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IMPACT OF THE 2016/17 DROUGHT ON SOMALI LIVESTOCK KEEPERS

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Abstract

Nomadic pastoralism and agropastoralism are the prevailing livestock production systems in Somalia, with a minimal proportion of livestock raised in (peri-)urban stall-feeding operations, amplifying the vulnerability of these traditional livelihoods to the recurring challenges posed by drought. The primary objective of this paper is to present a quantitative assessment of the impact of the 2016/17 drought on the livestock sector and the livelihoods of livestock-keeping households in Somalia. This analysis draws upon the findings of the drought impact and needs assessment (DINA I, II & III) conducted by the World Bank, the United Nations (UN), the European Union and the Global Facility for Disaster Reduction and Recovery (GDFRR) in late 2017.

The approach employed involves conducting an ex-post impact assessment using a modelling framework that compares the outcomes of a drought scenario with those of a no-drought scenario, based on pre-drought livestock population and production parameters. This analysis utilizes the Dynmod bio-economic herd model, which is a simple herd growth model that simulates the population dynamics of ruminant livestock herds over up to 20 years. In contrast to the DINA, which exclusively considered the drought year, this assessment extends its focus to encompass five post-drought years. This extended timeframe enables an evaluation of longer-term losses resulting from both immediate damage and subsequent repercussions. Furthermore, an effort has been made to illustrate the specific impact of drought on pastoral households and unmask the variability by location season, and household characteristics through a livelihood assessment conducted by the Food Security and Nutrition Analysis Unit (FSNAU) in 2014.

At the sectoral level, the drought resulted in approximately 4 million excess animal deaths, mainly affecting small ruminants, leading to estimated damages of about USD 290 million. In the drought year alone, total losses amounted to nearly USD 1 300 million, primarily attributed to a significant reduction in milk production and the decreased value of animal offtake. Over the subsequent five years, additional losses of USD 640 million occurred due to a decline in the livestock population. At the household level, the drought forced 2.2 million people into internal displacement, with 1 million individuals transitioning away from their traditional pastoral lifestyle by selling their breeding stock for food. This transition intensified food insecurity as these households became destitute.

Drought exerts severe short-, medium- and long-term impacts on communities, underscoring the need for in-depth studies to inform the development of effective policies and strategies.

Contents

Acknowledgements

This paper has been drafted by Joachim Otte, Dominic Wisser, Yakob Akilu, Priti Rajagopalan and Zehra Zaidi. This publication is part of the Flagship report on the impact of disasters on agriculture and food security. The objective is to provide a model showcasing the utilization of primary data to shape guidelines for examining the impact of disasters at both a national and subnational scale.

1 Introduction

Somalia, located in the Horn of Africa, has a surface area of approximately 638 000 km², with a coastline extending 3 025 km along the Gulf of Aden to the north and the Indian Ocean to the east. Agricultural land covers 70 percent of the country, of which close to 2 percent is arable land while 68 percent is permanent pasture.

The climate is arid or semiarid. Very small but elevated areas have an annual average rainfall of 500–600 mm but most of the country has an average rainfall that is only 100–200 mm. Rainfall is bimodal with two rainy seasons known locally as the '*Gu*' (April to June) and the '*Dyer*' (October to November).

Following the poor performance of the third seasonal rain beginning in 2016, the President of the Federal Government of Somalia declared a severe nationwide drought and state of national disaster in 2017. Given the predominance of arid and semi-arid rangelands, pastoralism is the most appropriate form of land use in Somalia. Pastoral and agropastoral livestock keeping forms the backbone of the mainly rural economy and, between 2013 and 2016, contributed around 60 percent to the gross domestic product (GDP) (World Bank & FAO, 2018). In normal years, exports of livestock and related products account for 80 percent of export earnings. The main export destinations are Near East countries, particularly Saudi Arabia (during the Haj season) but also Oman, Qatar, the United Arab Emirates and Yemen. Food aid and food imports are larger than the domestic production of grains, which covers only about 22 percent of annual cereal needs on average. Even in years of favourable climatic conditions, local production does not cover more than half of the needs. Meanwhile, remittances keep providing an important source of finance for the population. For example, between 2015 and 2017, Somali migrants transferred an average of USD 1.3 billion per year (World Bank, 2019).

The objective of this paper is to provide a quantified illustration of the impact of drought on the livestock sector and on livestock-keeping households using the Somalia 2016/17 drought experience as an example. To this end, we draw on the drought impact and needs assessment (DINA I, II & III) carried out by the World Bank, the UN, the European Union and the GDFRR in late 2017 and conduct an ex-post impact assessment using a modelling framework contrasting a drought with a no-drought scenario building on pre-drought livestock population and production parameters. In contrast to the DINA, which only considered the drought year, this assessment covers five post-drought years and therefore considers longer-term losses resulting from immediate damage and losses suffered in the drought year. The assessment focuses on livestock keepers and does not cover downstream impacts on livestock traders, slaughterhouses and exporters or macro-economic effects. Also, it restricts itself to livestock losses and does not cover grain production loss suffered by agropastoralists.

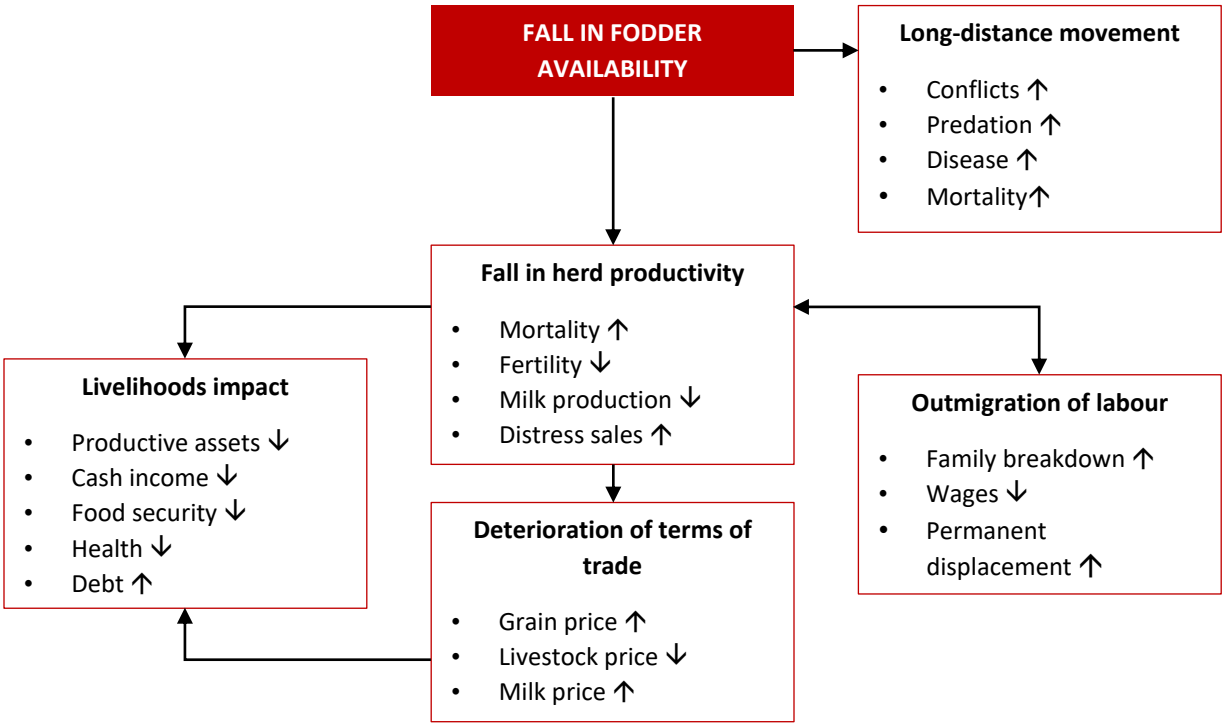
2 Background

2.1 Drought impact on pastoral livelihoods

Toulmin (1985) comprehensively documented drought impacts on pastoral/agropastoral livelihoods in sub-Saharan Africa (Figure 1). Decreased fodder availability due to low rainfall is the first main effect on livestock production systems. Low rainfall decreases the available drinking water, precluding the effective grazing of certain pastures. These recurring anomalies also lead to an increased susceptibility to diseases.

Animal fertility levels and the timing of conception are strongly related to the nutritional status of female animals. Drought years cause nutritional stress, so animals suffer from lower conception rates and higher miscarriage and stillbirth rates. Sheep and goats, whose gestation periods are about five months, suffer lower parturition rates in the drought year. Cattle and camels, whose gestation periods are 9 and 12–14 months, respectively, suffer reduced calving rates in the year following a drought year. Decreased numbers of offspring entering herds are further aggravated by their mortality caused by a fall in milk output as lactating females have reduced access to fodder. Lactation also ceases below a certain level of feed intake and after the death of calves, kids and lambs. Decreased milk availability also affects herders' families. Animal live weights decrease as grazing becomes scarce, reducing the value of stock as meat animals. In turn, decreased live weight increases death rates and disease susceptibility. Drought-related death rates vary by species and stock classes — cattle are generally less resistant than sheep and goats, which are less resistant than camels.

Figure 1. Drought impacts on (agro)pastoralist livelihoods



Source: Adapted from Toulmin, C. 1985. *Livestock losses and post-drought rehabilitation in sub-Saharan Africa*. Livestock Policy Unit Working Paper. 9. International Livestock Centre for Africa.

Herders salvage value from animals before they die to be able to afford food for their families and occasionally to feed and water the remaining animals. This causes sharp rises in livestock sales, but also depresses prices. Initially, the least essential herd members are sold, such as old males and barren females. As droughts lengthen, herd productivity falls further, as does the number of non-essential stock available for sale. This forces the sale of breeding females, which is an indication of acute stress because they represent productive capital crucial to herd maintenance and growth. This can be interpreted as a depreciation of assets and a reduction in ensuing income streams.

Markets play an important role in food security as grains are an important, though seasonally variable, part of diets. Pastoralists are estimated to obtain at least half of their overall calorie requirements from cereals – varying from 20–25 percent in the rainy season to over 70 percent in the hot dry season. Pastoral households' dependence on grain intensifies in times of drought due to falling milk supplies. The increased need to buy grains during droughts coincides with the reduced purchasing power of pastoralists resulting from poor-condition livestock, falling livestock prices and rising grain prices. Therefore, household incomes are affected on both the revenue side and the cost side.

Pastoralists can temporarily adapt to drought-induced falls in herd productivity by sending household members elsewhere to decrease the number of people depending on the family herd. Young males are typically sent with cattle and camels to distant (retreat) grazing areas where pasture availability is thought to be better. Other members may migrate to small towns to earn money.

Drought effects on livestock keepers depend on their livestock wealth and access to other resources – droughts affect wealth distribution and income. Droughts generally have a stratifying effect on (agro)pastoral communities. Poor households often become more impoverished, while wealthier households manage to contain their losses and even increase their assets. Even with proportional losses among herds of different sizes, larger herd owners are more likely to end drought periods with herds large enough to form breeding nuclei, while the holdings of smaller herd owners are likely to fall below survival thresholds.

2.2 Context

The Government of Somalia declared a nationwide drought and state of national disaster in 2017, following three seasons of below average rainfall. Most of Somalia's territory is made of permanent pasture, and the country receives an average rainfall of just 100–200 mm per year. Pastoralism is, therefore, the most appropriate form of land use, given the predominance of arid and semi-arid rangelands. Pastoral and agropastoral livestock keeping forms the backbone of the country's mainly rural economy, contributing 60 percent to the GDP in 2013–2016 (World Bank and FAO, 2018). The livestock sector is a major source of milk and meat, and an important source of employment and livelihoods.

Livestock and livestock products account for 80 percent of Somalia's export earnings in normal years. The country relies on food aid and food imports because domestic grain production covers only an average 22 percent of annual cereal requirements. Local production does not exceed more than half of domestic cereal requirements even in years of favourable climate.

Based on the productivity assumptions of various livestock species, (agro)pastoralists generate an annual revenue of around USD 3 billion in Somalia, of which two-thirds is from milk and one-third is from meat – mainly as live animal sales (Table 1). Given an estimated population of around seven million

(agro)pastoralists, the average annual per capita revenue of meat and milk sold and consumed by households amounts to roughly USD 430.

Table 1. Estimates of pre-drought (2015/16) livestock numbers, biomass, births and deaths, and potential animal and milk offtake by livestock species

	Camels	Cattle	Goats	Sheep	Total
Population (million heads)	6.61	3.93	28.70	13.65	52.89
Live weight (million tonnes)	2.02	0.82	0.64	0.31	3.79
Births (million heads)	1.31	0.99	18.14	6.99	27.43
Deaths (million heads)	0.54	0.36	7.85	2.94	11.69
Potential animal offtake					
Number (million heads)	0.77	0.62	10.28	4.04	15.71
Value (USD billion)	0.42	0.12	0.38	0.11	1.03
Milk offtake					
Quantity (million tonnes)	1.47	0.47	0.32	0.15	2.41
Value (USD billion)	1.28	0.36	0.24	0.11	1.99

Note: Potential animal offtake refers to the number of animals that can be removed from a herd without reducing herd size, i.e. the difference between the annual number of births and deaths.
Source: Authors' own elaboration.

Camels are the dominant species (more than 50 percent) in terms of biomass and revenue generation. Milk is the main source of revenue from camels and cattle (around 75 percent), while in small ruminants, milk and meat contribute about equally to revenue generation. The death toll is high even in normal years, with an estimated 12 million animals dying annually. About 60 percent of these deaths occur in young stock in the first three to four months of life, but around 2 million breeding females (out of 22 million) are also estimated to die each year – mostly sheep and goats.

Although (agro)pastoralists generate most of their income from livestock and livestock products, self-employment (firewood, charcoal burning, etc.), loans, cash gifts and remittances also contribute to generating income, particularly in poorer households.

3 Methodology

To obtain quantitative estimates of the impact of the 2016/17 drought on Somalia's (agro)pastoral livestock keepers, we model the herd/flock dynamics (camels, cattle, goats, sheep) and product flows (milk, live animals) using the Dynmod bio-economic herd model developed by CIRAD[1] over a 6-year time horizon (1 drought year and 5 post-drought years) comparing a no-drought scenario, based on population parameters of pre-drought years, with a drought scenario, in which production parameters are revised to reflect the effect of reduced feed (and water) availability on mortality, fertility, milk yield, body weight and offtake. The values of these parameters depend on the herds' biological performance and the management practices (during the pre-drought and post-drought periods). Values for production parameters were taken from scientific and grey literature while offtake rates were set to obtain herd structures consistent with those reported in the literature (age and sex). The parameter values considered to be affected by drought and the direction and timing of difference between the drought and no-drought models are shown in Table 2. The specific values used for the different species in the two scenarios are provided in Appendix 1.

Table 2. Production parameters considered affected by drought and direction and timing of difference between the drought and no-drought models

Parameter	Drought year	Post-drought years
Mortality		
Calves/kids/lambs	+	Pre-drought
Sub-adults	+	Pre-drought
Adults/breeders	+	Pre-drought
Offtake		
Female sub-adults	Pre-drought	-*
Female breeders	Pre-drought	-*
Male sub-adults	+	Pre-drought
Male adults/breeders	+	Pre-drought
Parturition rate		
Camels	Pre-drought	-
Cattle	-	-
Sheep and goats	-	+**
Milk yield	-	Pre-drought
Body weight		
Sub-adults	-	Pre-drought
Adults/breeders	-	Pre-drought

Note: * Until breeding herd has reached pre-drought size, ** Post-drought year ('flushing' due to high feed availability)

Source: Authors' own elaboration based on literature review.

[1] http://livtools.cirad.fr/dynmod

As the impact is focused on livestock-keeping households, rural market prices for live animals, milk and various types of food grain from 2015 to 2018 were used. Price data were obtained from the Food Security and Nutrition Analysis Unit (FSNAU) databases. Price details and the livestock-grain terms of trade are provided in **Appendix 1**.

Two impact analyses were carried out: the first at the national level to estimate the overall drought impact on livestock keepers and a second focusing on poor pastoral households, which are particularly vulnerable. For the country-level analysis, the 2014 livestock population figures reported by the FSNAU were used to generate the no-drought baseline as these values were also used for the DINA (the figures deviate from those reported in FAOSTAT, particularly in the case of goats, where FAOSTAT reports 11.6 million versus 27.8 million reported by the FSNAU). The drought impact on poor pastoral households was assessed using household information collected by the FSNAU in the Dawa livelihoods zone.

4 Results

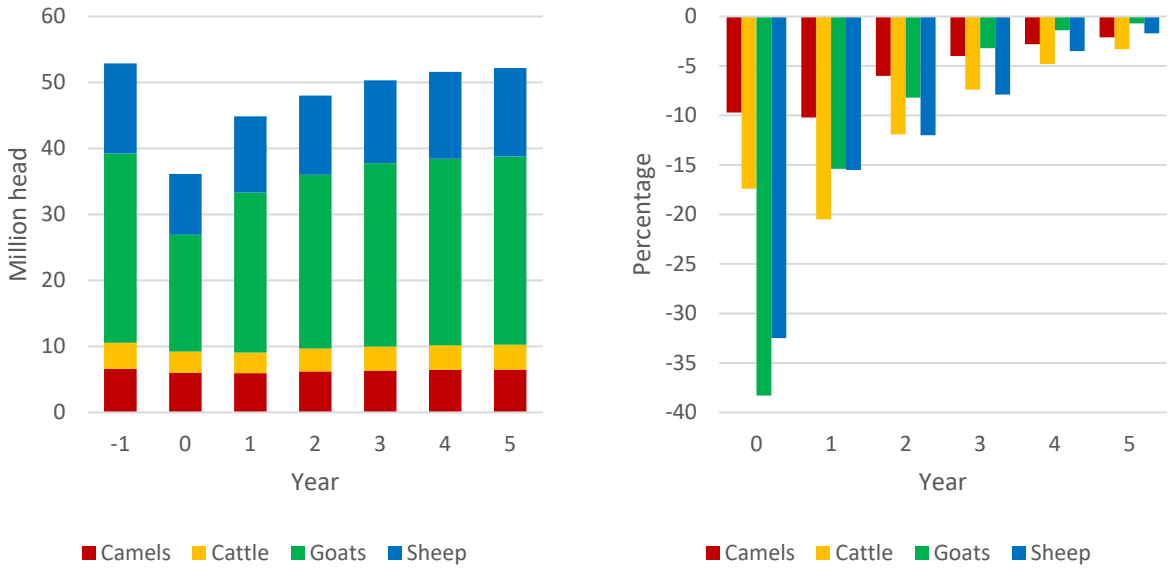
The comparison of the baseline no-drought scenario with the modelled drought suggests that drought decreased livestock numbers from 52.9 million in the pre-drought year to 36.1 million by the end of the drought year, i.e. by 16.8 million or 32 percent (Figure 2).

The overall impact on animal numbers includes declines in sheep and goats (over 30 percent) and in camels and cattle stock (under 20 percent). This dramatic decrease in overall livestock numbers in the drought year is the combined result of excessive drought-induced mortality and reduced reproductive performance, mainly that of small ruminants. Excess deaths in the drought year (4 million heads worth USD 290 million) are eclipsed by the deficit of 14.8 million births, the bulk of which are incurred by goats (10.5 million) and sheep (4 million).

In contrast to small ruminants, most of the decline in camel and cattle numbers in the drought year is the result of excess mortality – depressed fertility rates manifest mainly in the post-drought year. The combined impact of excess deaths and deficit births (18.8 million animals) on total livestock numbers is in addition to an estimated reduction of animal offtake in the order of 2 million heads.

None of the four species achieved full recovery to pre-drought numbers within the modelled time frame. Goats came the closest to the original population figure, while cattle numbers remained 0.1 million heads (3 percent) below the baseline.

Figure 2. Estimated livestock populations from pre-drought year to post-drought year 5 (left) and relative difference compared to pre-drought year (right)

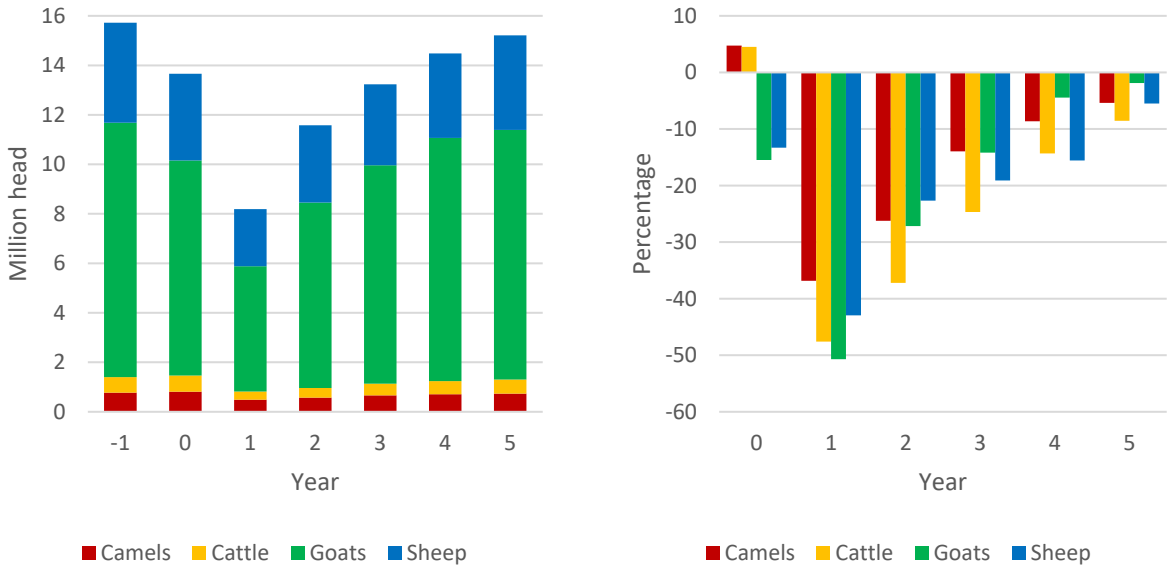


Source: Authors' own elaboration based on FSNAU 2014 livestock population data.

The offtake of live animals is the lowest in the post-drought year – down to 8.2 million heads from 15.7 million heads in the pre-drought year (Figure 3). This exceptionally large decrease in animal offtake in the post-drought year is primarily the result of the birth deficit of small ruminants in the preceding year. Relative reductions in animal offtake are also high in camels and cattle. However, in these species,

decreased offtake is driven by increased mortality in the drought year. For all species, offtake is further reduced by efforts to rebuild herds and, given that livestock populations have not yet reached pre-drought levels after five years, animal offtake is estimated to remain slightly below pre-drought levels.

Figure 3. Estimated livestock offtake from pre-drought year to post-drought year 5 (left) and relative difference compared to pre-drought year (right)

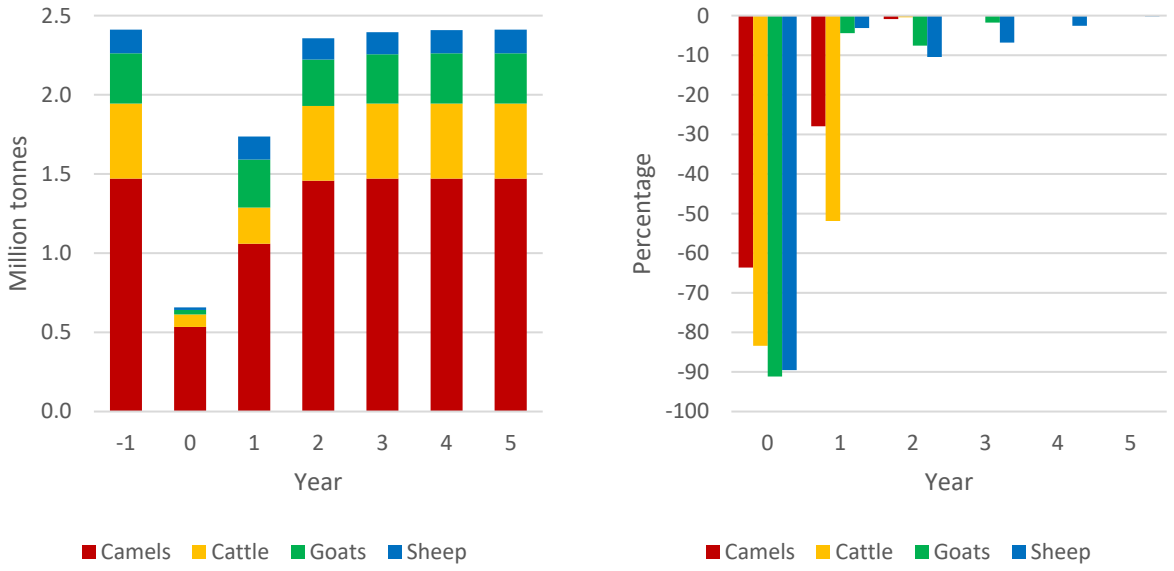


Source: Authors' own elaboration.

Milk offtake in the drought year dropped by an estimated 1.75 million tonnes (75 percent) compared to the estimated offtake of 2.4 million tonnes in the pre-drought year (Figure 4). Milk offtake was still only about 0.7 million tonnes in the post-drought year, which is 30 percent below pre-drought offtake. The milk production of small ruminants recovered noticeably in the post-drought year due to the increase in fertility (flushing) brought about by improved availability of feed. Conversely, the milk deficit in cattle and camels remained high due to the reduced calving rates in the post-drought year. In the drought year, the loss of milk and associated revenue accounted for close to 90 percent of foregone income despite drought-tolerant camels forming the backbone of Somalia's milking herd.

Milk production recovered in the post-drought year, but losses incurred due to reduced live animal offtake became predominant from the post-drought year onwards. Around three-quarters of the losses accruing in the post-drought year stemmed from reduced live-animal offtake, which, in turn, was caused by a sharp decline in the birth rate of small ruminants in the drought year and the necessity of rebuilding flocks. Rebuilding flocks/herds by retaining offspring is a slow process, and even five years after a drought, livestock numbers did not fully reach pre-drought levels – live-animal offtake remained nearly 5 percent below the baseline.

Figure 4. Estimated milk offtake from pre-drought year to post-drought year 5 (left) and relative difference compared to pre-drought year (right)



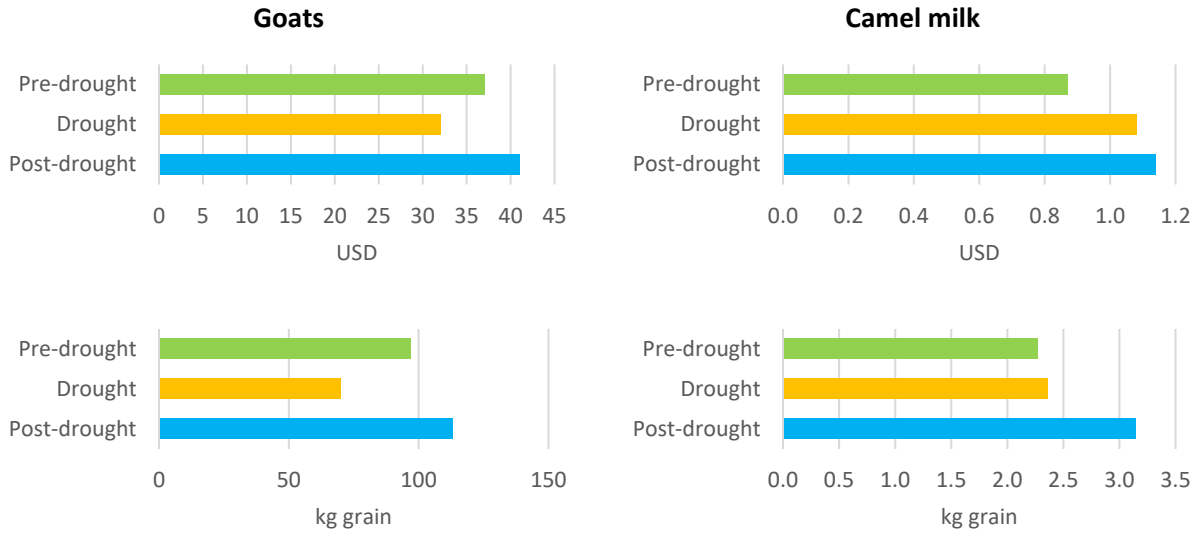
Source: Authors' own elaboration.

Rural market prices and terms of trade in grain for local quality (as opposed to export quality) goat and camel milk in the pre-drought, drought, and post-drought years illustrate drought-induced price movements (Figure 5). According to the FSNAU, prices for live cattle did not decrease substantially in the drought year, while those of camels, goats and sheep dropped by 10–15 percent. By contrast, milk prices rose by 20–25 percent in the drought year.

Prices of small ruminants rebounded in the post-drought year to over 10 percent above the baseline level, while camel and cattle prices remained unchanged. One reason that the prices of small ruminants rise first after a drought is that sheep and goats are in high demand as "seed" animals for post-shock herd repopulation as well as being affordable for average consumers. The price of milk still rose slightly in the post-drought year although milk production more than doubled compared to the drought year.

Swings in the terms of trade of livestock compared to grain were more pronounced than the changes in livestock prices – the amount of grain exchanged for livestock decreased by 20–40 percent or more in the drought year and increased by 15–20 percent for goats and sheep in the post-drought year.

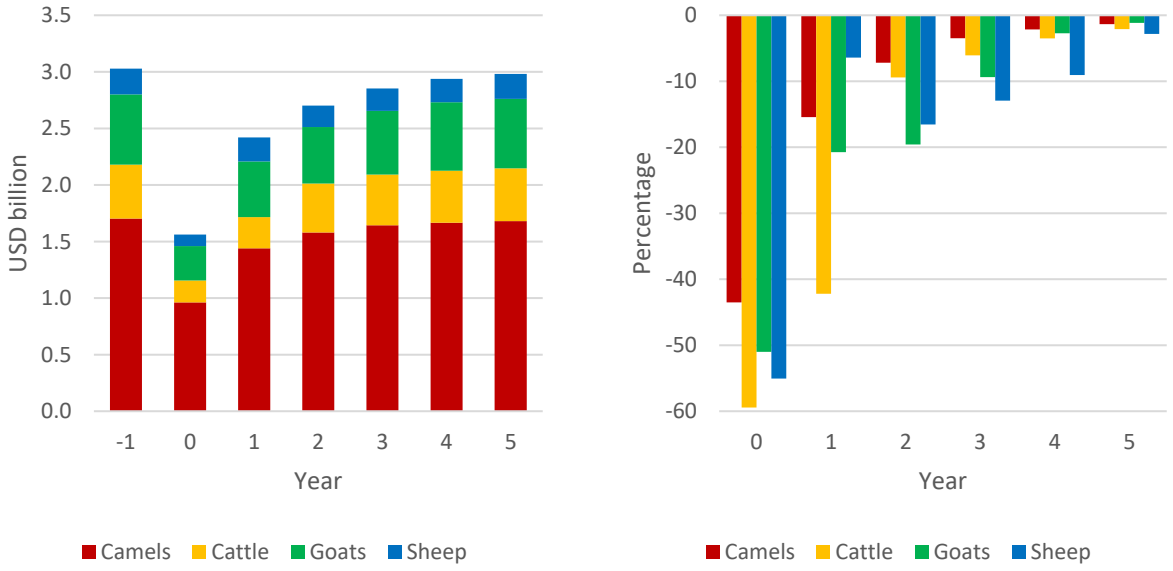
Figure 5. Average local market prices for local quality goat and camel milk (top row) and terms of trade in the pre-drought, drought and post-drought years (bottom row)



Source: Authors' own elaboration based on FSNAU price database.

In the case of milk, the drought-year price increase was similar to the average price increase in grain, leaving the milk–grain terms of trade relatively unaffected. However, milk prices continued to rise while grain prices declined in the post-drought year. This caused the milk–grain terms of trade to shift heavily in favour of pastoralists capable of supplying milk to the market. This reflects a typical drought/post-drought scenario and its impact on income distribution.

Figure 6. Estimated value of animal and milk offtake from pre-drought year to post-drought year 5 (left) and relative difference compared to pre-drought year (right)



Source: Authors' own elaboration.

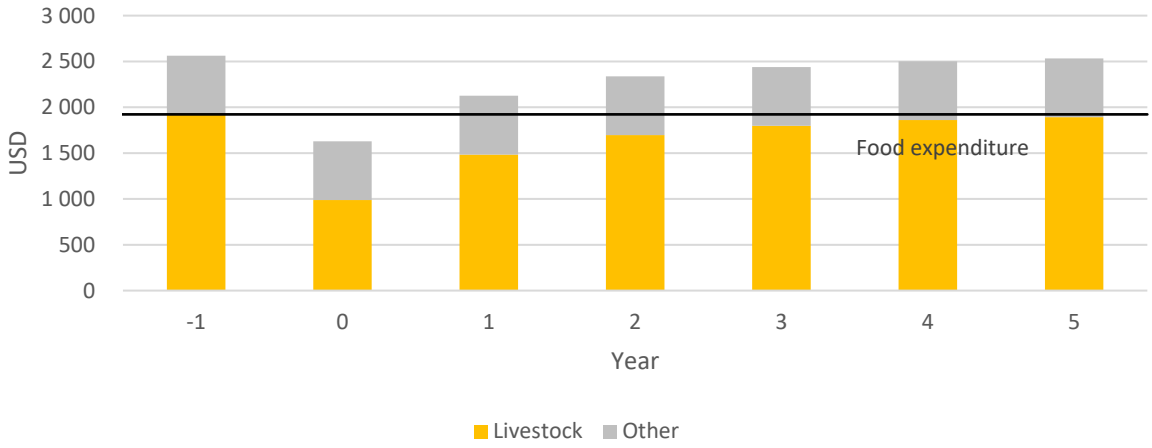
Using prevailing rural market prices, the value of animal and milk offtake dropped from USD 3 billion in the year preceding the drought to USD 1.5 billion in the drought year (Figure 6). Revenue from cattle was the most affected, dropping by around 60 percent due to the high loss in milk revenue (Figure 3). This was followed by small ruminants revenue falling by around 50 percent and camel revenue falling by around 40 percent. In the year that followed the drought, cattle revenue still lagged substantially, registering a decline of more than 40 percent compared to pre-drought levels. Meanwhile, revenue losses for other species were comparatively lower, with reductions of only 20 percent or less when compared to their pre-drought levels. This difference can be ascribed to price increases observed in small ruminants and milk during the post-drought period. It was only in post-drought year 4 that the estimated revenue losses fell below 10 percent for all species. The deterioration of the livestock–grain terms of trade in the drought year increases revenue losses by an additional 10 percent when expressed in kilogram–grain equivalent.

4.1 The impact of the 2016/17 drought on poor pastoral households

The above sectoral-level overview of drought impacts masks considerable variability by location, season and household characteristics. The FSNAU livelihood assessments in Somalia's Dawa pastoral livelihood zone (FSNAU, 2014) can be used to illustrate the impact of drought on pastoral households in the poor wealth group, a classification based predominantly on livestock holdings. The Dawa pastoral livelihood zone is in the southwest of the country and borders Kenya, with 30 percent of the pastoral population classified as poor by the FSNAU. The average household consists of 7 members, and the average herd consists of 3 camels, cattle, 23 goats and 10 sheep. Households earn around one-quarter of their income from non-livestock sources (e.g. firewood and charcoal burning) and spend around 75 percent of their income on food.

Expected livestock revenue from the mixed herds of pastoral households in Dawa in pre-drought, drought and post-drought years was estimated by applying the approach and parameter values and prices used in the sectoral model (Figure 7). Revenue from livestock does not meet food expenditure needs. Droughts cause livestock revenue to drop by around 50 percent; total income, assuming non-livestock income remains constant, falls about 15 percent short of pre-drought food expenditure. This 15 percent shortfall does not account for drought-induced increases in grain prices, so the actual shortfall is likely to be higher.

Figure 7. Estimated value of animal and milk offtake and non-livestock income from pre-drought year to post-drought year 5 for poor pastoralist households in the Dawa pastoral livelihood zone

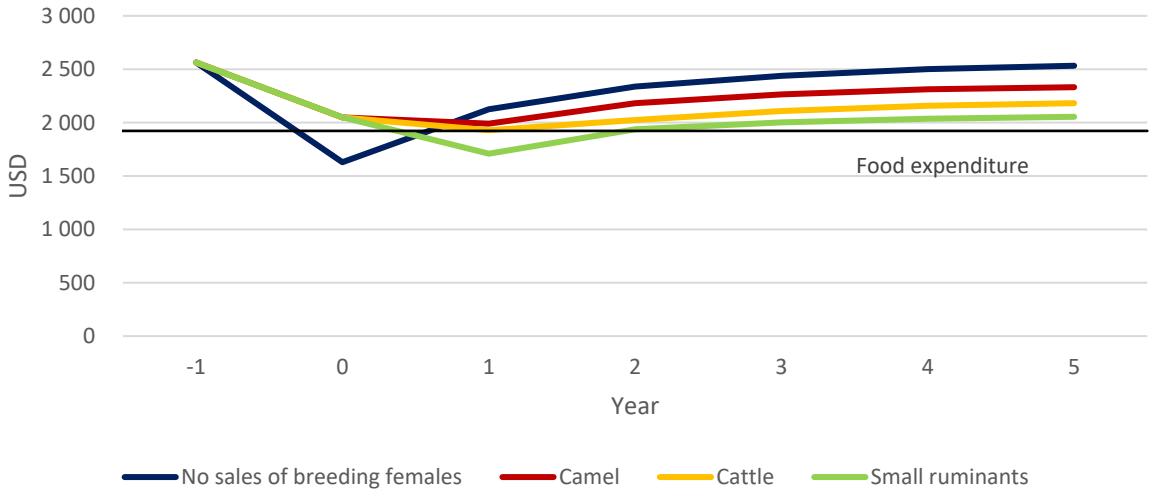


Source: Authors' own elaboration based on FSNAU data.

Pastoral households that cannot meet their food expenses have to rely on safety nets or liquidate part of their herd, possibly even valuable breeding stock. For the Dawa pastoral household, the deficit between total income and food expenditure in the drought year amounts to around USD 300. This corresponds roughly to the price of a young camel, one to two cows or ten small ruminants.

Given the small initial herd size and its further reduction by drought-related mortality and depressed fertility, breeding females or their replacements would have to be sold to cover the revenue–expense gap. The sale of breeding stock delays herd recovery and decreases livestock-related revenue in post-drought years (Figure 8), thereby increasing post-drought losses.

Figure 8. Projected income of a Dawa pastoralist household under three livestock sales strategies to compensate for income shortfall in a drought year



Source: Authors' own elaboration based on FSNAU data.

As Figure 8 shows, the sale of small ruminants is the least advantageous option as it merely pushes the revenue–food expenditure gap into the post-drought year, followed by four years of barely meeting food expenditures. This unfavourable outcome can be explained by sheep and goats that have to be sold, ultimately reducing the original flock of 33 head to about 6, or less than 20 percent. In this scenario, the estimated livestock revenue loss over the drought year and five post-drought years compared to the no-drought scenario amounts to USD 3 600 versus USD 1 800 if no breeding animals were sold for food purchases. Although it is not the best option, the sale of small ruminants is likely the preferred strategy because sales can be spread over time according to need and do not result in an erratic income. This example illustrates how poor pastoralists with small herds face a substantial risk of falling below the critical herd size necessary to satisfy food needs, forcing them to liquidate breeding stock and ultimately abandon their pastoral lifestyle.

5 Conclusion

Around 4 million excess animal deaths, mainly those of small ruminants, are estimated to have occurred in the drought year, inflicting damage of approximately USD 290 million. Estimated losses incurred in the drought year amounted to nearly USD 1 300 million from foregone milk production and USD 160 million from reduced quantity and value of animal offtake. In the post-drought year, the value of milk losses dropped to USD 150 million while the losses from reduced animal offtake rose to USD 460 million, mainly due to the reduced kid and lamb crop in the drought year. Further losses of USD 640 million accrued in post-drought years 2 to 5 as livestock populations remained below pre-drought levels and animal offtake did not reach pre-drought values.

At the household level, results show that, without external assistance, poor pastoral households possessing small herds before the drought will likely have to liquidate part of their breeding herd to cover food expenses. Forced sales of breeding stock further delay herd recovery or force households to abandon their pastoral lifestyle and become part of Somalia's current 2.2 million internally displaced people. Food insecurity becomes a chronic (rather than a temporary) problem when pastoralists become destitute. A pastoral seasonal assessment by FSNAU in Dawa indicates that 5 percent of poor wealth groups became destitute in each drought season because they lost their livestock. Approximately one million people are estimated to have lost their pastoral livelihoods and became internally displaced people due to the 2016/17 drought (World Bank Group, 2018).

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7 Appendix

Appendix 1: Methods

The baseline (no-drought model) is based on livestock population figures in the 2016/17 DINA. Production parameter values for the prevailing livestock species (camels, cattle, sheep and goats) and predominant breeds (Somali shorthorn zebu, blackhead Somali sheep, Somali shortear goats) were taken from scientific and grey literature. After setting baseline values for reproduction, mortality, weight for age, and milk production, baseline offtake rates were adjusted to reach an equilibrium population (steady population size) and a sex-and-age structure aligned with published information.

Table A1. Baseline (no drought) livestock populations and key production parameter values

	Camels	Cattle	Goats	Sheep
Animal numbers (million)*	6.61	3.93	28.70	13.65
Mortality				
Calves/kids/lambs	20%	20%	30%	25%
Other	5%	5%	10%	10%
Parturition rate	45%	60%	125%	115%
Newborn per parturition	1.0	1.0	1.20	1.05
Milk offtake/lactation	1 400L	600L	30L	30L
Weight at sale (male/female)	420/450kg	280/300kg	30/35kg	30/35kg

Note: [1] FSNAU values for 2014/15
Source: Authors' own elaboration based on literature review.

Table A2. Baseline (no drought) equilibrium annual offtake rates (percent)

	Camels	Cattle	Goats	Sheep
Females				
Subadults	0	0	0	0
Adults[1]	7	12	20	11
Males				
Subadults[2]	60	55	87	80
Adults[3]	7	12	20	11

Note: [1] Set to keep population size constant (maximum offtake without reducing population); [2] Set to generate 70–80 percent female animals in population and species-specific adult (breeding) male to female ratio (camels 50:1, cattle 10:1, small ruminants 20:1); [3] Equal to female
Source: Authors' own elaboration based on Dynmod simulations.

Table A3. Assumed drought-induced proportional change in baseline parameter values (percent)

	Camels	Cattle	Goats	Sheep
Increase in mortality				
Calves/kids/lambs	100	125	100	100
Other	75	100	75	75
Change in parturition rate				
Drought year	0	-25	-50	-50
Post-drought year	-25	-50	+10	+10
Change in milk offtake	-50	-67	-67	-67

Note: Offtake of males (subadult and adult) was increased by an absolute amount of 10 percent in the drought year.

Source: Authors' own elaboration based on literature review.

Table A4. Average rural market prices for livestock (local quality) and fresh milk in Somalia in pre-drought (I), drought (II) and post drought (III) 12-month periods

	Average rural market prices (USD)			Difference (percent)	
	Oct 2015 – Sep 2016 (I)	Oct 2016 – Sep 2017 (II)	Oct 2017 – Sep 2018	II vs I	III vs I
Camels	547	474	474	-13.3	-13.3
Cattle	186	185	186	-0.5	0.0
Goats	37	32	41	-13.5	10.8
Sheep	28	25	33	-10.7	17.9
Milk, camel	0.87	1.08	1.14	24.1	31.0
Milk, cow	0.76	0.92	0.94	21.1	23.7

Note: Prices were taken from the FSNAU price database, using those collected at rural markets, which are closer to those received by producers than urban market prices. Average prices over 12-month periods from October year N to September year N+1 were used (despite seasonal and regional variation). Cattle milk prices were used for goat and sheep milk. Local quality sheep prices were estimated from local quality goat prices using ratio of export quality sheep to export quality goat prices. Pre-drought (2015/16) prices used for years 2, 3, 4, and 5.

Source: FSNAU price database

Table A5. Rural terms of trade (average of red and white sorghum, and yellow and white maize)

	Rural terms of trade (kg of grain)			Difference (percent)	
	Oct 15 – Sep 16 (I)	Oct 16 – Sep 17 (II)	Oct 17 – Sep 18 (III)	II vs I	III vs I
Camels	1 427.70	1 037.30	1 306.10	-37.6	-9.3
Cattle	485.50	404.80	512.50	-19.9	5.3
Goats	96.60	70.00	113.00	-37.9	14.5
Sheep	73.10	54.70	90.90	-33.6	19.6
Milk, camel	2.27	2.36	3.14	3.9	27.7
Milk, cow	1.98	2.01	2.59	1.5	23.4

Source: FSNAU price database

Appendix 2: Results

Table A6. Estimated difference in animal numbers, births, deaths, milk and live animal offtake between no-drought and drought scenario

Year	0	1	2	3	4	5
Livestock population (million head)	-16.74	-8.03	-4.87	-2.55	-1.27	-0.70
Excess deaths (million head)	4.02	-2.15	-1.21	-0.61	-0.24	-0.10
Deficit births (million head)	-14.79	-0.96	-2.20	-0.79	-0.20	-0.04
Living animals offtake (million head)	-2.07	-7.53	-4.14	-2.49	-1.24	-0.51
Living animals offtake (USD billion)	-0.17	-0.46	-0.28	-0.16	-0.09	-0.05
Milk quantity (million tonnes)	-1.75	-0.68	-0.05	-0.02	-0.00	-0.00
Milk value (USD billion)	-1.30	-0.15	-0.04	-0.01	-0.00	-0.00

Source: Authors' own elaboration.

Table A7. Estimated damage and losses by livestock species in the drought year and five successive years (USD million)

	Damage	Losses					
	Y0	Y0	Y1	Y2	Y3	Y4	Y5
Camels	145.4	741.0	263.0	122.5	59.1	36.5	22.8
Cattle	80.0	283.3	201.1	44.8	28.9	16.7	10.0
Goats	45.7	317.1	128.9	121.7	58.3	16.9	7.1
Sheep	17.9	125.0	14.6	37.6	29.4	20.6	6.4

Source: Authors' own elaboration.

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