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Research article

IMPACT OF 2016-2017 DROUGHT ON HOUSEHOLD LIVESTOCK ASSETS AND FOOD SECURITY: THE CASE OF PASTORALISTS AND AGRO-PASTORALISTS IN BORANA ZONE, SOUTHERN ETHIOPIA

Mulugeta Shibru[1*], **Alfred Opere**[1], **Philip Omondi**[2] and **Maina Gichaba**[1]

[1] Department of Earth and Climate Sciences, Faculty of Science and Technology, University of Nairobi, mulugeta.shibru@gmail.com; aopere@uonbi.ac.ke; maina.gichaba@uonbi.ac.ke)

[2] IGAD Climate Prediction and Applications Centre (ICPAC), philip.omondi@gmail.com

* Correspondence: mulugeta.shibru@gmail.com; Tel.: +254708550282

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Abstract: Drought has been one of the climate-related disasters affected livestock production and livelihoods of the pastoralists and agro-pastoalists in Borana zone, Ethiopia resulting in heavy economic losses. The damage and losses incurred due to droughts in Borana have not been systematically collected. This research contributed in addressing the observed gap by systematically collecting and analyzing livestock asset losses due to the 2016-2017 major drought and its food security implications. Livestock holding statistics (before and after drought) and mortalities by species among others were collected from 529 sample households using mobile data collection methods. The sample households endured losses of half of its cattle (55%), a quarter of small ruminants (23%) and twenty percent of camels (19%) due to widespread drought induced mortalities in 2016-2017. In financial terms, sample households has sustained economic losses equivalent of 2,951USD on average. These losses translated to a total financial loss about 300 million USD for study area. The total cost of the drought would have been much higher had the cost of humanitarian aid be included in the financial analysis. The immediate and residual impacts of recurrent drought on livestock and other important livelihood assets contributed to the prevailing food security outcomes. The empirical evidence from this study clearly demonstrate the socio economic impact of drought. The anticipated increase of climate related disaster events will further exacerbate existing food insecurity, encour-

age maladaptation and deter from achieving Sustainable Development Goals (SDGs) 2 (end hunger), unless addressed in an integrated way locally. Further analysis of the efforts and challenges of **mainstreaming drought risk management** in pastoral area with in broader framework of the *disaster risk* management policy of Ethiopia is one of the recommendation to effectively implement the policy. This study has also uniquely estimated losses based on representative household sample survey and laid foundation for future losses and damage study in pastoral area. However, it is important to take into consideration the "indirect"' cost of the drought related humanitarian and livelihood assistance to "accurately" reflect monetary value and advocate policy action.

Key words: Drought, Impact, Livestock assets, Borana, Disaster Risk Management Policy, SDGs

Introduction

Ethiopia is among the eastern African countries that is grappling with global climate change challenges over time and its populations have suffered with climate related disasters of historical proportion. The major droughts of 1973, 1983-1985 were the two typical examples that have contributed to an estimated death of about 100,000 and 300,000 people respectively in addition to affecting significant percentage of the population of the country (CRED, 2020). EM-DAT-CRED has documented a significant number of people affected by various types of disasters including drought across the country since 1960's. The two recent droughts that hit the country in 2003 and 2015 for example, affected approximately 12.6 million and 10 million people in various regions of the country, respectively.

The Borana people in southern Ethiopia are among the population in the lowlands of Ethiopia that are negatively affected by climatic risks; and sustainability of their traditional livelihoods system appears to be very precarious. Climate variability is not entirely a new phenomenon to Borana pastoral system, a system that has traditional management strategy that are adaptive, and with embedded social structures and resources management system to respond to varied climate and associated distribution of resources (Riché B. et al, 2009). The Borana pastoral system is also the custodian of the most productive indigenous cattle breeds of East Africa recommended as suitable for Arid and Semi-Arid Lands (SA, 2010), where climate variability and harsh environmental conditions are the common features. However, indications are that the prevailing climate variability is becoming unpredictable, and the management strategies of the pastoralist are overstretching. Because of climate change, extreme weather and climate events, particularly drought have become very frequent, widespread and severe in their impacts. Ethiopia in its recently concluded National Adaptation Plan (NAP) suggested that the lowlands of Ethiopia are generally sensitive to increased temperatures and prolonged drought as compared to highlands agro-ecological zone (Ethiopia, 2019). As a result, livestock of pastoralists in the low land are exposed to an increased level of risk.

Drought has been one of the climate-related disasters that have affected livestock production and livelihoods of the Borana pastoralists resulting in heavy economic loss. The damage and losses incurred due to droughts in Borana were not systematically recorded over time as globally acknowledged data on disaster damage and

losses in the agriculture sector in general are not often systematically collected or reported (FAO, 2015). However, various researchers documented the livestock asset losses related to drought that can provide a snapshot of impact of drought-induced mortalities (Desta and Coppock, 2002; Shibru, 2001, Morton, 2006; Angasse and Oba, 2007; Desta et al 2008; USAID, 2011; Birhanu et al, 2015. Oxam, 2011).

This research contributed in addressing the observed gap in collecting and analyzing livestock asset losses systematically due to drought. It has methodically collected and analyzed livestock assets losses for 2016-2017 major droughts among pastoral and agro-pastoral households in southern Ethiopia and its food security implications to fill the gap. The evidence generated from this case study helps in informing / advocating policy reforms in drought risk management in pastoral areas.

Methods

In this section, the study area is described first, followed by data collection methods and analysis used to achieve the objective of the research.

2.1. Study area

This study was conducted in Borana zone, one of the twenty administrative zones of Oromia Regional State of Ethiopia. It occupies an area of approximately 55,711 km^2 (20% of the regional surface area), located between 3°36 – 6° 38′ North latitude and 3°43′- 39° 30′ East longitude and bordering Northern Kenya. The Southern Nations, Nationalities, and Peoples Regional State (SNNPRS) further border the zone to the west, to the north by the two Guji's Zones and to the east by Somali Regional State. The Zone is subdivided into thirteen woredas (districts) as shown in Figure 1. Pastoral production remains the dominant land use in Borana Zone in southern Ethiopia like other parts of lowlands of Ethiopia (Coppock, 1994). These groups generally raise a mix of livestock species (cattle, sheep/goat and camels) in different proportions depending on the climatic and rangeland conditions. There are also pockets of agro-pastoralists in the study area that depend on mix of crop and livestock production for their livelihood

2.2. Data collection methods

Household data collection: Household survey was the main source of data for this study. Household demography, characteristic, livelihoods assets, level of food security, droughts impacts, etc., are some of the key socio-economic characteristic included in the survey instrument. Perception questions with Likert scale is integrated into the instrument to assess sample households perceiion of recent drought impacts on various dimension of their livelihoods. Livestock holding statistics (before and after drought) and mortalities by species sustained by household because of 2016/2017 drought collected to determine the impact of drought. The instrument digitized into Open Data Kit (ODK) tools and facilitated mobile data collection using a smartphone.

Sampling procedures and Sample Size: Rural households that practice pastoral and agro-pastoral production as a means of livelihoods in Borana zone are considered as the population group of the research. This group were dispersed over an expansive area in the zone, thus further subdivided into woreda (districts), pastoral associations (PAs) and villages (ollas) administratively. Considering the variability and size of the zone, the research employed two-stage cluster sampling method. The primary sampling unity (PSU)-the clusters were selected at first stage and followed by selection of households, which considered as secondary sampling unity (SSU).

The sample size is very critical in sampling process. Hence this research determined its sample size based on a two-stage cluster sampling approach, levels of acceptable error, level of confidence, design effect and non-response rate. The sample size (n) of the study initially determined to be 845 households based on the equation presented below.

$$n = \frac{d * z^2 * p * q}{a^2} + nr * \frac{d * z^2 * p * q}{a^2}$$

Equation 1: Sample size determination formula

n Sample size
z alpha risk expressed in Z-score (this is 1.96 for 95% confidence level)
p Expected prevalence (unknown assumed to be 50%)
q 1-p (50%)
d design effect (assumed to be 2 although this is on the high side and it can be reduced to 1.5
a Absolute precision (margin of error ±5%)
nr Non-response rate (assumed to be 10%)

$$n = \frac{2 * 1.96^2 * 0.5 * 0.5}{0.05^2} + (10\% * 768) = 845\ HHs$$

The List of 162 rural PA collated from thirteen districts of Borana zone planning office used as PSU. Forty-five sample clusters were selected based on 845 households sample size determined using the above equation and Proportional Probability Sampling (PPS). However, Moyale and Guchi woreda (adjacent to each other) which constituted 13 of the 45 sample clusters (29%) were excluded from the final sample clusters due to conflict, displacement of population and overall instability in the area. The researcher reduced its sample plan to 627 households and 32 clusters. The research team has finally interviewed 529 households in total out of 627 planned. Three of the clusters were not covered due to security or not being pre-coded in the ODK form contributed for reduced number of households interviewed ultimately. The households distributed across 11 of 13 districts (85%) of the Zone. Figure 1 graphically presents the spatial distribution of interviewed households across the Zone.

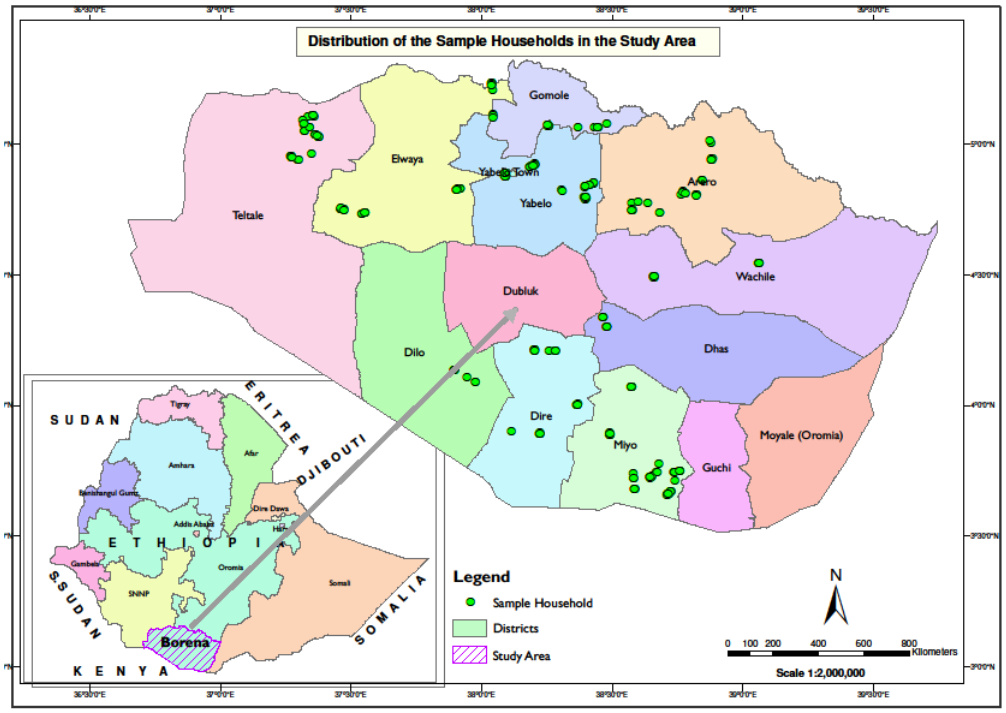

Figure 1: Distribution of the sample households in the study area
Source: HDX-Ethiopia Shape file and GPS points of Household survey

Secondary data sources: Food security indicators, Integrated Food Security Phase Classification (IPC) phases, estimate of acute food insecure population, humanitarian assistance in the area collated from published and unpublished sources to determine the trends of food insecurity as complementary information. Human and livestock population also collected from Borana zone departments used as secondary sources (Office, 2018)

2.3. Data analysis methods

Frequency distribution used to visualize the distribution of the variable. The graphical tool of SPSS/ MS excel facilitated the creation of different formats of graphs to present results in an easily understandable way. In addition, univariate analysis and appropriate descriptive statistics widely used in describing the main features of the household data. Cross tabulation and correlation also applied as deemed necessary, to explore relationship between variables and appropriate statistical significance calculated. The household level average statistics (e.g. livestock holding, mortalities rate etc.) further aggregated to study area level to ascertain overall statistics and used in determining the impact of 2016/2017 drought in terms of livestock asset losses. This research has employed similar approaches used by (Shitarek, 2012) in estimating economic losses in terms of monetary values due to drought of 2011 in Borana.

Sample household's food security situation were further analyzed using standard food security indicators to provide empirical evidence and substantiate the households' perception as to the impact of drought. The common frequency based and experiential indicators were calculated from the household data to measure

food security outcomes. These were compared with international accepted thresholds of IPC reference table. The Integrated Food Security Phase Classification (IPC) is a common global scale for classifying the severity and magnitude of food insecurity and malnutrition (IPC, 2019.). It has household reference table, which provides qualitative, graduated descriptions of five acute food insecurity phases, along with thresholds for key household-level outcome indicators used to classify the severity of acute food insecurity.

The outcome indicators as well as the phase classification generated from the household survey provided at snapshot analysis (at the time of the survey) of acute food insecurity. The available acute food insecure population estimate and level of humanitarian assistance in the area was further analyzed to determine the situation of 2016/ 2017 drought and trends of food insecurity.

Results

3.1. Demographic characteristics of sample households

Borana ethnic group accounts for the majority (82%) of the respondents, while the five ethnic groups (Guji, Konso, Gabara, Shewa and Burji) account 18% of the households. The proportion of the dependent age group (zero to 14 and over the age of 65) was 55% of the total family member. Female-headed households comprised 16% of the total, and the average family size was five. Most of the interviewed households do not read and write or are illiterate (85%), only 15% have some level of education (majority at primary level), and these are all male while female are illiterate. Those that have achieved secondary or post-secondary school (college and university) do not exceed 4%. Almost all the respondents that attended some level of education were male respondents.

3.2. Livelihoods of the sample households

The majority (90%) of the households mainly depend on livestock keeping or/ and crop farming activities for their livelihoods (Figure 2). The rest are engaged in non-traditional activities, such as trading (agricultural and non-agricultural goods), formal employment and others (casual labor, petty trading, charcoal and firewood sales).

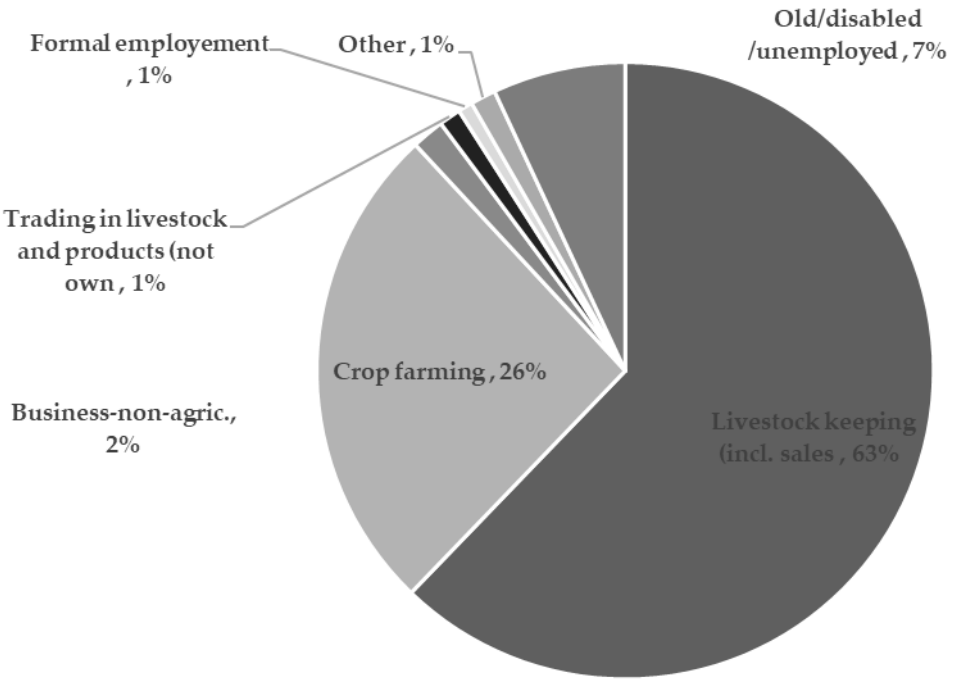

Figure 2: Relative importance of primary activities

The percent contribution of cash income from sale of livestock and products to annual cash income of the households further confirms that livestock keeping is the primary form of livelihood of sample household as illustrated in Figure 3. Remittance /cash gift determined as second major cash income contributor to households over the 12 months preceding the study considered as recent phenomena. Despite the fact that over a quarter of households primarily engaged in cropping, as a means of livelihoods, its contribution to annual cash income was very minimal (about one percent).

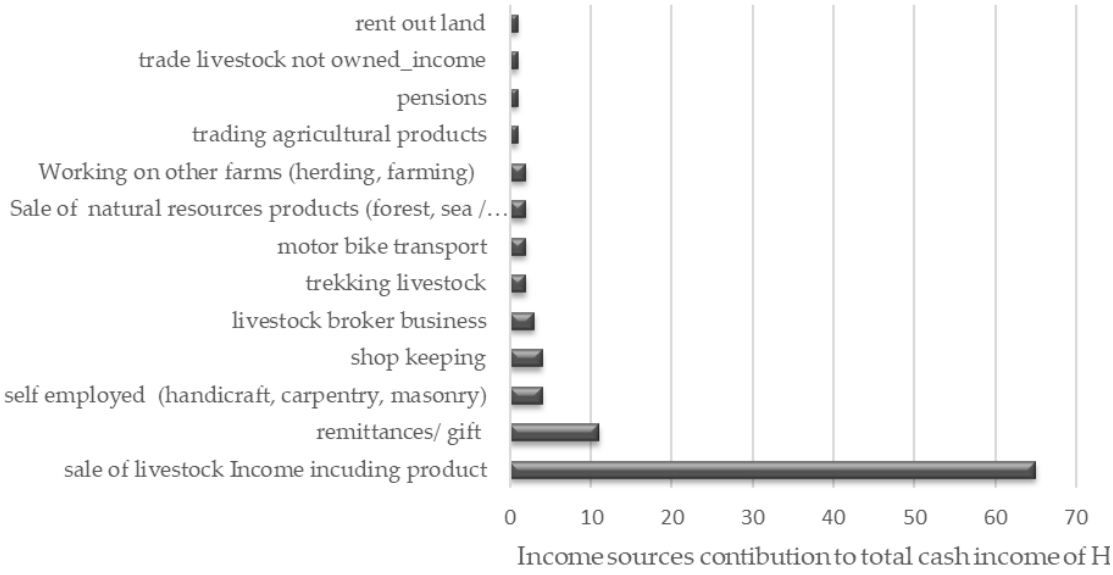

Figure 3: Household main sources of income and relative contribution of each (%)

Most of the sample households (about three-quarter) generated their cash income from two or less income sources over the last one year while about a quarter of the sample households generated from three sources. It was only about 3 % of sample households generated their annual cash income from four to five sources.

Cattle is still the dominant livestock species composition of a typical household in the area given its socio-economic and cultural values. About 87% of the sample households raise cattle exclusively or in combination with other species depending on agro-climatic and socio-economics it is only about 12 percent of the sample households who own the three main species of livestock locally called "triple sweet milk animals". In addition, it is only about 17% of the respondents reported to own camel (few heads) despite growing awareness of its adaptability to drought. Slightly over half of the 490 sample households (56%) excluding missing values declared their involvement in dry land farming practice. Women account about a quarter of the respondents (23%) involved in this practice. The majority of households (72%) involved in crop production over the last 10 years and longer while the remaining 28 % of involved in recent time particularly over the last five years.

3.3. Households' perception of impacts of drought

Figure 4 summarizes the important outcome of the household perception as to the impact of 2016/17 drought and its significance on various dimension of their livelihood in Likert scale transformed using median value. The consecutive analysis also provided further evidences to two of the significant perceived impacts of the prevailed drought, livestock mortalities and acute food insecurity.

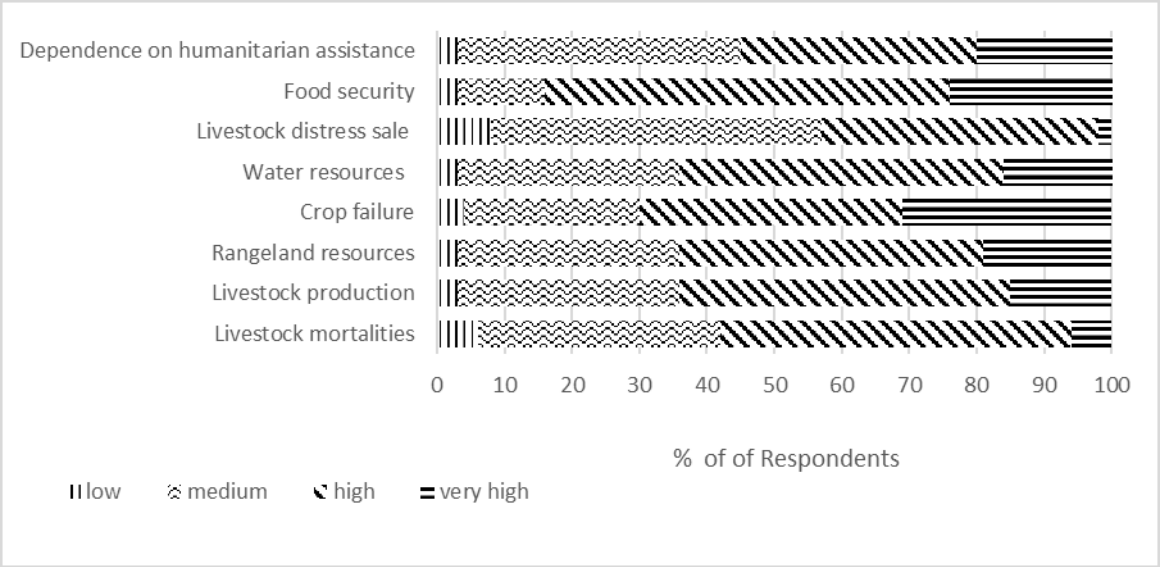

Figure 4: Respondent perception impacts of drought on Likert scale

3.4. Livestock mortalities estimate by species

Drought induced livestock mortalities was one of the perceived impacts of 2016/2017 drought. Mortality rates (in percentage) are estimated based on reported number of livestock death (by species) per households in comparisons with live-

stock holding before the drought. The household level data (average statistics) further aggregated to overall area level to ascertain overall mortalities rate presented in Table 1.

Table 1: Descriptive statistics of livestock mortalities 2016/ 2017 drought by species

	N*	Mean	Median	SE**	Range***
cattle	491	0.55	0.56	0.01	0-1
sheep /goats	420	0.23	0.18	0.01	0-1
camels	90	0.19	0	0.03	0-1

*'N' represents the total number of individuals in the sample.
** Standard Error ("SE") is sample mean deviation from the actual mean of a population
*** Range: is the difference between the highest and lowest values.

Mortalities rate, which was significant for cattle species (55%) further analyzed for various herd group to ascertain degree of susceptibility and presented in Table 2.

Table 2: descriptive statistics of cattle herd mortalities 2016/ 2017 drought

	N	Mean	Median	SE	Range
bull / oxen	491	0.19	0.17	0.01	0-1.0
cows	491	0.21	0.19	0.01	0-1.0
heifers	491	0.06	0.00	0.00	0-0.6
immature male	491	0.04	0.00	0.00	0-0.36
Calves	491	0.15	0.13	0.01	0-0.6

3.5. Household's livestock inventory

Pastoralists and Agro-pastoralists in the study area own on average about 20, 15, and 1 cattle, goat/sheep, and camel respectively before 2016/ 2017 drought (refer Table 3). This ownership is equivalent to about 17 Tropical Livestock Units (TLUs) in total. TLUs is a reference unit which facilitates the aggregation of livestock from various species and age to a common unit. In this study conversion factors of 1, 0.7 and 0.1 were used for camel, cattle and small ruminates based on established coefficients on the basis of the nutritional or feed requirement of each animal. Cattle account for about 84% of the species composition of the typical households before the drought while sheep/Goat and camels account for 12% and 4% respectively. The species and herd composition (ratio) calculated by converting heads of livestock to TLUs.

Cattle, sheep/goats, camels and TLUs mean holding of sample households have declined by 64, 49, 33% and 61% percent respectively after drought. Cattle still account for about 77% of the species composition of households after the drought while sheep/Goat and camels account for 17% and 6% respectively. The mean holding have shown improvement currently as presented in Table 3 but far from reaching its pre-drought (before drought) level.

Table 3: Households mean livestock holding for three reference period and test of significance

	N	before drought	after drought	Current	change after Vs before	change after Vs current	t (df)	P-value
Mean # of cattle	529	20.3±0.9	7.3±0.5	8.5±0.5	-64%	16%	22.31 (528)	<0.01
Mean # sheep and goats	529	14.6±0.7	7.4±0.5	8.1±0.5	-49%	9%	21.08 (528)	<0.01
Mean # camels	529	0.9±0.1	0.6±0.1	0.6±0.1	-33%	0%	5.27 (528)	<0.01
Mean TLU	529	16.6±0.7	6.4±0.4	7.4±0.4	-61%	16%	22.9 (528)	<0.01
Total TLUs	529	8781	3411					

A paired-samples t-test result presented in Table 3 that compare the mean statistics before and after drought including TLUs suggest that there was a significant difference in the livestock statistics for the two-reference period (before and after drought).

Comparison of livestock ownership of different species and households reported (frequency) for livestock species ownership before, and after drought clearly demonstrate the impact of drought on livestock inventory at household level. For example, household without any head of cattle, stockless locally called *Qolle* has doubled after drought mainly due to the drought induced mortalities as depicted in Figure 5

Livestock holding in lower holding category (less that five heads of cattle) often considered as poor (*Iyyessa*) wealth category in Borana have also increased 3.5 folds when the pre drought number compared with after drought. The second level of lower wealth band also increased to lesser extent after drought. The relative higher wealth band (greater that 11 heads of cattle) declined 25-100% as illustrated in Figure 5. Similar pattern was observed for total TLUs holding as presented in Figure 6

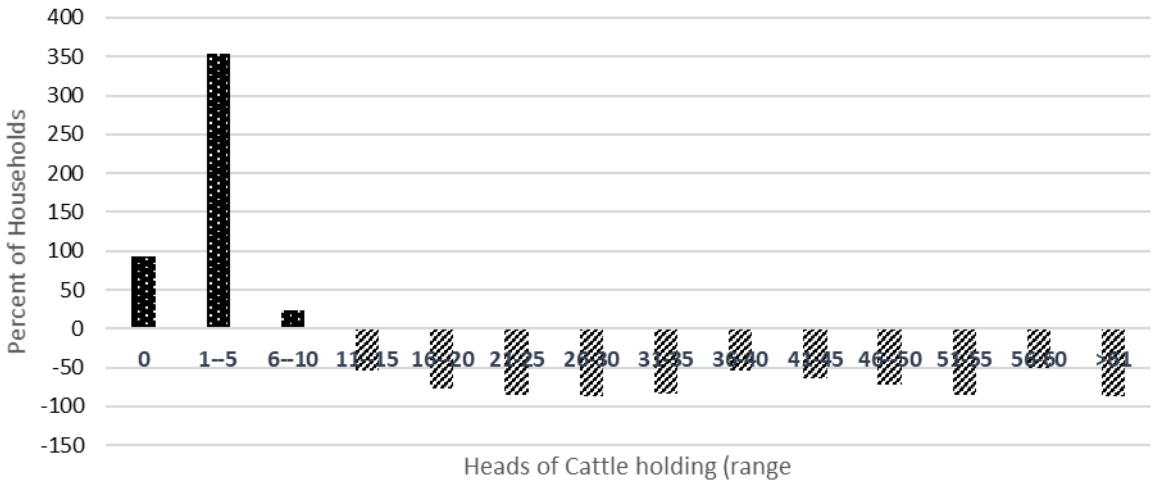

Figure 5: Comparisons of percent of household's cattle holding before and after drought period

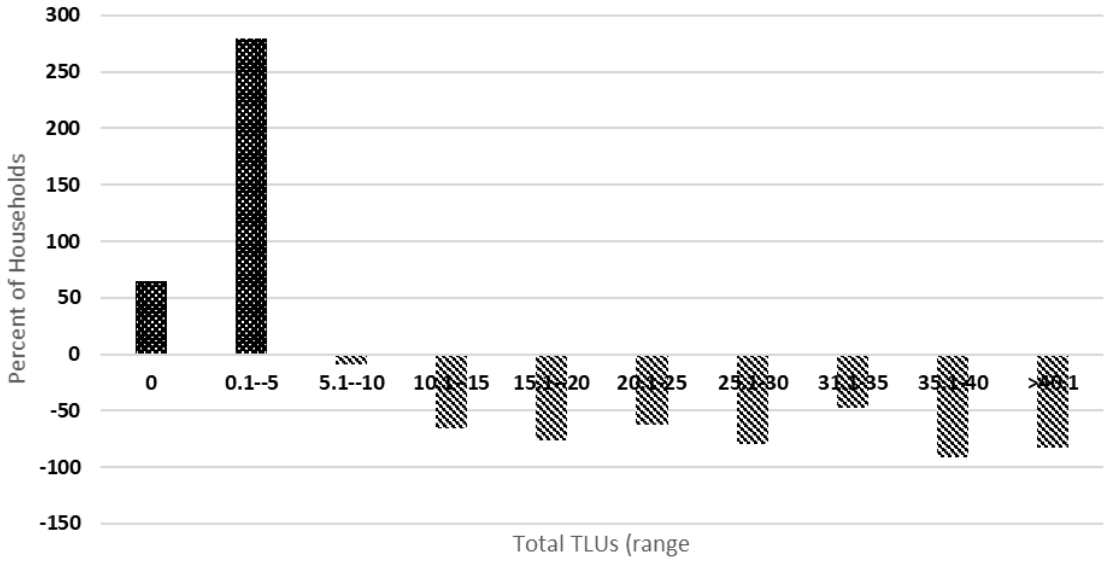

Figure 6: Comparisons of percent of households Total TLUs holding before and after drought

3.6. Economic losses estimation in monetary values

The estimated number of livestock by species owned by sample households before drought multiplied by mean livestock mortalities rate in estimating total livestock death by species for sample households. The economic loss in monetary value for sample households estimated by multiplying estimated dead livestock with prevailing average unit price of cattle and long-term price of goat presented in Inter-agency drought impact assessment report (Desk, 2017).

The percentage of cow from the total cattle population of the sample household used in determining the total number of cows dead during drought and estimating losses of (milk/ butter) because of mortalities of cows. About 60% of the total cows in the herd assumed to be milk-producing animals annually (CSA, 2000/2001 and J. PAGOT 1993). In addition, production parameters data from milk values chain analysis conducted in Borana also used to estimate milk production (CARE-Ethiopia, 2009). The estimated milk in liter lost multiplied by prevailing market price ascertained from the assessment report (IGAD, 2017) and personal communication

A shared insurance contribution of 10.5% (of total livestock value lost from the area) is assumed (IGAD, 2010)

The total population of the Borana zone is estimated to be 718,000 people (or 120,000 households) in 2015, and the average family size is six persons (Office, 2018). The household reduce to 101,600 by removing urban population. The average loss per household multiplied by estimated pastoral and agro-pastoral HHs in Borana to extrapolate the total drought related financial losses. Table 4 presents the summary of economic losses per household, capita and stud area level in local currency EB or equivalent in USD converted using the then prevailing exchange rate (1 USD equivalent to 22.6 Ethiopian Birr).

Table 4: Drought induced livestock asset losses and monetary value estimation

	Cattle	Goats / sheep	Camels	Total in EB	Total in USD
Total value of lost livestock in EB	23,159,520	1,157,429	951,900	25,268,849	
Value of lost from milk / butter (EB)	6,114,016	32,048	1,216,060	7,362,124	
Shared Insurance Values lost (EB)	2,431,750	121,530	99,950	2,653,229	
Total loss	31,705,286	1,311,007	2,267,910	35,284,202	
Loss per HH	59,934	2,478	4,287	**66,700**	**2,951**
Loss per person	9,989	413	715	**11,117**	**492**
Total loss for entire Borana	6,087,414,835	251,713,353	435,438,624	**6,774,566,812**	**299,759,593**

3.7. Food security analysis

The immediate impacts of recent droughts (2016/2017) and residual impacts of recurrent drought on livestock and other important livelihood assets contributed to the current food security outcomes. The outcome indicators as well as the phase classification generated from the household survey.

Food Consumption Score (FSC): is a composite score based on dietary diversity, food frequency, and the relative nutritional importance of different food groups. FCS was calculated using the frequency of consumption of different food groups (eight) consumed by a household during the 7 days before the survey. Scores were clustered into three groups; the results of the analysis categorize each household as having poor (28 or less), borderline (between 28 and 42) or acceptable food consumption (greater than 42) as presented in Figure 7.

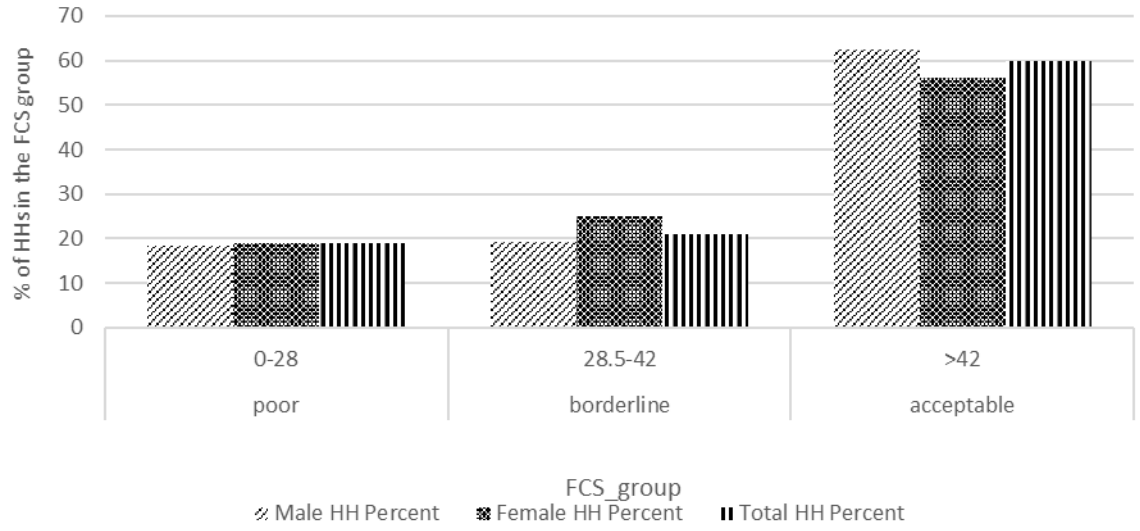

Figure 7: Food Consumption Scores of sample household August 2019

The femal households tend have slightly lower FCS as compared to male houeholds as presneted in Figure 7 that indicates challenges of access to food during the

survey. However cross tabulation and Chi-square statistics indicate the difference in FCS between the two groups was not statistical significant (Pearson Chi-square test P-value 0.321). The two group of households have no difference in terms of their caloric intake and diet quality.

Households Dietary Diversity Scores (HDDS): dietary diversity is observed on the number of different food groups (out of 12) consumed over a 24-hour period. Most of the sample households (92%) determined to have low HDDS while only about 8% having medium HDDS (5-6 food groups) as presented in Figure 8. The male and female households have no difference in their HDDS as Chi-square statistics was not significant (Pearson Chi-square test P-value 0.548).

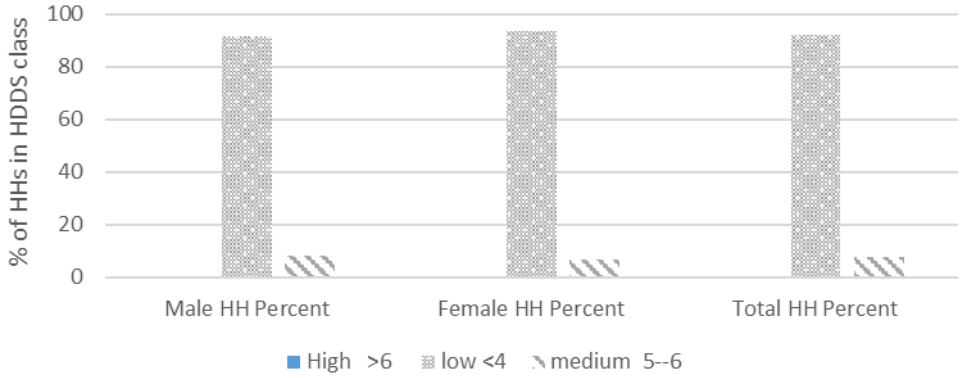

Figure 8: Household Dietary Diversity Score (HDDS) of sample household August 2019

Household Hunger Scale (HHS): is a behavioral (severe one) measure to assess severe household hunger. The HHS consists of three questions and three frequencies that, when administered in a population-based household survey, allows for estimating the percent of households affected by three different severities of household hunger over the past month. Two out of ten household have experienced moderate to severe hunger over the past month before the survey as presented in Figure 9. The male and female households have no difference in their HHS as Chi-square statistics was not significant (Pearson Chi-square test P-value 0.444)

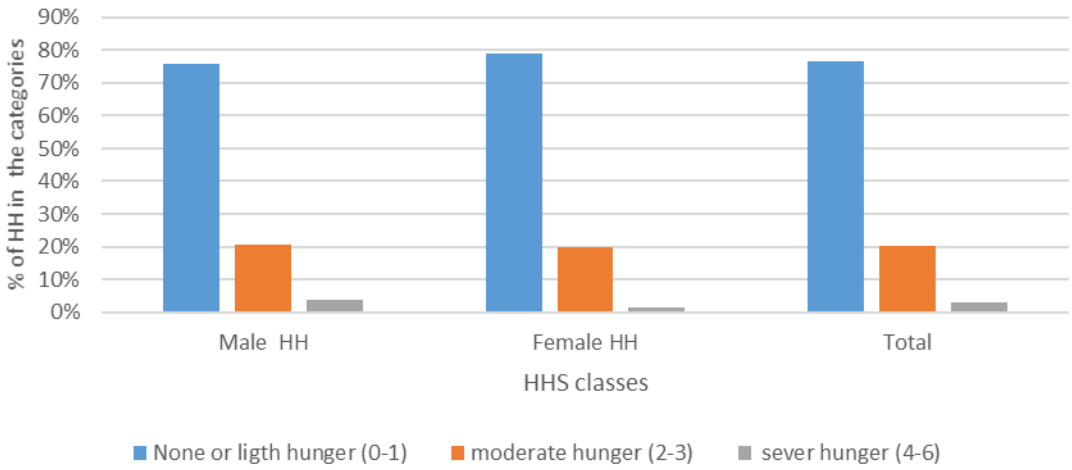

Figure 9: Household Hunger Scale (HHS) of sample household August 2019

The Coping Strategies Index (CSI) is behavioral measure of household food security that is based on the many possible answers to one single question: "What do you do when you do not have adequate food, and do not have the money to buy food?"

CSI is the strategies household adopt when they cannot access enough such as food consumption changes; expenditure reduction; income expansion. The Reduced CSI is based on a common set of five strategies and weights. The below presented data related Food based coping strategies. About seven out of ten household adopted severe forms strategies more frequently in last one week before the survey when households did not have enough food or money to buy food as presented in Figure 10.

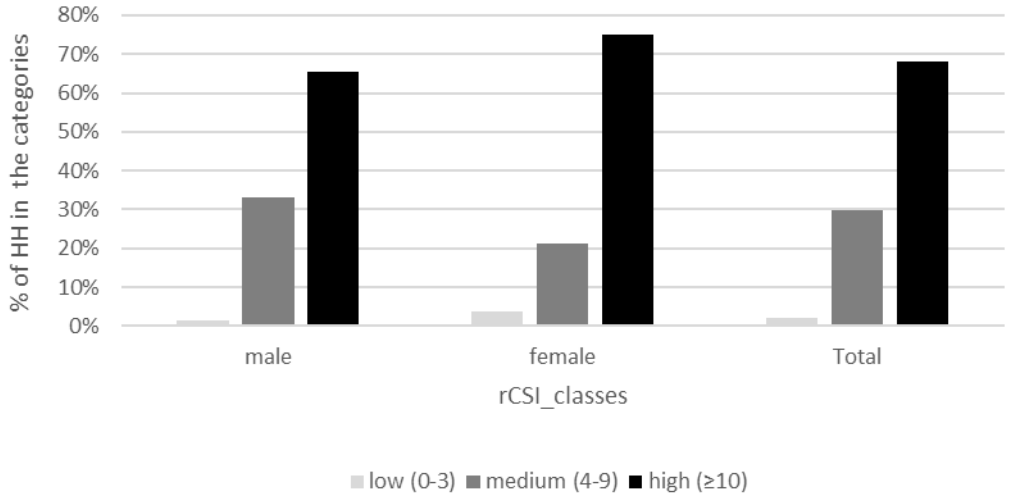

Figure 10: Reduced Strategies Index (rCSI) of sample household August 2019

The female has relatively experienced higher rCSI as compared to male as Chi square test significant (Pearson Chi-square test P-value 0.035).

Food security indicators and associated IPC phases: each of the four-outcome indicators i.e. FCS, HDDS, HHS and rCSI and their categories presented above are used to identify the indicative IPC phase. The indicative Phases for the area classification based on the worst-off ≥20 percentage of the population. The study adopted non-stratified approach in collecting the evidence. This consists in getting evidence for the whole study area – Borana zone and for each direct evidence assessed for worst off phase that affects at least 20% of the population. It concluded that the area overall classified as IPC phase 3 (crisis) at the time of the assessment based on the convergence of the outcome indicators as presented in Table 5.

Table 5: Converagence of the food security indciators and indicative area IPC phase

Borana	Minimal	Stressed	Crisis	Emergency	Famine	Indicative phase
FCS	61%		21%	19%		3
HDDS	8%		56%	34%		4
HHS	69%	7%	20%	2%	1%	3
rCSI	2%	75%	12%	11%		3
Ranges						
LC						
Ranges						

Source: Household survey result, July-August 2019

The IPC seasonal analysis conducted after survey (July-Sep 2019) based on consensus building process and stratified sampling of the Livelihoods Zones (LZs). The

analysis results relevant for the study area revealed that 30-50% of assessed LZ projected to experience severe acute food insecurity (IPC 3 and 4) and require urgent humanitarian assistance and livelihoods protection (Figure 11).

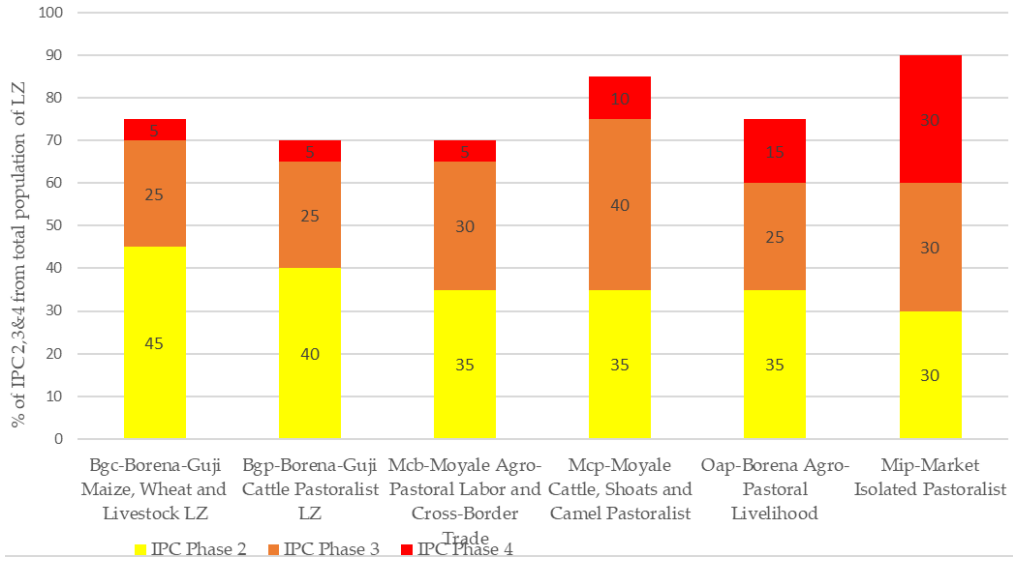

Figure 11: percentage of IPC 2, 3 and 4 from total population of LZ (July-Sep 2019)

Source: FAO-Ethiopia

The analysis also provided the population estimate in various acute food insecure per LZ. The aggregation of the LZ data to overall area level indicate that about 34% total population of the zone (434,819 people) estimated in severe acute food insecurity (IPC 3 and 4) as ascertained from the IPC population projection at the time of the assessment

The two subsequent seasonal IPC analysis projection (Oct-Jan 2020 and Feb-June 2020) also reveal that severe acute food insecurity increased or persisted depending on the LZ. IPC adopted in Ethiopia very recently could not able to provide adequate trend data (comparable) to ascertain the trends of acute food insecurity.

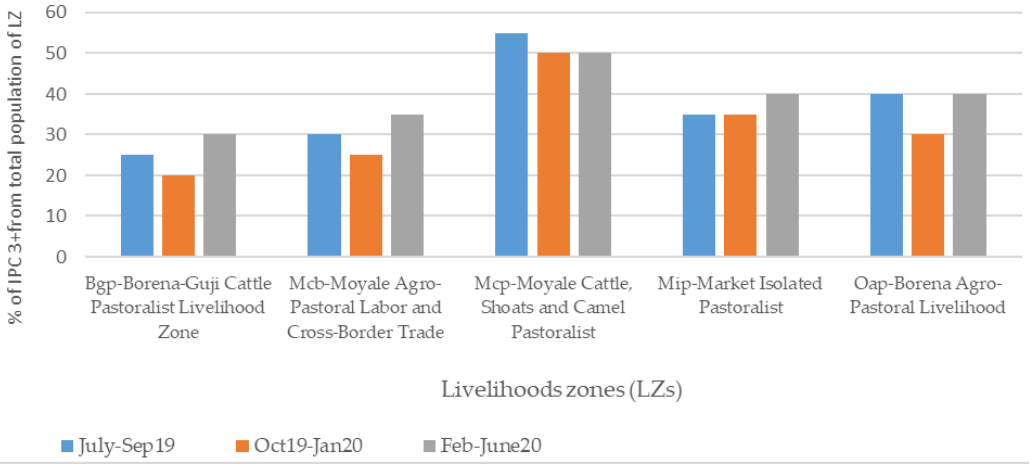

Figure 12: Percentage of IPC 3+ from total population of LZ for the last three seasons

Source: FA0_Ethiopia

Discussion

Key informants considered 2016-2017 drought as one of the worst droughts in Borana since 1960's. It has contributed to estimated losses of half of cattle (55%), a quarter of small ruminants (23%) and twenty percent of camels (19%) for the sample households. The excess mortalities of livestock were associated mainly with starvation and dehydration due to severe pasture and water scarcity during drought. Catley et al (2014) in their study of livestock mortalities in Ethiopia concluded starvation/dehydration as main contributors for excess mortality for livestock during drought in Borana. Livestock mortality due to poor animal nutrition is on the rise in recent time even during normal years. The excess mortalities of livestock contributed for significant decline of mean holding livestock per households and impoverishment. Households' who have lost their cattle completely (*Qolle*) have doubled after drought. Livestock holding in lower holding category (less than five heads of cattle) have increased 3.5 folds after drought. The relative higher wealth band (≥ 11 heads of cattle) exhibit decline of 25-100%.

Pastoral and agro-pastoral HH in Borana has sustained financial losses equivalent 66,700 EB (2,951 USD) on average because of drought induced mortalities as inferred from the analysis. The economic losses sustained per household in this drought was higher by 55% comparted to losses in 2011 drought (1784 USD) estimated by (Shitarek, 2012). These losses translated to a total financial loss estimates about 6.8 billion EB or 300 million USD for the entire study area using then exchange rate. The situational assessment report (Desk, 2017) further confirm significant losses of livestock. The consolidated report indicates that about 400,000 livestock reported to have died in 2016/2017 in Borana zone predominantly due to drought. The expert also converted the lost livestock into monetary values using the prevailed average price of per head of livestock i.e. 3000-4000 EB. It was estimated financial loss of 1.2-1.6 billion EB equivalent to 53-70 million USD in Borana using then exchange rate. However, mortalities statistics collated per district used for estimation was not comprehensive and disaggregated various species of livestock as acknowledged by assessment team members.

Livestock losses presented have affected the majority of the households who directly and indirectly depend on livestock for their livelihoods and cash income. Cows and calves that sustained higher rate of mortalities during the drought for example have affected the milk production of the families and future herd growth of the households. The surviving lactating animals were also emaciated and milk yield per cow dropped dramatically due to severe shortage of feed and water during drought. Hence, *availability and consumption of milk* and animal *source foods per households* reduced significantly during the drought period and subsequently due to losses of the livestock assets particularly female reproductive animals.

The livestock losses have also limited the income generation capacity of the households who primarily depended on sale of livestock and its products for cash income of the households to purchase food and non-food items from the market. Market prices of the surviving animals decreased rapidly due to poor quality and high supply of emaciated livestock to the market. The price of a quintal of maize for example increased by about 25% (800 EB from 650 EB) while the goat price decreased by 70% (400 EB from 670 EB). The Government and humanitarian actors established destocking centers to salvage cattle and declining term-of-trade that affect their food security and livelihoods

The impacts of losses on milk production and income reflected on individual food security indicator as well as the outcome indicator. About 40% of the sample households have fallen into borderline to poor FCS groups during the survey that entails consumption gaps to meet caloric intake and diet quality with normal production system. Most of the sample households (92%) determined to have low HDDS because less consumptionof diversified food. The limited availability and consumption of protein based nutritious food (milk and animal source of diet) affected children, women and elderly food security and nutrition status. Increased levels of malnutrition (severe and moderate) reported during the drought due to reduced consumption of animal-source foods (drought assessment report) linked with losses of livestock particularl female reproductive animals. Two out of ten household have experienced moderate to severe hunger over the past month before the survey. In addition, about seven out of ten household adopted severe forms strategies more frequently in the week before the survey when households did not have enough food or money to buy food. The women has relatively experienced higher rCSI as compared to male. The limited access of food for women compared to male and associated undesirable coping strategies further aggravated by intensified labor demand and workload related to search of water, hay and firewood during drought. It concluded that the area overall classified as IPC phase 3 (crisis) at the time of the assessment and require humanitarian and livelihoods protection support.

The wide-range of humanitarian assistance and livelihood protection support provided by Government and humanitarian actors mitigated the severity of the impacts. Seven out of ten sample households (68%) in study area are still dependent on productive Safety Net Programme in its fourth phase (FDRE, 2015) after the severe drought subsided an indication of the persistent food insecurity. The severe acute food insecurity increased or persisted depending on the LZ as the two subsequent seasonal IPC analysis projection (Oct-Jan 2020 and Feb-June 2020) shown. Households (poor household) were eking their living by crop farming, firewood selling, and some opportunistic income activities complemented with ongoing safety-net program.

Conclusion and recommendation

The evidence of livestock asset losses and associated monetary value from this study clearly demonstrate the socio economic impact of drought. IPCC in its fifth assessment report (IPCC, 2014), indicated that the frequency, intensity and cost of natural hazards further increases in the coming decades. The anticipated increase of climate related disaster events will further exacerbate existing food insecurity, encourage maladaptation and deter from achieving one of the SDGs i.e end hunger, achieve food security and improved nutrition, and promote sustainable agriculture unless addressed in an integrated way at local or global level.

The Government of Ethiopia National Policy and Strategy on Disaster Risk Management ((FDRE), 2013) emphasizes the importance of mainstreaming climate change impact including disaster risks into relevant sectors to mitigate or/and reduce its impacts However, the recurrent losses of livestock assets with collossal economic and social values despite "predictable" nature of drought (Desta and Coppock, 2002) and early warning indicators is clear indication of either failure of

existing policy or implementation gaps at different level. Actors in the study area have continued focusing more in responding the emergency needs, rather than understanding reoccurrence nature of drought and developing plan to mitigate / reduce its impact. Hence, it is important to analyze the efforts and challenges of **mainstreaming drought risk management** in pastoral area with in broader framework of the *disaster prevention and preparedness* management policy to ensure its effective implementation to achieve its goal**.** The effective implementation of the policy in the area will reduce impact of recurring droughts and associated livestock assets losses that have significant socio-economic benefits for pastoralist, regional and national economy.

This study has uniquely estimated livestock asset losses based on systematic and representative household sample survey that will lay foundation for future losses and damage estimation in pastoral area. However, economic losses estimation has not taken into consideration "indirect"' cost of the drought related humanitarian assistance and livelihood protection support to mitigate the impacts due to challenges of getting such information. It is important future damage and losses estimation take into consideration such cost to appropriately reflect "accurate"" monetary value of the drought impact to advocate policy action.

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Author contributions

Mulugeta Shibru is doctoral candidate at department of Earth and Climate Sciences, Faculty of Science and Technology, University of Nairobi. The entire doctoral studies including this research paper supervised by the three Co-Authors. Alfred Opere (Associate Professor) and Maina Gichaba are (Senior Lecturer) at the same department. Philip Omondi is Project Manager at IGAD Climate Prediction and Applications Centre (ICPAC). Mulugeta was responsible for the design, conduct, and reporting of the Doctoral research project including drafting of this manuscript based on the research project. The Co-Authors have provided direction and motivation in entire process as mentors. They have guided the candidate in overall design and execution of the research project and reviewing the draft manuscript.

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Conflicts of interest

The authors have not declared any conflict of interests.