

Changes in Livelihood Aspirations among Formally Educated Pastoral Youth in Northern Kenya

**Roy Van Anda
Brett L. Bruyere
Jonathan Salerno**

Human Dimensions of Natural Resources, Colorado State University

**Alfonso Lengima
Vivian Alinta
Apin Yasin**

Samburu Youth Education Fund, Archer's Post, Samburu, Kenya

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Abstract

Impacts on rangeland health as a result of climate change, land fragmentation, and modernization continues to threaten pastoral livelihoods and ecosystem processes around the world. In response, more and more pastoral youth are enrolled in formal education, with hopes of diversifying their future incomes with non-pastoral employment. As youth spend more time in the classroom and less time herding, perceptions and values of traditional pastoral livelihoods may be changing, which may directly affect local grazing pressures and local rangeland health. Using a game-like scenario methodology, this study measured perceptions and values of traditional pastoral livelihoods and non-traditional contemporary income-earning opportunities among formally educated youth of Samburu, Kenya. Results found all student groups generally aspired to destock their herds and diversify their incomes. Male students showed some tendency to restock following favorable conditions, and students with more years of formal education tended to destock the most. Implications of the findings on the future of pastoralism is discussed, including potential effects on livestock holdings, and the possibility that formal education can lead to changes in rangeland condition.

Keywords: pastoralism, Kenya, Samburu, livelihood diversification, formal education

Introduction

The rangelands of sub-Saharan Africa are a valuable but threatened resource, supporting a variety of wildlife populations alongside pastoral communities that manage herds of sheep, goats, camels, and cattle. Like other pastoral communities around the world, the *Samburu* (italicized refers to *Samburu* as a tribe; non-italicized refers to the geographic location) of northern Kenya face several complex socio-ecological changes: climate change, human population growth, land tenure change, and fragmentation, among others (Reid, Fernández-Giménez, & Galvin, 2014). These factors contribute to the frequency and severity of many challenges, including drought, disease, tribal conflict, human-wildlife conflict, and rangeland degradation, all of which directly threaten the long-term viability of pastoralism in the region (COMESA, 2009; Opiyo, Wasonga, Nyangito, Schilling, & Munang, 2015). Rangeland health in particular has become a focal point for many conservation projects in regions such as Kenya, where 84 percent of the land mass is classified as drylands and some reports estimate that 70 percent of the sub-Saharan African rangelands overall are considered to be moderately to severely degraded (United Nations, 1994; Kimiti, Hodge, Herrick, Beh, & Abbott, 2017).

Mobility has historically been one of the most effective adaptation strategies to sustain pastoral livelihoods. However, pastoralists are increasingly more inclined or even pressured to settle due to large-scale infrastructure (e.g., roads, fences) and land tenure changes (e.g., shifts to private land), as well as recent conservation planning initiatives that can restrict movement. Consequently, pastoralists often must adopt other strategies to meet their needs (Opiyo et al., 2015; Pas, 2018). Income diversification is one such adaptation strategy, which often requires pastoralists to settle, at least temporarily, to pursue wage labor or salaried occupations (Lesorogol, Chowa & Ansong, 2011).

Income diversification is often considered in tandem with formal education, since formal education is thought to help contribute to poverty alleviation by equipping students with skills and knowledge to pursue alternative income sources, whether they be livestock-based or not (Kuria, 2019; Little, Aboud, & Lenachuru, 2009; Maiyo & Ashioya, 2009; Tarabini, 2010). In recognition of this connection, pastoralists in regions such as Samburu enroll their children in formal education now more than ever before (Buchmann, 2000; Bruyere, Kincheloe, Pickering, Heisel, & Lekanta, 2018; Enns & Bersaglio, 2016; Lesorogol, 2003).

The purpose of this study was to determine how formal education may influence perceptions and decisions about future livestock holdings and non-livestock livelihoods among formally educated Samburu youth. Results and the methods used from this project can help influence pastoral adaptation and livelihood diversification practice and research, and be useful to conservation agencies, governments and non-governmental organizations as they determine conservation and development plans.

Literature Review

Income Diversification in Pastoral Communities

For this study, we define income diversification similarly as Little, Smith, Cellarius, Coppock, and Barrett (2001) to mean any non-pastoral income-generating activity, such as wage labor, salaried employment, farming, shop ownership, and gathering and selling of natural materials (e.g., firewood gathering, charcoal burning). Literature has primarily framed income diversification for pastoralists as a risk-reduction strategy during shock events such as drought (Barret, Reardon & Webb, 2001; Little et al., 2001; Opiyo et al., 2015). In many instances, diversification is temporary; pastoralists who lost a significant portion of their herd may seek other income in the short term and eventually return to herding when conditions improve (Opiyo et al., 2015; Scoones, 1998).

Relationship between Formal Education and Income Diversification

Education has a well-established positive influence for obtaining non-pastoral employment (Kuria, 2019; Little et al., 2001; Little et al., 2009; Maiyo & Ashioya, 2009; Rao, Lawson, Raditloaneng, Solomon, & Angula, 2019). Pastoral households with educated heads of household often have larger incomes (Kuria, 2019) and have a foundation for long-term sustained income, which leads to important outcomes such as improved food security (Little et al., 2009). For example, an Ethiopian study by Headey, Taffesse and You (2014) found that education proved to be a more successful long-term poverty alleviation strategy than irrigation and similar agricultural and infrastructure development, as education increased a community's technical capacity and empowerment.

While income alternatives to pastoralism in many areas are more numerous now than in previous years, these opportunities remain relatively limited overall in sub-Saharan Africa (Buchmann, 2000; Bruyere et al., 2018; Lesorogol, 2003). For example, a study in Turkana in northwestern Kenya found that many youth saw the emerging oil industry as a potential alternative to pastoralism. However, there were actually few employment opportunities created by the oil industry, which exacerbated socio-economic differences between a select few individuals and the rest of the community (Enns & Bersaglio, 2016). Further, while new income options are increasing, accessibility to formal education needed for those jobs remains limited for many households, which can contribute to more risk and tribal conflict in some communities, as some individuals prosper economically while others are left behind (Enns & Bersagilo, 2016; Maiyo & Ashioya, 2009).

Regardless of the actual job opportunities from formal schooling, the perceived value of education is generally positive in many pastoral regions, as there is recognition that school also improves a person's knowledge and skills such as social mobility, status and critical thinking, which are important in a variety of roles in life (Buchmann, 2000; Headey et al., 2014; Lesorogol et al., 2011). In a study by Bruyere and colleagues (2018), formally educated individuals ranked all options for a traditional pastoral life as the least desirable, while less educated individuals' responses were more variable, desiring both modern and traditional ways of life. Similar trends in youth aspirations shifting away from pastoralism and towards

education and salaried employment have been found throughout other parts of the world, including India (Dyer, 2001), Mongolia (Ahearn & Bumochir, 2016), China (Iselin, 2011) and South Africa (Rao et al., 2019).

Destocking and Restocking Behavior

As formal education and income diversification become more common in pastoral communities, changes in the ways in which herds are managed has followed (Little et al., 2009). Recent evidence from a study conducted in Samburu suggests that as income diversification increases, herd size decreases. The same study noted that 90 percent of pastoral participants destocked their herd size significantly and added more non-pastoral income sources in the past 20 years (Lenaiyasa, Bruyere, Salerno, & Pickering, 2020). Follow-up interviews from the study found that households that diversified their income did so out of concern for the instability of livestock ownership.

Further, formally educated individuals who have regular non-pastoral income tend to lose a higher percentage of their herd during shock events such as drought, more than their less formally educated peers who lack non-pastoral income (Little et al., 2009). On the other hand, Little and colleagues (2009) also found that in the time period following a drought when livestock prices are low, the same formally educated individuals increased their herds by almost 50 percent more than their less formally educated counterparts (Little et al., 2009). In numerous studies, individuals with formal education were better positioned, via non-pastoral income, to restock following times of market failure, such as during and after drought and disease outbreaks (Headey et al., 2014; Little et al., 2001; Little et al., 2009; McPeak, Little, & Doss, 2011).

Gender, Education, and Livelihood Diversification

In patriarchal pastoral communities like those in East Africa, gender norms play a significant role in how households respond to socio-ecological change. Women are particularly at risk to stressors like drought due to their low economic, political, and social status (Nelson, Meadows, Cannon, Morton, & Martin, 2002; Ongoro & Ogara, 2012; Rao et al., 2019). In pastoral tribes around the world, including *Samburu*, women have responsibilities, such as gathering firewood and water, that directly put their lives at risk as drought and human-wildlife conflict make such tasks more arduous, time-consuming and dangerous. Women are also often dependent on their husbands' livestock and monetary assets to support their role as caretakers for the home and children, leaving women vulnerable as they balance financial dependence with their critical role in maintaining well-being for the household (Nelson et al., 2002; Ongoro & Ogara, 2012; Rao et al., 2019). In response, women in Kenya and elsewhere practice their own income-generating activities such as selling beadwork, poultry keeping, charcoal burning and selling, and small livestock sales (Ongoro & Ogara, 2012; Smith, 2015).

However, women's income diversification options remain limited in Samburu, in part because women are not typically prioritized for formal education (Lesorogol, 2008; Maiyo & Ashioya, 2009). While contemporary views and initiatives prioritize women's education as a way to reduce poverty and promote sustainability (see

Duflo, Dupas, & Kremer, 2015; Lesorogol, 2008; Roudi-Fahimi & Moghadam, 2003; Kuria, 2019), cultural barriers continue to challenge the success of these initiatives, indicated in part by persistently higher school dropout rates by girls (Buchmann, 2000; Lesorogol, 2008; UNESCO, 2003; Roudi-Fahimi & Moghadam, 2003).

Based on prior literature and the needs of the Samburu region, the purpose of this research was to address two important questions: How do formally educated Samburu youth perceive and make decisions about future potential income-earning options, including livestock herding? Further, do their perceptions and decisions differ based on years of formal education and gender?

Study Area

The *Samburu* population is estimated to be around 310,000, nearly evenly split among men and women (Kenya National Bureau of Statistics, 2019), occupying 300km² of mostly semi-arid rangelands located in the Samburu district of North Central Kenya (Figure 1). The region supports numerous megafauna wildlife species that are, in part, the basis of a robust wildlife tourism economy in the area. Rainfall is bimodal, averaging between 200-250 mm annually between March and early June, and November to December, though drought events are increasingly frequent, occurring approximately every five years. Rangelands in this region are considered to be severely degraded with increasing accounts of soil erosion, gully formation and bare ground spread (Kimiti et al., 2017).

Figure 1. Location of Samburu, Kenya



Source: adapted from <https://www.21global.ucsb.edu>

Samburu County is one of the poorest regions in Kenya with 70-75 percent of residents below the national poverty line, estimated to be below USD 30 per adult per month (Kuria, 2019; Njonjo, 2013). Like other pastoral regions, Samburu's

population is skewed toward the young, with children (up to 14 years of age) estimated to be around 43 percent of the population, and those between 15 and 34 an additional 35 percent. Approximately 68 percent of the population have not completed any formal education, 26 percent have completed primary school, and 6 percent have completed secondary or post-secondary school (Njonjo, 2013). The net school enrollment rate in Samburu County is approximately 43 percent of boys and 40 percent of girls actively attending primary school, which is among the lowest rates in Kenya (Mumiukha, Ngugi, Ndiga, & Fedha, 2015).

Pastoralism has been practiced for hundreds of years in the region, with herders tending to goats, sheep, cattle and camels. Historically, young men (called *moran*) were responsible for herding and protecting livestock, oftentimes moving long distances to access healthy rangelands for grazing. Young boys may herd small livestock closer to home prior to joining the *moran* age set and its herding responsibilities. Women and girls traditionally were less involved in herding animals, although it is not unusual for women to tend to smaller livestock kept at the home. Nowadays, with a changing landscape, more land privatization, higher emphasis on school enrollment for children, and more settlements, closer-to-home herding can take a variety of shapes and forms in terms of who is tending to the animals, though traditional nomadic herding still remains the responsibility of *moran*.

This study took place in the community of Archer's Post, located in Samburu County along the Ewaso Ngiro River. Archer's Post is the largest market town and permanent settlement in the Waso Ward of the county, hosting five primary and two secondary education schools. In addition, a number of non-pastoral income opportunities are available, such as small-scale retail/trade, wage labor, and tourism-related services. These activities are becoming more common as the relatively new development of a tarmac highway has increased accessibility to neighboring communities and markets.

Methods

Study Design

We developed an interactive activity that used a game-like approach to collect data. Design of the interactive activity was driven by local input to ensure regional relevance and cultural context, as well as to replicate realistic scenarios. After the first version of the activity was designed, local youth research assistants piloted the activity with participants, resulting in adjustments to improve activity flow and contextual accuracy.

At the beginning of the activity, the two-person teams were provided with the same baseline of assets: 20 goats, two cows, and 10,000 KSH (approximately USD 98), which represented a modest and relatable amount of assets. In addition, teams had the option to purchase tree seedlings, wildlife deterrents and fuel-efficient stoves at the beginning of every round. The activity consisted of 13 rounds in which participants were given opportunities to buy or sell livestock in every round, adopt non-livestock income earning opportunities (e.g., open a small shop, build rooms

for local rentals), pursue post-secondary training, and make adjustments in their type of housing, cooking fuel and similar locally relevant choices. Many choices required students to first acquire the assets to fund their preferences, which often required consideration for whether to retain or sell livestock. Assets could be increased via livestock reproduction (representative of real gestation rates for each livestock type) and other options associated with salaried jobs, one-time project-based work (a common employment opportunity in the region), or investment options (e.g., building a boarding complex with rooms for rent). In addition, in each round students responded to a scenario in which they had to deliberate a course of action, often in response to social or environmental change (e.g., droughts, wildlife conflict, heavy rains). In some instances, the scenario was intentionally trivial (i.e., no bearing on livestock, income or rangelands) and aimed at keeping participants engaged; in other instances, the scenario had a direct impact on livestock, income or rangeland health, and was intended to prompt participants to consider actions that affected their livelihoods. At the end of each round, each teams' livestock holdings, cash assets, and decisions were recorded on a data sheet by the participants to be later collected by research assistants for analysis. Local research team members debriefed with participants about how they felt while playing the game. See Table 1 for a list of scenarios in each round.

Table 1. Scenarios in each round of a livelihood activity by youth in Samburu, Kenya

Round	Scenario
1	Participation in a cultural performance for tourists. Dice roll determines amount of compensation.
2	Livestock loss to predators based on fuel sources (i.e., leaving livestock less attended to gather fuelwood versus prior purchase of fuel-efficient stove)
3	Early signs of drought / Livestock prices decrease / Option to buy/sell
4	Determining livestock loss to predators based on ownership and use of predator deterrents
5	Option to sell numerous livestock at competitive price to commercial buyer
6	Continued signs of drought / Livestock prices decrease further / Option to buy/sell
7	Charitable donation to participants' choice of a community cause. Participants choose between conservation or non-conservation options
8	Rains return / Livestock prices increase / Option to buy/sell
9	Erosion concerns from rains / Extent of erosion determined by dice roll / Situation potentially mitigated by prior purchase of tree seedlings
10	Contribution (amount determined by dice roll) for rangeland restoration efforts
11	Early signs of drought / Livestock prices decrease / Option to buy/sell
12	Option to earn extra one-time income / Participants choose between conservation or non-conservation options
13	End of activity / No scenario

Sample

Using a convenience sampling approach, local members of the research team recruited participants from all four levels of secondary school (i.e., Forms 1 through 4), upper levels of primary school (i.e., Standards 6 through 8) and secondary school graduates. Participants' age was not a consideration; *Samburu* more commonly identify with an age set (an approximately ~15-year time period) rather than a specific age number, so the latter is not reliable information when asked. In our convenience sampling approach, idle students were asked by local members of our team if they would be interested in participating in an activity about pastoral and non-pastoral options for the future. The activity took place in common spaces such as local eateries and community centers to provide easy access and to conduct the activity in a setting familiar to participants.

Participants were paired into teams of two individuals based on the same gender and grade levels. Two teams played the activity simultaneously, although the activity itself was not a competition between the two teams, and there was no incentive or reward contingent on how one team performed compared to the other. The rationale for teams was due to the collaborative decision-making style that is common among tribes in the region—rarely are decisions made individually (Lesorogol & Boone, 2016)—and to establish a more engaging research environment for participants by participating with their peers. The activity was played 39 times for a total of 78 teams (156 total youth), averaging between 90 and 120 minutes per activity.

Analysis

We entered data into the Statistical Program for the Social Sciences (SPSS) for statistical analysis. Statistics included descriptive aggregate statistics, pre/post comparisons of assets at various points during the activity (including beginning and end), and group comparisons based on gender (t-tests) and years of formal education (ANOVA). In addition, linear regression analyses were run to determine predictive strength of years of education on livestock and cash assets. Livestock holdings were calculated based on tropical livestock units (TLUs) following Lenaiyasa et al.'s (2020) approach in the same region: one TLU was the equivalent of 1.0 cows, 0.7 camels and 12.0 goats/sheep. Statistical significance was set at the $p < 0.05$ level.

Methodological Rationale

The interactive activity was developed as a way to measure the preference of various livestock and non-livestock opportunities by *Samburu* students. This approach was selected for multiple reasons. First, some members of the research team represented demographics historically associated with power, and we wanted a method which relegated those members' roles to mostly being observers. Second, the activity had more potential than traditional methods (e.g., focus groups, surveys) to engage our participants with the research, through discussion and collaborative decision-making, which could further help minimize the effect of the researcher-participant differences (Franks, 2011; Riet, 2009). Finally, the activity provided opportunities to contribute to student learning; it required teams to analyze options, consider tradeoffs, calculate gains and/or losses, and other

cognitive activities. This helped ensure that participation itself provided benefit to the youth, an important ethical consideration to our research team regarding reciprocity.

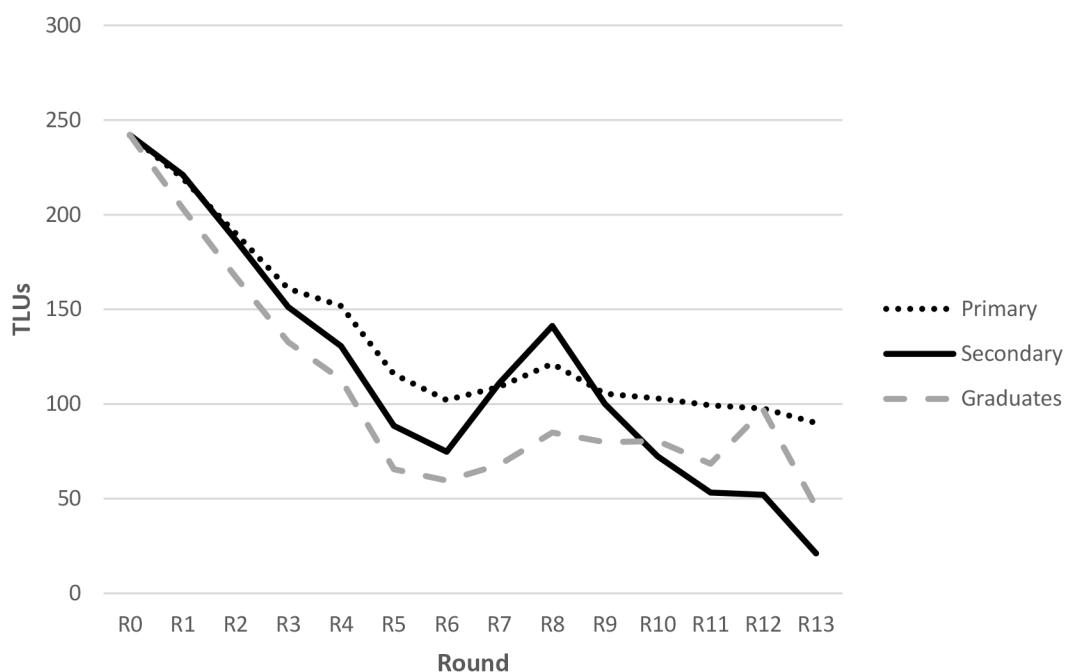
Results

Of the 78 teams, 26 were enrolled in primary school (13 male teams, 13 female teams), 28 in secondary school (17 male teams, 11 female teams), and 24 teams were secondary school graduates (12 male and 12 female teams; Table 2).

Table 2. Characteristics of 78 participant teams

Education Level of Team	Male Teams	Female Teams	Total
Upper primary school	13 (16.6%)	13 (16.6%)	26 (33.3%)
Secondary school	17 (21.8%)	11 (14.1%)	28 (35.9%)
Graduate of secondary school	12 (15.4%)	12 (15.4%)	24 (30.8%)
Totals	42 (53.8%)	36 (46.2%)	78 (100%)

All teams started with 242 livestock TLUs, and average TLUs decreased every round during the activity except twice (Figure 2). Within the first two rounds, in which there was no introduced scenario that affected livestock prices, mean TLU totals were reduced by an average of 60.65. Following round 5, the mean TLU was 161.21 compared to the 242.00 TLU starting point. Total TLUs increased only at the end of rounds 7 (from 78.79 to 96.05) and 8 (from 96.05 to 115.81), following a scenario of improved rangelands condition due to rain.

Figure 2. Total livestock units by the three cohorts of students

One-way ANOVA results of TLUs between primary, secondary, and graduate level students were significantly different ($p < 0.05$) in round 5 ($p < 0.04$), round 6 ($p < 0.04$) and round 13 ($p < 0.01$; see Table 2). Primary school teams, on average, had more TLUs on-hand at the end of every round, apart from round 8. Moderate restocking occurred across all groups in rounds 7 and 8 (overall TLU average increase of $\bar{x}=38.46$ by round 8; see Table 3) following a drought scenario when livestock value reached its lowest point.

Table 3. Average total livestock units for entire sample at key points in the activity*

Activity Round	Mean	SD	Primary	Secondary	Graduates	f-ratio	p-value
TLUs at start	242	n/a	242	242	242	n/a	n/a
End of Round 1	214.45	50.61	219.12	220.97	203.27	0.99	0.38
End of Round 2	181.35	64.41	190.15	186.70	167.19	0.97	0.38
End of Round 3	148.24	72.73	160.87	151.20	132.65	1.01	0.37
End of Round 4	131.76	75.91	151.75	130.54	112.99	1.73	0.18
End of Round 5	89.93	73.76	115.80 ^a	88.47 ^{a,b}	65.53 ^b	3.19	0.05
End of Round 6	78.79	62.61	102.07 ^a	74.73 ^{a,b}	59.56 ^b	3.26	0.04
End of Round 7	96.05	81.93	109.13	111.14	67.89	2.46	0.09
End of Round 8	115.81	98.31	121.28	141.21	84.95	2.40	0.10
End of Round 9	95.11	86.81	105.44	100.01	79.88	.63	0.54
End of Round 10	85.22	72.80	102.95	72.28	80.44	1.31	0.28
End of Round 11	73.64	72.50	99.25	53.26	68.42	3.01	0.06
End of Round 12	82.15	106.65	97.57	52.02	96.84	1.74	0.18
End of Round 13	52.26	62.53	90.00 ^a	21.10 ^b	45.70 ^b	10.62	< 0.01

* different subscripts indicate significant ($p < 0.05$) group differences

Linear regression analysis found years of formal education to be a significant predictor of TLUs at round 5 (adjusted $R^2 = 0.08\%$; $p = 0.05$; see Table 4 and Figure 2) and round 13 (adjusted $R^2 = 20.2\%$; $p < 0.01$; see Table 5 and Figure 2). With each additional year of formal education, the TLU value is predicted to decrease by 0.30 in round 5 and 0.46 in round 13.

Table 4. Regression analysis to determine effect of years of education on total livestock units at end of round 5

	Standardized regression coefficient (β)	T	Sig.	F	Adjusted R^2
Independent variable		4.48	<.01	6.013	0.08
Years of education	-0.30	-2.45	< .01		

Dependent variable = Livestock units at end of round 5

Table 5. Regression analysis to determine effect of years of education on total livestock units at end of activity (round 13)

	Standardized regression coefficient (β)	T	Sig.	F	Adjusted R^2
Independent variable		5.60	<0.01	16.69	0.20
Years of education	-0.46	4.09	< 0.01		

Dependent variable = Livestock units at end of activity

In terms of gender, no significant difference in TLU values was found between male and female teams except for rounds 8 ($p = 0.02$) and 10 ($p = 0.03$; see Table 6). In round 8, on average, male teams restocked more (average TLU increase of $\bar{x} = 59.58$) than females (average TLU increase of $\bar{x} = 15.32$).

Table 6. Average total livestock units (TLU) for male and female teams in all rounds

Round	Group		t-value	p-value
	Mean (\bar{x}) TLU for male teams	Mean (\bar{x}) TLU for female teams		
End of Round 1	218.31	209.28	-0.77	0.44
End of Round 2	180.57	180.47	0.01	0.10
End of Round 3	147.02	150.67	-0.21	0.83
End of Round 4	132.52	131.00	-0.09	0.93
End of Round 5	90.86	84.32	0.39	0.70
End of Round 6	79.99	73.00	0.49	0.63
End of Round 7	105.68	81.72	0.19	0.88
End of Round 8	139.57	88.31	2.35	0.02
End of Round 9	111.34	78.90	0.10	0.36
End of Round 10	81.01	87.79	0.69	0.03
End of Round 11	68.58	78.44	0.46	0.09
End of Round 12	86.45	75.88	0.43	0.67
End of Round 13	48.12	58.75	0.46	0.14

Discussion

Destocking

The results indicate that students across all education levels and genders generally chose to destock from the very beginning, a goal that remained consistent throughout most of the activity. The desire to attain non-pastoral income sources was stronger than the desire to accumulate livestock, indicating a potential value shift away from traditional pastoral livelihoods and toward more diversified incomes. Exposure to alternative income-earning options via the classroom has likely impacted the students' perceptions; primary schools in our study site are typically located in settlements and near market centers, providing direct exposure to alternative livelihoods and lifestyles in those locations. Students also participate in field trips that facilitate exposure to other regions and communities that represent contemporary lifestyles. In addition, peer observation of others who have gone to school and media exposure further showcase aspects of a non-pastoral life that are likely influencing how students think and feel about their future.

Students' destocking behavior and interest in non-pastoral income sources coincides with previous research findings in this community. Both Lenaiyasa et al. (2020) and Bruyere et al. (2018) have pointed to increased interest and practice of non-pastoral livelihoods among youth in general, a finding that was stronger for those with formal education. Our study is consistent with these results, and also parallels evidence of similar shifting values and perceptions of livelihoods among youth in other pastoral communities around the world (see Ahearn & Bumochir, 2016; Dyer, 2001; Iselin, 2011; Rao et al., 2019).

Difference by Education Level

Results from the regression analyses and group comparisons showed that as individuals complete more formal education, they are more likely to prefer smaller herds of livestock and pursue non-livestock livelihoods. For example, in the first nine rounds of the activity, teams with the most formal education (i.e., secondary school graduates) consistently had fewer TLUs than their primary and secondary school peers. Secondary school graduates also took greater advantage of a fluctuating livestock market by selling more livestock when market prices were high. By the end of the activity, however, graduates and students currently in secondary school were similar in their TLUs, while primary school students owned more livestock than both groups, on average.

This pattern can be at least partially explained by different levels of exposure to alternative livelihoods as well as higher-level critical thinking, as individuals attain more skills and exposure with additional years of school. Secondary students typically attend school outside of their home community of Archer's Post, often in much bigger cities and towns, while primary students remain at home where there is less diversity of livelihoods. The cross-cultural and cross-community interaction facilitated by secondary school enrollment appears to play at least a partial role in impacting students' perceptions of their future livelihoods. These experiences are more numerous as students proceed through, and eventually complete, secondary school, and thus our graduated participants destocked at the highest rates.

Results from Lenaiyasa et al. (2020) pointed to similar findings about education's influence on interest in livestock herding. In their study, *moran*, who typically have little to no formal education, were found to have higher interest in livestock-based activities than their counterparts who attended school. Our results indicated that as an individual received more education, they were more likely to be involved in buying and selling livestock, particularly in response to market forces, and ultimately ending up with a much smaller herd than that which they started. This is a notable finding; pastoral participation in actively buying and selling livestock has often been minimal in the past (Schilling, Opiyo, & Scheffran, 2012), and increased buying and selling may positively affect drought adaptation (Opiyo et al., 2015). Those with larger herds may be more likely to actively participate in livestock trading (Rutto, Odhiambo, Njuguna, & Murithi, 2013), but as individuals receive more formal education and diversify their income, the size of one's herd can affect individuals in different ways; some may choose to invest in more livestock—in particular, higher-value livestock such as cows and camels—while others may shift away from livestock altogether.

Restocking

Average TLUs increased only following a second drought scenario, when livestock prices reached their lowest point. Livestock holdings began to drop again shortly thereafter, after market prices returned to the original value, indicating motivations to buy and sell were based on a mix of factors related to market forces (buying at low prices) and non-livestock aspirations (sell at high prices to afford start-up of a non-livestock income option). Overall, the objective for most teams appeared to be to maintain a small number of livestock while acquiring and saving cash to engage

in non-pastoral income sources and taking advantage of “buy low” opportunities when they arose.

Participants’ buy/sell responses to scenarios that influence livestock prices act as a risk mitigation strategy, by adjusting herd size in times of resource scarcity (e.g., drought), resource abundance (e.g., rainfall) and market opportunities (e.g., opportunity for large-scale livestock purchase by an outside entity). In this way, income diversification may support pastoral livelihoods, particularly during times of drought and similar challenges, as the literature suggests (Opiyo et al., 2015; Scoones, 1998). However, the interest in pastoralism has seemed to decrease overall, as interest in alternative income sources increases and social values shift away from the accumulation of livestock to the accumulation of modern currency. The motivation to diversify among our participants, regardless of the level of education and gender, is possibly associated more with opportunities that are perceived as more desirable, rather than to mitigate the risk of herding. Lenaiyasa et al. (2020) found similar results, as those who diversified their income did so not only to avoid risk associated with herding, but because they preferred to pursue jobs and alternatives they learned about in school.

Gender Comparison

Males and females destocked throughout the activity at similar rates. However, male teams reacted to market price fluctuations (i.e., buying and selling) more than females, such as restocking more when livestock prices bottomed out. This difference may be rooted in the tradition of pastoralism, which is historically practiced by males, and their social status, in which herd size is one indicator of standing in a community. Females, on the other hand, may have a greater interest in non-pastoral activities, for a variety of reasons. One, females in this region are more responsible for livelihood diversification of their household (including non-pastoral income generation; see Walker et al., 2021). This also coincides with findings from Ongoro and Ogara (2012) and Smith (2015) in which women were the primary livelihood diversifiers of their households, while men remained primarily interested in herding activities, despite the risk. Second, while women do participate in some herding activity in the region, they may give more consideration than men to non-livestock income options, given that such options are accessible to them and oftentimes more stable sources of income than livestock. Finally, women earning their own income can lead to enhanced autonomy, decision-making and stature in her community, and the options for doing so are more abundant in the non-livestock sector.

Conservation Implications

Rangeland degradation is among the highest primary concerns in Samburu, as rangelands provide the base support for pastoralism, wildlife (and wildlife-based tourism in the region), and overall ecosystem services and processes (Kimiti et al., 2017). Rangeland near permanent settlements tends to be more severely degraded, driven by herders maintaining similar-sized herds of livestock but keeping them closer to home, as well as climate change and drought. In response, non-governmental organizations and conservancies have developed and adapted various grazing management plans in consideration of both wildlife and

human/livestock populations. These organizations might also consider investing in youth education as an avenue that can positively influence grazing pressures in the future, as individuals with more formal education may be more willing to change the composition and size of their herds to mitigate risk and influence rangeland condition. In fact, many community-based organizations focused on conservation in the region provide educational support already.

The cultural value of livestock remains strong among pastoral tribes in Samburu. In our study, TLUs decreased but never reached zero. Pastoralism will continue given its long tradition, but herd sizes or the composition of herds might change as levels of formal education enrollment and non-livestock employment increase, affecting rangeland health in some way depending on the changes and how they are managed. For example, cattle can have positive or negative effects on rangelands depending on other environmental conditions (Kimuyu et al., 2017), and goat herding often needs a management regime to ensure rangelands are not overly degraded (García, García & Osoro, 2012). An investment in education can also build greater local capacity to solve complex issues relevant to the region, including overgrazing, tribal conflict, and persistent poverty. Education is therefore not only a direct benefit to the student and their household, but beneficial to the wider social-ecological system.

Recommendations

Samburu County of northern Kenya is an impoverished region with significant socio-ecological challenges that can exacerbate rangeland degradation. Formal education can contribute to poverty alleviation, food security, and potentially alleviate grazing pressures on local rangelands. While enrollment in formal education is increasing, completion rates remain significantly low as the cost of education (e.g., tuition, uniforms, and school materials) remains high and the opportunity to earn a sufficient income is unstable. To reap the socio-economic and environmental benefits of education, public and non-governmental entities need to not only prioritize educational access but also persistent enrollment, particularly for women, as they face significant risks that contribute to high dropout rates. Further, emphasis needs to be placed on developing opportunities for non-pastoral employment, particularly occupations that can be fulfilled by women as they continue to demonstrate a strong desire and ability to diversify their income and improve the resilience and adaptive capacity of their households as a result.

Limitations

Young women in this region typically have less time availability, as they bear a substantial portion of the household labor burden; this led to an unequal male/female participant balance in our study. While the difference was relatively minor (46.2% versus 53.8%), there may be characteristics or preferences within our female sample that are more telling of the young women who were actually available to participate than those who were not. Similarly, sample sizes across education levels were unequal as both the participants and the research team faced time constraints, specifically secondary school graduates and secondary students who are more likely to be out of town to attend school or jobs. In addition, there was not a control group that included youth with little or no formal education, which

would enable us to better determine the influence of education. Finally, two of the authors of this study were affiliated with a conservation academic department at a university in the United States, and although they were committed to structure the research team in a way to distribute decision-making and influence across all members, they represented demographics associated with power and historic marginalization in this region of Kenya.

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Roy Van Anda, M.S., completed his Master's degree in the Human Dimensions of Natural Resources Department at Colorado State University.

(roy.van_anda@rams.colostate.edu)

Brett L. Bruyere, Ph.D. is an associate professor in the Human Dimensions of Natural Resources Department at Colorado State University.

(brett.bruyere@colostate.edu)

Jonathan Salerno, Ph.D. is an assistant professor in the Human Dimensions of Natural Resources Department at Colorado State University.

(jonathan.salerno@colostate.edu)

Alfonso Lengima served as a research assistant with the Samburu Youth Education Fund in Samburu, Kenya. (samburu@samburuyouth.org)

Vivian Alinta is a program coordinator at the Samburu Youth Education Fund in Samburu, Kenya. (vivianalinta.syef@gmail.com)

Apin Yasin is a program director at the Samburu Youth Education Fund in Samburu, Kenya. (mailto:myasinapin.syef@gmail.com)

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