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Applying livestock thresholds to examine poverty in Karamoja

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Abstract

In pastoralist and agro-pastoralist areas, wealth and poverty are closely aligned to levels of livestock ownership and social inclusion. Whereas cash income per capita is a useful measure of poverty in non-pastoralist areas, measures of livestock ownership per capita are needed to understand poverty in pastoralist systems. This study estimated a livestock threshold for agro-pastoralist households in Karamoja, being the minimum per capita ownership of livestock needed to sustain a predominantly agro-pastoral livelihood. The study then applied the livestock threshold to pre-existing livestock population data to estimate the proportions of households above and below the threshold. Using an estimated livestock threshold of 3.3 Tropical Livestock Units (TLU)/capita for agro-pastoralism, 56.5% of households in Karamoja's main livestock-keeping districts were below the threshold and could be categorized as livestock-poor. The ownership of livestock was skewed in two main ways. First, there was a high-end skew with the wealthiest 30% of households owning 69.3% of all livestock in terms of TLU. Second, there was a low-end skew. Among poorer households, below the 3.3 TLU/capita livestock threshold, livestock ownership was skewed away from the threshold. Forty-seven per cent of these households owned only 1.2 TLU/capita or less; 13% of households owned no livestock at all. These findings are discussed, with programming and policy recommendations.

Keywords: Karamoja, Livestock, Poverty, Livestock threshold

Introduction

Changing pastoralist livelihoods and measuring poverty

It is widely recognized that across pastoralist areas of East Africa, there is a long-term trend of changing livelihoods and livelihood diversification. Early research associated this trend with state and market integration of pastoralists (Dahl 1979; Ensminger 1992) and, to varying degrees, livestock losses due to conflict, drought, or animal disease outbreaks. For example, in Isiolo District in northern Kenya in the 1960s and 1970s, the undeclared *shifta* war between Kenya and Somalia led to dramatic losses of livestock, which were then exacerbated by four periods of drought into the mid-1980s (Hogg 1986). Over time, human population growth, declining access to land, and uncertain climatic trends have added layers of complexity to livelihoods in these pastoralist areas, but with relatively few people pursuing livelihoods that rely exclusively on livestock and with livestock ownership often concentrated among wealthier households (Catley 2017).

Diversified livelihood activities in pastoralist areas can be broadly categorized as positive diversification and negative diversification (Little 2016). Positive diversification often involves activities that are associated with livestock production and marketing, has meaningful levels of income relative to the time and labour involved, a relatively safe working environment, and takes place without harmful social or environmental consequences (Little 2016). Other forms of positive diversification include certain types of business development for those with access to capital or credit and related employment. In contrast, negative diversification can involve substantial labour for limited income; exposes workers to health risks or abuse, especially for women and girls; or has

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negative environmental impacts. It can also include forms of outmigration such as those associated with limited income and remittances, or family break-up.

Drawing on long-term research in northern Kenya and southern Ethiopia, McPeak et al. (2012) explained pastoralist diversification using four types of household: "left out" of pastoralism, with limited cash or livestock, and trapped in lowly remunerative employment; "moving from" a dependence on pastoralism to some alternative livelihood, with sufficient cash but few livestock; "staying with" pastoralism, with sufficient livestock but limited cash, and minimal diversification outside of pastoralism; and "combining" non-pastoral activities (cash) and pastoralism, with sufficient cash and livestock. Similarly, the Moving Up Moving Out analysis described the gradual shift of livestock from smaller/poorer to larger/wealthier herds as livestock production commercialized, and wealthier owners took over more control of land and water (Catley and Aklilu 2013). Reports on livestock ownership from Afar and Somali regions of Ethiopia (Sabates-Wheeler and Lind 2013), and Marsabit County, Kenya (Mburu et al. 2017) implied that the most households in these areas could be categorized as "left out".

Running parallel to research on livelihoods trends in pastoralist areas has been research and debate on how to measure changes in poverty and wealth, and the limitations of using conventional indicators such as cash income to assess economic status. In general, the literature on pastoralists' own perceptions of poverty, vulnerability, well-being, and identity consistently highlights the importance of livestock ownership, social connectedness, and a position in society that enables the sharing or receipt of livestock (Haaland and Keddeman 1984; Deng 1998; Harragin 1998; Helander 1999; Talle 1999); poverty is closely related to social exclusion, and livestock are the main financial asset and a social asset. In contrast, conventional poverty assessments use cash income as a key indicator and, likewise, use an income threshold to define the poor and non-poor. One result is that pastoralists can be categorized as universally poor (e.g. Little et al. 2008) which, in turn, supports misguided notions of weak or irrational production. Although cash income is a relevant indicator for the four categories of diversifying pastoralist households described by McPeak et al. (2012), equally important is an understanding of livestock ownership and trends in livestock ownership over time.

In the same way that a poverty line or income threshold is used in conventional poverty assessments, a "livestock threshold" has often been used in studies that refer to wealth and poverty in pastoralist areas. The use of livestock thresholds dates back to the late 1960s, and an assumption that a minimum number and type of animals were required to meet the basic food needs of a pastoralist household. Using estimates of herd production, especially milk production, early livestock threshold analysis in East Africa calculated figures of between 4 and 5.5 Tropical Livestock Units (TLU) per person (Pratt and Gwynne 1977; Kjaerby 1979). Using the Food and Agriculture Organization's definition of TLU as an animal of 250 kg bodyweight (Jahnke 1982), the threshold was equivalent to about six to seven cattle, or 40 to 50 sheep or goats per person. Examples of the use of livestock thresholds include research in northern Tanzania that reported 77% of Massai households falling below a "minimum pastoral survival limit of 5.5. livestock units per capita" (Talle 1999) and, more recently, poverty analysis in Marsabit County of Kenya that used a 4.5 TLU/capita threshold (Mburu et al. 2017). An important challenge with TLU/capita figures, especially when comparing populations or changes over time, is that different researchers have used different definitions of TLU. Similarly, the earlier threshold of 4 to 5.5 TLU/capita was estimated for subsistence pastoralism with minimal market engagement, whereas livestock sales have long been a critical part of pastoralist economies. If so, it is not only milk production and consumption that is important for calculating livestock thresholds, but also the terms of trade between livestock and cereals.

The Karamoja sub-region and changing livestock ownership

Situated in northeast Uganda, the Karamoja sub-region has a population of approximately one million people; three main ethnic sub-groups, the Dodoth, the Jie, and the Karimojong; and nine main tribal groups (Stites et al. 2007). Agro-pastoralism is the predominant livelihood system, with mobile livestock production supplemented with seasonal crop production, especially sorghum and maize. Dating back to the late 1800s, Karamoja has been associated with violence and livestock raiding, and in part, the changing fortunes of different groups have been linked to livestock losses and gains through raiding, in addition to other events such as droughts and livestock disease outbreaks. The area has long been described as the poorest region of Uganda, with high levels of human malnutrition and food insecurity and low levels of health and education.

Karamoja's history is marked by repeated attempts by colonial and post-independence governments to disarm communities and improve security (Knighton 2003). In 2002, the Government of Uganda shifted its disarmament strategy towards a more militarized and forceful approach, and in mid-2006, disarmament became almost exclusively a military exercise by the Ugandan army. Aerial and land attacks on civilians resulting in human casualties, excessive force, illegal detainment, torture, destruction of *homesteads*, and other human rights abuses

were widely reported (Stites et al. 2007). In terms of the impact of the disarmament programme on livestock, from 2006 to 2010, the Uganda military enforced a system of "protected kraals" under which they controlled the timing of livestock releases from the kraals each day and livestock mobility (Stites and Akabwai 2010a, b). Although herders and owners were involved in decision-making on livestock management to some degree, ultimately, the army decided on the locations where the livestock would be grazed. The confinement of livestock and disrupted mobility was associated with declines in production, especially milk production, and increased livestock mortality due to disease.

The government disarmament programme in Karamoja wound down in 2009 to 2010 and was followed by reports of dramatic livestock losses during the previous 10 years, a concentration of livestock among wealthier households, and, for those without animals, major impacts on livelihoods (Burns et al. 2013; Stites et al. 2016). At this time, the concern was that limited animal ownership pushes poorer households into diversified activities, but especially negative activities. In 2018, it was evident that many forms of diversification in Karamoja had harmful social or environmental consequences or resulted in very low levels of income and poverty traps (Bushby and Stites 2016; Iyer and Mosebo 2017). For example, for households relying on income from casual labour, levels of income were too low to enable savings to grow to buy livestock, or to pay school fees. Although households might shift towards more crop production as a result of livestock losses, this was a relatively high-risk activity in much of Karamoja due to frequent rain failures and the use of manual labour that limits the size of plots (Cullis 2018). Outmigration to urban areas, including Kampala and other cities in Uganda, to find work or simply survive was also an important part of the Karamoja livelihood context (Stites et al. 2007; Sundal 2010; Stites and Akabwai, 2012). For many, this is another high-risk activity with minimal rewards and can involve begging, sweeping mills in exchange for collecting fallen grain, unloading trucks, or selling metal found in garbage dumps. Amid the reports of more skewed livestock ownership after disarmament were also reports of active and growing livestock markets in Karamoja, including a dynamic cross-border trade with Kenya (Rockeman et al. 2016; Aklilu 2017).

In terms of cash income, in 2013 a UNDP Human Development Report for northern Uganda used a USD 1.25 per day poverty line and reported that 65.8% of people in Karamoja were below this threshold, compared to a national average of 35.5% (United Nations Development Programme 2015). By reference to the four categories of diversification outlined above (McPeak et al. 2012), people below this cash-based poverty line in Karamoja might be described as "staying with" or "left out" of pastoralism. The Ugandan government's National Household Survey assesses poverty using consumption expenditure indicators, and the most recent survey for 2016 to 2017 reported that 60.8% of people in Karamoja were below the national poverty line, relative to the national average of 27.0% (Uganda Bureau of Statistics 2017).

This paper examines livestock ownership patterns in Karamoja to estimate the number and proportion of households with enough animals to practise agro-pastoralism to generate most of their food and income from livestock and crop production. The paper also aims to provide insights into the number and proportion of households who are likely to be experiencing a poverty trap. These households would have very low levels of livestock ownership but also low income, and so would struggle to rebuild their herds to a sufficient level to resume an agro-pastoralist livelihood.

Methods

The research involved two main stages. First, a livestock ownership threshold was estimated for agro-pastoralism in Karamoja using a simple economic model. Second, the livestock threshold was applied to pre-existing livestock population data for Karamoja.

Estimating a livestock threshold

The estimation of a livestock threshold assumed that an agro-pastoralist household in Karamoja derives food from three main sources: the direct consumption of livestock products, especially milk; the sale of livestock in exchange for cereals; and the direct consumption of own-produced cereals. Using parish-level human census data for Karamoja from 2014 (Uganda Bureau of Statistics 2018), a model household size of six people was used, comprising two adults and four children. Within this household, it was also assumed that the labour required for livestock herding, crop production and other tasks such as childcare, would limit the time available for any other substantial income-generating activities, i.e. diversified activities. Therefore, the household's capacity to meet its basic food and income needs depended mainly on the size, composition, and productivity of the herd; the area of land available for crop production; crop yields; labour available for herding and cultivation; and market prices of livestock and cereals. The main assumptions that guided the development of the model are shown in Table 1.

The model was developed in MS Excel using the concept that household food energy requirements would need to equal (or exceed) food energy acquired from milk and cereals for the household to meet its basic food needs. This is expressed in the following formula:

Table 1 Model components and assumptions

Model component	Assumptions
Household characteristics and food needs	• The model used a household of six people, comprising two adults and four children (UBOS 2018). • Food energy needs per person were assumed to be 2100 kcal/day.
Livestock herd and production	• Milk in agro-pastoralist households in Karamoja is derived mainly from cows and goats. • Milk production and offtake depend on the number of cows and does of breeding age, reproductive performance, production, and herd management. • Production losses include losses due to disease and drought. • Information on livestock herd production in Karamoja is limited, but relevant information is available from comparable pastoralist systems in East Africa. • The food energy value of cow and goat milk is known.
Land and crop production	• The area of land available from cropping is limited by the use of hand tools and manual labour; the model used a land area of 0.4 ha cultivated. • For the sake of simplicity, the model used sorghum as the single crop produced by the household. • Limited information is available on sorghum yields in Karamoja, or losses due to pests, rainfall variability, and other causes; information on post-harvest losses is also limited. Sorghum yields were averaged from estimates provided by the Nabuin Zonal Agricultural and Research Development Institute. • The food energy value of sorghum is known.
Market behaviour and price data	• Good information is available on the prices of livestock and cereals in Karamoja; the model used average prices for 2017. • The model assumed that the household sold young male goats and bulls and retained breeding females; this approach is consistent with maximizing herd growth while also selling animals to meet domestic needs.

$$E_{\mathrm{h}} = (N_{\mathrm{a}} \times E_{\mathrm{a}} \times D) + (N_{\mathrm{c}} \times E_{\mathrm{c}} \times D) = E_{\mathrm{m}} + E_{\mathrm{os}} + E_{\mathrm{ps}}$$

E_{h} = total annual household food energy requirements
N_{a} = number of adults in the household
E_{a} = adult daily energy requirement
N_{c} = number of children in the household
E_{c} = child daily energy requirement
D = number of days in a year
E_{m} = food energy derived from livestock milk
E_{os} = food energy derived from own sorghum
E_{ps} = food energy derived from purchased sorghum

For the three sources of food energy, the following formulae were used:

$$E_{\mathrm{m}} = \left\{\left[\left(N_{\mathrm{g}} \times B_{\mathrm{g}} \times \left(1{-}M_{\mathrm{g}}\right)\right) \times O_{\mathrm{g}} \times L_{\mathrm{g}}\right] \times E_{\mathrm{gm}}\right\} + \left\{\left[\left(N_{\mathrm{c}} \times B_{\mathrm{c}} \times (1{-}M_{\mathrm{c}})\right) \times O_{\mathrm{c}} \times L_{\mathrm{c}}\right] \times E_{\mathrm{cm}}\right\}$$

E_{m} = food energy from milk
N_{g} = number of goats in the herd
B_{g} = proportion of breeding female goats
M_{g} = mortality and losses in adult goats due to disease, drought, and gifts
O_{g} = daily goat milk offtake
L_{g} = goat lactation period
E_{gm} = energy content of goat milk
N_{c} = number of cattle in the herd
B_{c} = proportion of herd as breeding cows
M_{c} = mortality and losses in adult cattle due to disease, drought, and gifts
O_{c} = daily cow milk offtake
L_{c} = cow lactation period
E_{cm} = energy content of cow milk

$$E_{\mathrm{os}} = A \times Y \times E_{\mathrm{s}}$$

E_{os} = energy derived from own sorghum
A = area of land cultivated
Y = sorghum yield
E_{s} = energy content of sorghum

$$E_{\mathrm{ps}} = (I_{\mathrm{l}}/P_{\mathrm{s}}) \times E_{\mathrm{s}}$$

E_{ps} = energy derived from purchased sorghum
I_{l} = income from livestock sales
P_{s} = price sorghum
E_{s} = energy content of sorghum

In the calculation of energy derived from purchased sorghum, the following formula was used to calculate the income from livestock sales:

$$I_{\mathrm{l}} = \left[\left(N_{\mathrm{g}} \times B_{\mathrm{g}} \times \left(1{-}M_{\mathrm{g}}\right)\right) \times \left(R_{\mathrm{g}} \times \mathrm{M/F} \times (1{-}M_{\mathrm{k}}) \times P_{\mathrm{g}}\right)\right] + \left[\left(N_{\mathrm{c}} \times B_{\mathrm{c}} \times (1{-}M_{\mathrm{c}})\right) \times \left(R_{\mathrm{c}} \times \mathrm{M/F} \times (1{-}M_{\mathrm{ca}}) \times P_{\mathrm{c}}\right)\right]$$

I_{l} = total income from livestock sales
N_{g} = number of goats in the herd
B_{g} = proportion of breeding female goats
M_{g} = mortality and losses in adult goats due to disease, drought, and gifts
R_{g} = annual birth rate of goats
M/F = ratio male/female births
M_{k} = mortality and losses in kids due to disease, drought, and gifts
P_{g} = price of young male goat
N_{c} = number of cattle in the herd
B_{c} = proportion of herd as breeding cows
M_{c} = mortality and losses in adult cattle due to disease, drought, and gifts
R_{c} = annual birth rate of cows
M/F = ratio male/female births

M_{ca} = mortality and losses in calves due to disease, drought, and gifts

P_c = price young male bull

Using the five formulae above, a spreadsheet was designed in which the formulae were linked and in which the number of goats (N_g) and the number of cattle (N_c) in the herd could be adjusted to achieve a food energy balance of zero or reach a figure that was as close as possible to zero. The number of goats and cattle was then converted into TLU/capita. The values for each variable used are shown in Table 2.

The list of assumptions in Table 1 shows a reliance on the two main types of data, with different levels of validity. First, relatively valid information was available for variables such as human food energy needs, the energy values of foods such as milk and sorghum, and the market prices of livestock and cereals in Karamoja. These variables were either standard figures derived from nutrition tables or absolute market price figures. Second, less valid information was available on herd production, livestock losses, land cultivated, and sorghum yields and losses, because no studies that described these variables

Table 2 Input variables and values for the livestock threshold model

Variable	Value
Household size and food energy	
Family size adults, N_a	2
Family size children, N_c	4
Daily energy requirement adult, E_a (kcal)	2100
Daily energy requirement child, E_c (kcal)	2100
Proportion of household dietary energy from cereals	82%
Proportion of household energy from milk	18%
Herd structure	
Proportion of goat herd as breeding females, B_g	70%
Proportion of cattle herd as adult females, B_c	65%
Losses and gifts	
Annual kid disease and drought mortality, losses, and gifts, M_k	40%
Annual adult goat disease and drought mortality, losses, and gifts, M_g	35%
Annual calf disease and drought mortality, losses, and gifts, M_{ca}	40%
Annual adult cattle disease and drought mortality, losses, and gifts, M_c	35%
Reproduction	
Annual birth rate goats, R_g	1.50
Annual birth rate cows, R_c	0.80
Birth ratio male to female, M/F	50%
Milk production and offtake	
Goat milk offtake/day (l), O_g	0.20
Goat lactation period (days), L_g	90
Food energy goat milk (kcal/l), E_{gm}	692
Cow milk offtake/day (l), O_c	0.5
Cow lactation period (days), L_c	180
Energy value cow milk (kcal/l), E_{cm}	660
Livestock prices	
Price of goats (UGX), P_g	70,000.00
Price of young bulls (UGX), P_c	700,000.00
Crop production	
Sorghum area planted (ha), A	0.4
Sorghum yield (kg/ha), Y	800
Price sorghum (UGX), P_s	2590
Energy value sorghum (kcal/kg), E_s	3290

were available for Karamoja. Information on pastoralist herd structure and production was obtained from the literature and, where possible, from pastoralist areas adjacent or close to Karamoja (Devendra and McLeroy 1982; Jahnke 1982; Mefit-Babtie Srl. 1983; Njanja 1991), and information on the area of land cultivated and sorghum production was provided by the Nabuin Zonal Agricultural Research Center in Karamoja. We assumed wide variation between households for these variables and variation by year and season. In part, these limitations were handled by measuring the effect of changing the values of selected variables on the livestock threshold. The selected variables were livestock survival, sorghum yields, milk offtake, and the prices of cattle, goats, and sorghum.

Applying the livestock threshold

To measure the proportions of households above and below the livestock threshold in Karamoja, we used raw data from a livestock demographic survey commissioned and conducted in 2017 (Schloeder 2018). This survey collected livestock ownership figures from a sample of 3578 households across Karamoja's seven districts at that time. From the raw dataset, we selected the six districts of Napak, Nakapiripirit, Moroto, Kaabong, Kotido, and Amudat and categorized these areas as the main livestock-rearing districts. We excluded households in Abim District, as we categorized Abim as primarily an agricultural district.

This selection of districts produced a sample of 2729 households. For each household in this sample, we converted the numbers of livestock by species and household into TLU, using conversion factors of 1 cattle = 0.7 TLU, and 1 sheep or goat = 0.1 TLU (Jahnke 1982) and then calculated the TLU/capita for each household. We again assumed an average household size of six people.

Results

Livestock threshold for agro-pastoralism

The simple household model produced a livestock threshold for agro-pastoralism in Karamoja of 3.3 TLU/capita, with a herd comprising 45 goats and 22 cattle. Below this threshold, a household could not meet its basic food energy requirements and would need to supplement its own-produced food (or income from livestock) from other sources. However, as indicated in the "Estimating a livestock threshold" section, the capacity of a household to pursue diversified activities, in addition to herding livestock or growing crops, would partly depend on the time available for these other activities; the average household had only two adults.

Outputs with the model set at a 3.3 TLU/capita threshold are shown in Table 3. After the consumption of milk and own-produced sorghum, the annual food energy balance would be met through the sale of livestock and related sorghum purchases; the herd could produce nine male goats and two bulls for sale each year, with the income sufficient to buy enough sorghum to meet this requirement. In this model, the annual household cash balance after sorghum purchases is Ugandan shillings (UGX) 50,257 (USD 13.57), i.e. a very limited sum for other domestic expenses such as health, education or for livestock purchases.

Table 3 Model outputs at livestock threshold of 3.3 TLU/capita

Output	Value
Household total annual food energy requirement (kcal)	4,599,000
Energy derived from milk consumption	
Goat milk (kcal)	255,037
Cow milk (kcal)	552,123
Total energy from milk consumption (kcal)	807,160
Energy derived from sorghum consumption	
Energy derived from own-produced sorghum (kcal)	1,052,800
Energy requirement from purchased sorghum (kcal)	2,739,040
Income from livestock	
Young male goats (UGX)	644,962.50
Young bulls (UGX)	1,561,560.00
Total income from livestock (UGX)	2,206,522.50
Sorghum purchases and cash balance	
Cost of total sorghum needs (UGX)	2,156,265.85
Balance after sorghum purchases (UGX)	50,256.65

The model outputs were derived using a herd of 45 goats and 22 cattle, equivalent to 3.3 TLU per household member

If livestock mortality in the model was reduced by 20% (survival increased by 20%), the annual cash balance increases 6-fold (Table 4). This increase was mainly dependent on cattle survival relative to other livestock species and indicates the relevance of support such as veterinary programmes and drought management on livelihoods. As expected, increases in livestock prices lead to more cash income and a higher annual cash balance. However, increases in sorghum prices have the opposite effect, producing a food deficit. This is because the household in the model is a net purchaser of sorghum, i.e. purchases exceed own production.

Distribution of livestock ownership

Figure 1 shows the pattern of livestock ownership in the six main livestock-rearing districts of Karamoja. The five lowest wealth deciles (50% of human population) owned 11.2% of livestock, whereas the wealthiest three deciles (30% of human population) owned 69.3% of livestock.

Figure 2 shows the mean TLU/capita by wealth decile and, as expected, has a similar pattern of ownership to that shown in Fig. 1. Applying a livestock threshold of 3.3 TLU/capita to the graph shows that the lowest six

Table 4 Effect of changing livestock production and livestock and cereal prices on household cash balance

Input variable	Change in input variable	Annual cash balance with livestock threshold set at 3.3 TLU/capita
Basic model	No changes	UGX 50,257
Production changes		
Livestock survival	Increase by 20%	UGX 308,625
Sorghum own production	Increase by 20%	UGX 216,017
Milk yield	Increase by 20%	UGX 176,753
Price changes		
Cattle price	Increase by 10%	UGX 114,753
Goat price	Increase by 10%	UGX 206,412
Sorghum price	Increase by 10%	UGX 165,369

wealth deciles, or about 60% of the population, fall below the livestock threshold. An actual count of households showed that 1542 households from the sample of 2729 households owned less than 3.3 TLU/capita, or 56.5% of the households.

Figure 3 looks specifically at households below the 3.3 TLU/capita threshold. The graph illustrates a skewed ownership away from the threshold, indicating a substantial livestock asset gap for many households in terms of attaining the threshold. For example, 67% of households below the livestock threshold owned 1.5 TLU/capita or less, i.e. less than half of the required livestock to reach the threshold.

Discussion

Study limitations

The livestock threshold for agro-pastoralism in Karamoja was relatively straightforward to calculate, but the validity of the 3.3 TLU/capita figure depended heavily on the design of the model and the estimates for the variables that were used for the model (Table 2). The design of the model drew heavily on previous studies, and the concept of people's basic food needs being met through their own production and the use of income to purchase food. The model design focused on livestock production and crop production and did not include income from non-livestock and non-crop-related activities. Given the average household size in Karamoja of two adults and four children, it was assumed the labour required for livestock herding, crop production, and domestic tasks would leave minimal time for other activities.

Regarding the selected values for the variables used (Table 2), some of these values were standard figures (e.g. the energy values of specific foods); others were absolute values, recorded locally (e.g. market prices of livestock and cereals); and other values were drawn from the literature (e.g. herd composition and production indicators). The main source of inaccuracy in the threshold model is the latter set of indicators because basic production information was not available for livestock in Karamoja in early 2018 when the model was developed, and so we used figures from other pastoralist areas of East Africa. In mid-2019, detailed information on herd

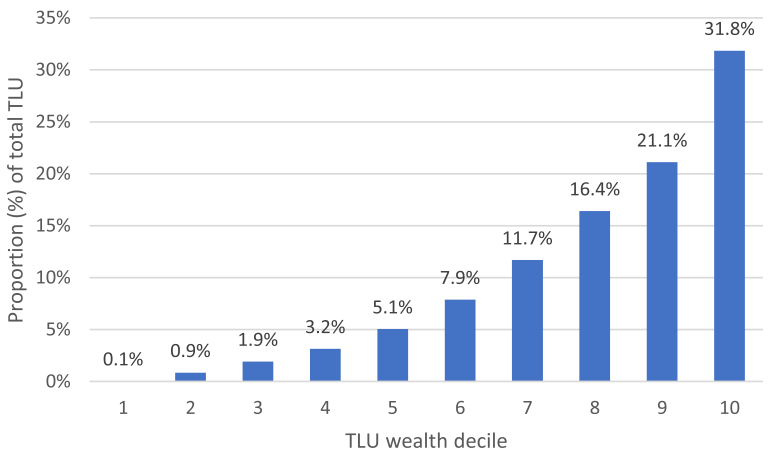

Fig. 1 Total livestock ownership by wealth decile, Karamoja[a], 2017. Notes: $n = 2729$ households. [a]Data derived from the six districts of Amudat, Kaabong, Kotido, Napak, Nakapiripirit, and Moroto covered by the 2017 livestock demographic survey (Schloeder 2018)

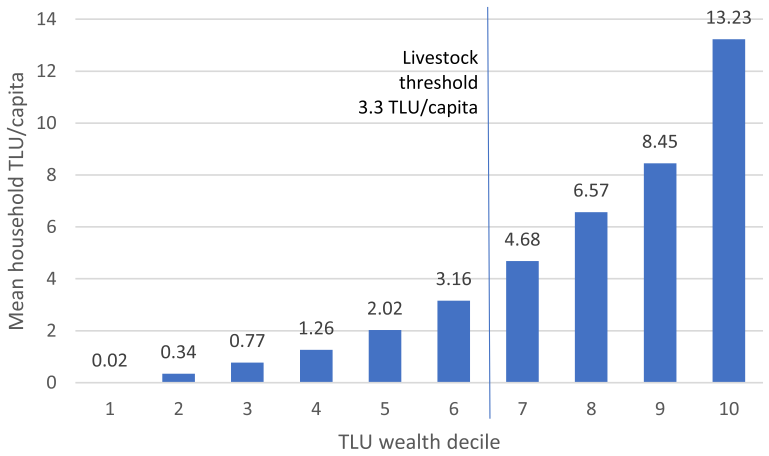

Fig. 2 Livestock ownership (TLU/capita) by wealth decile, Karamoja[a], 2017. Notes: $n = 2729$ households. [a]Data derived from six districts as per Fig. 1

structures and livestock production became available for Karamoja, based on 1200 interviews with livestock owners in five districts (Behnke and Arasio 2019). Therefore, the next stage of our research involves a re-calculation of the livestock threshold using herd data that is specific for Karamoja. A specific livestock threshold for pastoralists (as opposed to agro-pastoralists) can then also be estimated. The 3.3 TLU/capita livestock threshold for Karamoja was consistent with other dryland areas of Africa. For example, modelling by the World Bank suggested that "3–4 TLU/capita are needed for pastoralists to stay above the poverty line." (De Haan 2016).

When applying the livestock threshold to the livestock population estimate, we could not verify the validity of the survey data that was used (Schloeder 2018). Data was collected using a questionnaire, and typically, the use of questionnaires to collect livestock ownership data from pastoralists is subject to various non-sampling errors, including misinterpretation or inconsistent interpretation of the questions asked, or conscious misreporting of animal ownership, especially under-reporting. The risk of under-reporting is likely to be high in situations where populations have long-term experience of development or humanitarian aid and expect aid to continue, when government policies or narratives are critical of pastoralism, or when government actions have had negative impacts on livestock survival. All three of these conditions applied to Karamoja. The survey report discussed some aspects of unreliable data, but only in relation to variables other than the basic herd size and composition.

Overall, there were three main limitations to our use of the survey data. First, the 2017 livestock survey did not collect data on the ownership of donkeys, camels, or poultry, and therefore, the survey under-estimated the total household livestock ownership. Camels were particularly important in Amudat District, which was occupied mainly by Pokot pastoralists. As a large and

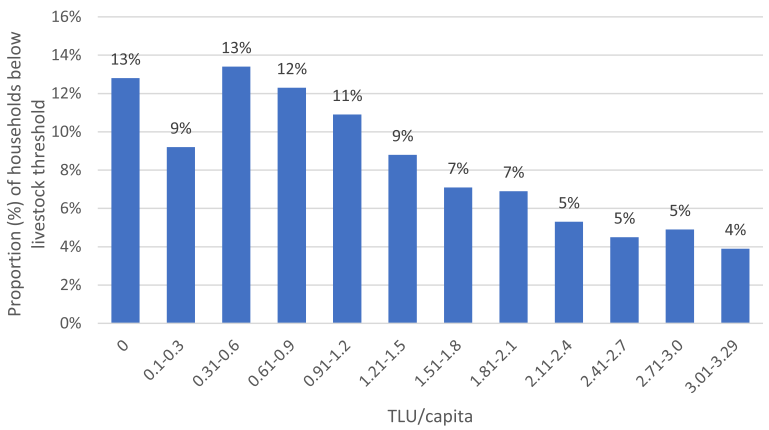

Fig. 3 Livestock ownership in households below the livestock threshold, Karamoja, 2017

valuable livestock species, camels are more likely to be owned by wealthier households. For example, a recent study in Rupa sub-county in Moroto District and Loroo and Amudat sub-counties in Amudat District reported that camels were owned by 45% of households, and these households had above-average income (Salamula et al. 2017). Camels represented 44.7% of herd composition in terms of TLU. The net effect was that the livestock ownership of wealthier households would be understated across the analysis. Donkeys are often an important livestock species kept by pastoralists and are used for transport, e.g. for moving firewood, charcoal, or water; omitting donkeys from the analysis led to an under-estimation of TLU/capita, especially in poorer households. Poultry have a very low TLU value of only 0.01 TLU, and so the ownership of small numbers of poultry will not have much effect on the TLU/capita figures.

For the sake of simplicity, we regarded Amudat District as agro-pastoralist. Also, we did not probe the definition of "household" in the survey, or the possibility that wealthier households might be polygamous, with more household members (e.g. see Levine 2010).

Livestock ownership and poverty

The livestock ownership pattern in agro-pastoralist and pastoralist areas of Karamoja is broadly similar to other pastoralist areas of East Africa where comparable data are available. For example, whereas the wealthiest 30% of the agro-pastoralist and pastoralist population in Karamoja owned 69.3% of livestock (Fig. 1), in 11 different pastoralist ethnic groups in northern Kenya and southern Ethiopia, the wealthiest 30% of households owned 75% of livestock in terms of TLU (McPeak and Little (2017). Similarly, in Afar and Somali regions of Ethiopia, the wealthiest 30% of households owned approximately 75.7% and 71.2% of livestock, respectively (Sabates-Wheeler and Lind 2013).

An assessment of poverty in the Marsabit District of northern Kenya included the use of a 4.5 TLU/capita threshold to define non-poor and poor households (Mburu et al. 2017). The assessment reported that 88.6% of households were livestock-poor, and over 70% were both income- and livestock-poor. Also, a wider study on dryland livestock systems in Africa in 2016 concluded that "given expected population growth of 3% per year for pastoralists and 2.5% per year for agro-pastoralists, assuming the same ownership patterns, and based on a 'business as usual' scenario characterized by a continuation of current policies, 77% of pastoralists and 55% of agro-pastoralists will have less than 50% of the TLU per capita needed to stay above the poverty line by 2030, suggesting they will feel pressure to exit from the sector or face living indefinitely in poverty" (De Haan 2016).

Our findings indicate that although the selected pastoralist areas of Ethiopia, Kenya, and Karamoja have important ecological, economic, and social differences, patterns of livestock ownership by wealth group are broadly similar. In terms of the four categories of livelihood diversification described by McPeak et al. (2012) in northern Kenya and southern Ethiopia, our findings indicate that a substantial proportion of households in Karamoja are "left out" of pastoralism. For these households, other research on employment and wage rates (Iyer and Mosebo 2017), crop production (Cullis 2018), and livelihood diversification more generally in Karamoja (Bushby and Stites 2016) highlight the difficulties of finding sources of income or food beyond those that require substantial effort for minimal returns. Similarly, 65.8% of people were reported to be below a cash income poverty line of USD 1.25/day in 2015 (United Nations Development Programme 2015). Therefore, many households in Karamoja are likely to be both livestock-poor and cash-poor, and this situation has at least two implications. First, as Karamoja's livestock ownership profile is so similar to other dryland areas of East Africa, the effect of the government disarmament programme between 2002 and 2010 could have been both an overall reduction in livestock population and an acceleration of livestock redistribution towards wealthier households. Second, poverty assessments in Karamoja need to measure both livestock ownership and cash income.

The finding that 56.5% of households in the six selected districts fell below the livestock threshold is broadly consistent with the measures of food insecurity and malnutrition in Karamoja. As so many households have too few animals, insufficient access to animal milk would be expected, with direct and negative impacts on the nutrition of children and mothers in particular. Low livestock holdings also force poorer households to rely more heavily on crop production, but in a context where yields are low, e.g. due to rain failures or only cultivating small areas due to labour constraints (Cullis 2018). However, in contrast to food security and nutrition assessment reports of about 45% of households with no livestock (Food and Agriculture Organisation 2016), our finding was that only 13% of households were without any animals (Fig. 3).

As proposed by studies in Kenya and Ethiopia, poverty in pastoralist areas is best understood by measuring both livestock assets and income (McPeak and Little 2017). In part, this is because the limited livestock ownership among poorer households means that they must use non-livestock sources of food income to meet their basic needs. In Karamoja, this is illustrated in our finding that 56.5% of households were below the livestock threshold. These households would be relying heavily on diversified livelihood activities such as crop production (but largely

due to circumstance, not choice), casual labour, and having multiple "small jobs" in towns—including outmigration to find work, agricultural labour, mining, the collection and sale of firewood and charcoal, and other activities (Bushby and Stites 2016). Therefore, a combination of livestock ownership and income measurement not only shows who is poor, but also largely explains why they are poor and the extent to which poverty traps are evident. Plus, a basic comparison of wage rates with food prices and other domestic needs such as school fees indicates the extent to which households are able to save cash, buy assets, or invest in education. Measuring income is also relevant to wealthier households or those "combining" with pastoralism or "moving up". These households will often show positive diversification by investing in local businesses, livestock services and trade, and education.

Livestock poverty and development programmes

Since the 1970s, development programmes in pastoralist areas of East Africa have often recognized the importance of livestock and so have included livestock marketing, veterinary services, fodder production, rangeland management, water development, and similar activities. However, there has also been a general tendency to view pastoralists as universally poor, rather than consider the different aspirations and strategies of different wealth groups. This raises the question of whether livestock programming in Karamoja can shift from area-wide, generic delivery of interventions to a more poverty-focused approach. This would mean focusing not on all of the livestock owners as represented in Figs. 1 and 2, but those at or below the livestock threshold in Fig. 3. For programming to be effective, the specific livelihood strategies and needs of this livestock-poor population need to be far better understood. Our ad hoc observations and conversations in Karamoja indicate that many poorer households aspire to re-build their herds, because they see other wealthier households benefitting from larger herds, and because they recognize the limitations of diversification activities. However, relatively little is known about the strategies that poorer households are using to acquire livestock, how they manage the few animals they currently possess, or how social networks and livestock sharing or gifts assist poorer households or are affected by the skewed pattern of livestock ownership. These are important areas for further research to guide more effective livestock programming. A critical issue is to understand traditional restocking practices and the strategies used by poorer households to build herds.

In terms of asset transfers to pastoralists and agro-pastoralists, there is a long history of restocking projects in East Africa, mainly associated with drought recovery, and more recent regular cash or food transfers under social protection programmes. Restocking has been shown to improve food security and reduce dependency on external support (Lotira 2004; Wekessa 2005), but only when well-designed and implemented. Good design often means complementing, rather than replacing, traditional restocking systems, and so, a good prior understanding of these systems is needed (Livestock Emergency Guidelines and Standards 2009). Effective restocking also depends heavily on strong community participation and flexibility; these aspects are easier to ensure in small-scale, localized approaches compared with large-scale projects. In addition, recipients of livestock under restocking usually require additional support until herds have grown to a sufficient size to produce meaningful amounts of milk and offspring; this support has been mainly in the form of food aid and veterinary care. Typically, more effective restocking projects have provided numbers of animals, especially small ruminants, that are close to the livestock threshold, and so, restocking has a high initial cost per household. For example, to provide a family of six people in Karamoja with 3.3 TLU/capita would cost approximately USD 3700 using 2018 livestock prices. Partly for reasons of cost, restocking projects have tended to be small-scale and involves hundreds of households or less.

In contrast, social protection programmes in pastoralist areas of Ethiopia and Kenya have involved relatively small cash (or food) transfers per household, and the low cost enables these programmes to reach a large number of households. In Kenya, the Hunger Safety Net Programme covers Mandera, Marsabit, Turkana, and Wajir counties, and statistics on average household size and programme coverage indicated that approximately 94% of the population was registered and at least 25% received regular cash transfers (Catley et al. 2016). In Ethiopia, the Productive Safety Net Programme includes the pastoralist Afar and Somali regions, and pastoralist areas of Oromia Region, and aimed to cover over 2.5 million people in these areas between 2008 and 2012. Although these large-scale programmes aimed to improve food security, and build and protect financial assets, mainly livestock, evaluations of these programmes indicate some food security benefits, but limited or no livelihood impacts in terms of livestock assets (Oxford Policy Management/Institute for Development Studies 2012; Kumar and Hoddinott 2015). In part, this relates to the size of the cash transfers in these programmes and the need to maximize the number of beneficiaries against a finite programme budget. This means that the size of the transfers is sufficient to contribute towards food purchases, for example, but not sufficient to enable meaningful purchase of productive financial assets such as livestock.

Conclusions

Poverty in Karamoja can be understood by considering both livestock ownership and cash income, but also, the extent to which poorer households can draw on traditional or changing forms of social support. Livestock programming in Karamoja needs to consider the specific livelihood aspirations of people who currently own few or no animals, the strategies they are using to acquire livestock, and how they manage very small herds against the need to find food and income from non-livestock sources. Area-wide livestock programming needs to change towards more poverty-focused approaches and take account of widely varying livestock ownership across households.

Abbreviation

TLU: Tropical livestock unit

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Authors' contributions

AC designed the study. AC and MA sourced the data, co-analysed the data, and co-interpreted the findings. Both authors read and approved the final manuscript.

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Availability of data and materials

The paper presents all variables and values used in the research. Raw data from a livestock population survey was provided by the organization that conducted the survey.

Declarations

Ethics approval and consent to participate

The research did not involve human subjects.

Consent for publication

The paper contains no individual's personal data.

Competing interests

There are no competing interests.

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