their opinion on 15 selected impacts which were identified by discussing with the farmers prior to data collection. “Extent of environmental hazards” scores for each of the 109 respondents an effort was also made to compare the relative hazards using scoring techniques and the following formula EHI (EHI= N1 x 3 + N2 x 2 + N3 x 1 + N4 x 0). Along with the Environmental Hazards Index (EHI) and the rank order of each environmental hazard. A Drought Impact Index (DII) is used to fulfill this objective using the following formula

$DII = N_1 \times 3 + N_2 \times 2 + N_3 \times 1 + N_4 \times 0$

DII= Drought Impact Index

N_I = Number of farmers observed “high” impact of drought.

$N_{2=}$ Number of farmers observed “medium” impact of drought.

N_3= Number of farmers observed “low” impact of drought.

N_4= Number of farmers observed “not at all” impact of drought.

A four-point rating scale was used for computing the impact score of a respondent [19]. For each constraint, a

score of 3, 2, 1, and 0 were assigned to indicate the extent of impact faced by the respondents as high, medium, low, and not at all, respectively. The overall impact-facing score was computed for each of the respondents by summing their attained scores. The possible score of the Drought Impact Index (DII) for each of the respondents could range from 0 to 45, where 0 indicates no drought impact and 45 indicates the highest drought impact facing. The DII score for each of the impacts could range from 0 to 327, where 0 indicates the lowest extent of impact and 327 indicates the highest extent of the impact of drought by the farmers. Ranking of the impact was done based on the DII scores for the impacts. Attempts were also made to find out the suggested solutions to the identified impact of drought using a closed-form question in the questionnaire. The ranking was done based on the number of citations for each of the suggestions by the respondents.

3. RESULTS AND DISCUSSIONS

3.1 Demographic Data

Table 1 describes the demographic information of the respondents. The majority of the respondents 73.4% were male while 27.6% were female. The result indicates that male dominates the production of Sorghum in the Baki district. This may imply that the women grow other crops rather than Sorghum, it may also be that the women are busy with home activities as compared to men, this requires further other studies in order to investigate this aspect. Similar findings were found by [20], [21], [22]. In regard to age, nearly half of the respondents under study (45%) had the age group above 40 years followed by the age group 29-39 years (36.7%) while the lowest (18.3%) were scored by the 18-28 years of age group. Those above 40 years represent the senior most group and are assumed to be the most experienced inter of farming practices, drought prediction, and drought adaptation strategies. Similar findings were stated by [20], [21], [22].

Table 1. Demographic data of the respondents

Variables	Frequency	Percentage
Gender		
Male	80	73.4%
Female	29	27.6%
Total	**109**	**100**
Age		
18-28	20	18.3%
29-39	40	36.7%
> 40	49	45%
Total	**109**	**100**
Marital status		
Single	20	18.3%
Married	80	73.4%
Divorce	9	8.3%
Total	**109**	**100**
Experience		

1-3 years	17	15.6%
4-6 years	50	45.9%
Above 6 years	42	38.5%
Total	**109**	**100**
Education		
Illiterate	80	73.4 %
Can read and write	19	17.43 %
Primary Education	10	9.17 %
Total	**109**	**100**

The majority of the respondents were married (73.4%), (18.3%) of them were single and the remaining (8.3%) were divorced. Similar findings were stated by [20], [21]. According to the farming experience of the respondents, most of the respondents (45.9 %) had 4-6 years of experience tracked by >6 years (38.5%) whereas (15.6%) of them had 1-3 years of farming experience in the Sorghum crop. It shows that most of the farmers under study have enough experience in farming. This result is in line with the results found by [20]. The educational background of the farmers is an important resource that makes a difference in the agriculture sector. Results in Table 2 show that the majority of the sorghum farmers 73.4 % were illiterate, while 17.43 % of farmers can read and write, and 9.17 % of the farmers had attained primary education. The finding supports the earlier works of [23] in Nepal that the level of education still remains very low in rural areas. The high number of respondents who have no formal education and are illiterate could have missed the opportunity to learn the importance of weather forecasting and seasonal climate forecast which is important to farmers in determining the time of planting and drought adaptation strategies. This result is in line with the results found by [21], [22].

3.2 Impact of the drought on the Sorghum production farmers

Impact of drought on the sorghum production farmers. The computed scores of impacts faced by the sorghum farmers ranged from 34-45 with a mean of 42.927 and a standard deviation of 2.348. based on the observed scores, the distribution of the respondents has been presented in Table 2. The results presented in Table 2 reveal that the highest proportion of the sorghum farmers (78 percent) faced high impacts on drought, while 18.3 percent and 3.7 percent of them faced medium and low impacts, respectively.

Table 2. Distribution of farmers according to the extent of impact (N=109)

Range		**Categories**	**Respondents**		**Mean**	**Standard deviation**
Possible	Observed		Frequency	Percent		
0 –45	34 – 45	Low (up to 37)	4	3.7	42.927	2.348
		Medium (38-41)	20	18.3		
		Hight (>42)	85	78.0		

The majority of the farmers in the selected area face a high impact of drought on their sorghum production activities, this reflects that there exist a good number of impacts that could results reduction of yield and in food insecurity the areas. A similar finding was found [21].

3.3 Rank order of impact of the drought on the Sorghum production

For getting a better understanding of the impact of the drought on the sorghum production farmers, it is necessary to conduct a comparative analysis of the impacts. For this purpose, the determination of the extent of impacts faced by sorghum farmers was identified as high, medium, low, and not at all, and based on their responses, the impacts-facing indices were calculated for 15 selected impacts. The extent of impact faced by the sorghum farmers in Somaliland considering the Drought Impact Index (DII) values along with their rank order has been presented in Table 3.

Table 3. Statement-wise score Impacts experienced by the Sorghum farmers

Impacts	Farmers (N=109)				Drought Impact Index (DII)	Rank order
	High	Medium	Low	Not at all		
Crop failure	109	0	0	0	327	1st
Reduce the income of the farmers	107	1	1	0	324	3rd
Decrease crop yield	107	2	0	0	325	2nd
Increase crop pests and diseases infestation	106	1	1	1	321	6th
Increased irrigation cost	94	8	5	2	303	12th
Increase unemployment	83	9	12	5	279	15th
Cause conflict on the water source	90	5	7	7	287	14th
Severe loss of livelihoods.	103	1	3	2	314	10th
Severe food insecurity	103	3	1	2	316	8th
Increase Food prices	106	1	2	0	322	5th
The decline in water availability	106	2	1	0	323	4th
Decrease soil fertility	104	3	2	0	320	7th
Reduce the area of cultivated land	102	4	1	2	315	9th
Reduction of fodder for the animals	95	6	3	5	300	13th
Rural-urban migration	98	6	4	1	310	11th

Results of Table 3 indicated that the **'Crop failure'** (DII 327) is found to be the major drought impact faced by the farmers in the production of sorghum. The most immediate effect of drought on the farming sector is a fall in crop production, due to inadequate and poorly distributed rainfall [24]. According to [25] the effects of drought are a result of crop failure. The findings support the earlier argument by [26] that revealed that in the United State of America, the poor temporal spread of rainfall is harmful to crop. The second top-ranked impact of drought faced by farmers is "Decrease crop yield" Water scarcity during drought decreases the chances of crop growth leading to decreased yield. An IPCC report opines that `grain crops such as maize, rice, wheat, cowpea, among others are set

to suffer up to 5% reduced yields as a consequence of reduced precipitation motivated by climate change [27]. The third-ranked impact of drought faced by the farmers is "Reducing the income of the farmers" (DII 324). The income generated from the sales of these food crops serves as the main source of livelihood for the peasant farmers from which the educational and health needs of their families are also met [28]. "Another indicator used in assessing the effects of drought is loss of income" [24], [27]. "This has a ripple effect as retailers and those who provide goods and services to farmers face reduced business. This leads to unemployment, increased credit risk for financial institutions, capital shortfalls, and probable loss of tax revenue for local and national governments" [29]. The fourth-ranked impact of drought faced "The decline in water availability" Recurring droughts have diminished water supply rendering many rivers seasonal and drying them completely. According to [30] drought affected east African countries including Somaliland by resulting in prolonged dry and hot periods when there is a scarcity of water for the normal needs of the community, agriculture, and the ecosystem. The fifth-ranked impact of drought faced by the farmers was an 'increase in food prices (DII322). Conspicuously, another effect of drought is on the prices of food and income loss as a consequence of reduced crop yields [31]. Food price hikes are increasingly becoming a threat to fighting poverty and hunger across the developing world including Somaliland [32], [33]. This is primarily due to reduced crop yields which create high demand for grains

3.4 Drought adaptation strategies suggestions

Results in Table 4 revealed 10 adaptation strategies commonly used by sorghum farmers to adapt to the effect of the drought on their farming activities. (Table 4). All the adaptation strategies reported focused on reducing the effect of drought which seems to be a more frequent problem for farmers in the study area.

Suggested solutions to adapt to the recurrent drought as offered by the farmers were identified and ranked which are given in Table 4.

Table 4: Rank order of the suggested drought adaptation strategies

No	Adaptation	Respondents		Rank
		Frequency	Percent	
1	Livelihood diversification	80	73%	5th
2	Weather forecasts and early warnings system	85	78%	4th
3	Land use planning	40	37%	10th
4	Drought-tolerant crop varieties	100	92%	1st
5	Use of short-duration crop varieties	95	87%	2nd
6	Integrated farming system	55	50%	8th
7	Soil and water conservation	60	55%	7th
8	Changing the time of sawing, planting, and harvesting	75	69%	6th

9	Water harvest for irrigation use	90	83%	3rd
10	Zero tillage to conserve soil	50	46%	9th

Results in table 4 reveal that farmers ranked the adaptation strategies in the 1st position (92%) for the Drought tolerant crop varieties that can tolerate the effect of drought and improve productivity. A similar suggestion was also found in the study of [34]. Moreover, farmers demanded the use of short-duration crop varieties ranked in the 2nd position (87%). In addition, water harvest for irrigation use ranked 3rd (83%); followed by weather forecasts and early warnings system 4th (78%); and livelihood diversification ranked 5th (73%), a similar study supporting this was also found by [35]. The last adaptation strategy mentioned by the farmers is proper land use planning ranked 10th (37%) to adopt the effects of the recurrent drought.

CONCLUSIONS AND RECOMMENDATION

The study concludes that the majority of the farmers had faced the high impact of drought on their sorghum production which is engraving the food insecurity condition. Moreover, "Crop failure", "reduce the income of the farmers", "decrease crop yield" and decline of water availability were top-ranked impacts of drought on the sorghum farmers. These impacts are needed to be solved to increase the production of the farmers and ensure the food security of these households. In addition, findings indicate that more than two-thirds of the respondents are illiterate and can't read and write. So, it could be concluded that more non-formal education like mass education is needed in the study area. There are various drought adaptation strategies suggested by these farmers to counter the effect of drought; engaging drought-tolerant crop varieties is the most preferred drought adaptation strategy among the Sorghum farmers while Land use planning is the least preferred. This is interesting because if access to weather information by farmers could be improved, a large number of smallholder farmers could be protected against the adverse effects of droughts. The Government of Somaliland, NGOs, INGO, and other stakeholders should aim at improving and implementing those coping strategies by supporting farmers in providing drought-resistant crop varieties, short-duration crops, the establishment of weather forecasts, early warning systems, and water harvesting for irrigation use for farmers to have more options for coping strategies in the future climatic shocks.

CONSENT

As per international standards, respondents' opinions have been collected and preserved by the author(s).

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