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Building pastoralists' resilience to shocks for sustainable disaster risk mitigation: Lessons from West Pokot County, Kenya

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ABSTRACT

Most pastoralists' in Sub Saharan Africa (SSA) are adversely affected by climate-change related shocks such as droughts and livestock diseases. These shocks lead to deterioration of livestock quality and even mass death of herds. This leaves pastoralists vulnerable as they derive most of their food and income needs from livestock, necessitating emergency disaster response and the need to build their long-term adaptive capacity. In most cases however, investments only focus on reducing risks and not on building long-term adaptation strategies. In this study, we analyzed factors affecting household resilience among the pastoralists of West Pokot County in Kenya. A focus group discussion and key informant consultations were held to understand community perspectives on the historical nature of climate-change related shocks. In additional, individual household surveys were done with 191 randomly selected households to obtain information on the shocks experienced by pastoralists, coping strategies, long term adaptation strategies and external support, their uptake of these and the effect on their resilience. The household resilience index was constructed using Principal Component Analysis (PCA). An ordered probit regression was used to analyze the effect of socio-demographic, institutional factors and adaptive practices on households' resilience. It was noted that years of formal schooling, household income, access to credit and extension and adaptive practices such as post harvest use of field crops for grazing, enclosures, stocking improved breeds, bee keeping, ethno-veterinary practices and afforestation have a positive and significant effect in building household resilience to shocks. There is therefore a need to direct investment to bolster pastoralists' own efforts towards building their resilience.

1. Introduction

More than one-third of the land surface on earth lies within the Arid and Semi-Arid Lands (ASALs) [3]. Pastoralism is the main livelihood activity in most ASALs of Sub Saharan African (SSA) countries [10,14]. The livestock reared enable pastoralists to meet their food and income needs [2]. Pastoralism depends heavily on natural resources for pasture, grazing and transhumance. Natural resources in the ASALs have been declining due to population growth. This has led to human encroachment into grazing lands and land degradation [19]. The bleak situation is worsened by the negative effects of climate-change induced shocks such as droughts. With limited access to water and pasture, many pastoralists lose part of their herds during drought periods [12,28]. Loss of livestock, which is the main source of food and income, plunges households down the vulnerability path and consequently, it may take the household a long time to recover and 'bounce back' to normal *ex ante* conditions.

Pastoralists are affected the most when shocks such as droughts strike compared to other livelihoods [1,18,21,25]. This is because water and pasture become scarce during drought. This results in low milk and meat productivity, which are the main components of pastoralists' diet, leading to food insecurity [21]. Livestock quality deteriorates and in the event of prolonged droughts, the livestock die. Shiferaw et al. [22] observed that the huge losses caused by droughts in SSA threaten to undermine the gains made in economic, social and environmental development in the region in the last few decades. For instance, in Kenya ASALs, it is estimated that over 25% of cattle population is lost during droughts due to pasture and water scarcity [20]. Kenya has had 28

Abbreviations: ASALs, Arid and Semi-Arid Lands; CIDP, County Integrated Development Plan; CTA, Technical Centre for Agricultural and Rural Cooperation; FAO, Food and Agriculture Organization of the United Nations; IIRR, International Institute for Rural Reconstruction; RIMA, Resilience Index Measurement and Analysis; SSA, Sub-Saharan Africa; WISP, World Initiative for Sustainable Pastoralism; NDMA, National Drought Management Authority

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droughts over the last 100 years with the last 20 occurring in the last 50 years. This leaves at least 3 million people, the majority of who are pastoralists, in need of emergency aid [28]. Mostly, however, investments in the ASALs only focus on reducing risks when disaster strikes and not in building long term adaptation.

Concerted efforts are needed to help strengthen pastoralists' adaptive capacity to shocks. Udmale et al. [26] stresses the importance of strengthening local level adaptation as a key step in managing droughts. Building pastoralists' coping strategies, adaptive capacity and resilience to shocks has considerable potential for sustainable development [10]. Coping strategies are important in the recovery process after a shock as it may either help a household escape the poverty trap or fall even deeper into destitution and misery [5].

Over the years, the extent and impacts of droughts have widened in the SSA region, thus raising concerns on the effectiveness of the existing adaptation strategies. Kenya is a signatory to global agreements and frameworks towards building resilience to risk posed by drought. These include Sustainable Development Goals (SDG goal 13), United Nations Framework Convention on Climate Change (UNFCCC), Paris Agreement and Sendai Framework on Disaster Risk Reduction. At the national level, Kenya has put in place legislations and relevant institutions to deal with disasters and emergencies. The National Drought Management Authority (NDMA) coordinates all activities related to drought management. There is also Kenya's Vision 2030 and the Big 4 Agenda, which outline various measures for sustainable development. Despite these policy and legislative frameworks, occurrences of drought still result in emergency situations, especially in the ASAL counties, and a lot of investment goes towards handling the crises rather than in developing appropriate preventive measures.

Strengthening people's adaptive capacity is more cost-effective and stabilizes livelihoods more than humanitarian emergency response [23]. This enables them to anticipate, absorb, adapt to, and recover from the effects of shocks in a manner which protects livelihoods, accelerates and sustains recovery and supports economic and social development and transformation [10].

The County government of West Pokot together with other partners have put in place interventions aimed at building pastoralists' resilience. However, pastoralists' uptake of these interventions and their contribution to overall resilience has not been empirically studied. There is therefore a need to understand the kind of interventions that work in the pastoralists' context and the extent to which they contribute to people's livelihood resilience so as to guide investments in such initiatives. In order to address the aforementioned challenge, this study assessed how pastoralists in West Pokot in Kenya cope with shocks and build their adaptive capacity.

2. Materials and methods

2.1. Study area

The study was carried out in West Pokot County, Kenya (Fig. 1). It covers an area of 9169.4 km^2 with an estimated population of about 600,000 persons according to the most recent national census of 2009. Pastoralism, in form of agro-pastoralism and nomadic pastoralism supports over 90% of the county's population County Government of West Pokot [7].

2.2. Sampling and data collection

A two-stage sampling procedure was employed. In the first stage, sampling was purposively done to capture the arid and semi-arid locations for a livelihood comparison between two areas within West Pokot, Kenya. In the second stage, villages and households within the locations were randomly selected. A total of 19 sub-locations; 10 in the arid areas and 9 in the semi-arid areas were studied across the locations. Data was collected on household socio-demographic characteristics, exposure to shocks, coping mechanisms and adaptation strategies using a combination of methods namely; a focus group discussion (FGD), key informant consultations and individual household survey. Participants of the FGD were pastoralists with over 20 years experience who provided information on the changes and challenges the community has been undergoing. Youth pastoralists (7) and an officer from the county extension department were also included in the FGD. Semi-structured checklists and questionnaire were used to conduct the FGD, key informant interviews and individual household survey. Of the 22 participants in the FGD, 6 were women. The FGD and key informant consultations provided insights on the current and historical trends on shocks, coping strategies and adaptive practices. Household survey data was collected from 191 randomly selected respondents. The data collection was done from December 2016 to February 2017. Data was collected through face-to-face interviews using semi-structured questionnaires.

Only household heads or their spouses or household members over 18 years old who had lived in the household for at least 1 year and were familiar with the daily household activities were interviewed during the survey.

3. Calculations

3.1. Data analysis

This study adopted the Food and Agriculture Organization's (FAO) Resilience Index Measurement and Analysis (RIMA) framework in the analysis. The RIMA framework explains the interaction between shocks and their effects on households, with resilience accounting for the difference in outcomes between two similar households exposed to the same shock [11]. The framework best describes how resilience can be quantitatively measured in the context of pastoralist participation in the various opportunities considered in this analysis. This participation has an impact on their livelihood and the overall resilience to shocks.

Following the RIMA approach, resilience was measured in terms of income and food access (IFA), assets - Agricultural and non-Agricultural Assets (ANA), access to basic services (ABS), agricultural production technology (APT), social safety nets (SSN), economic activity (EC) and adaptive capacity (AC). This can be expressed as:

$$R = f(IFA, ABS, ANA, APT, SSN, EC, AC) \quad (1)$$

Principal Component Analysis (PCA) method was used to generate resilience indices of each household. The PCA method is a common tool used by previous studies to generate the weights for the variables used in resilience index construction [4,13,21,25]. The chosen variables should conform to the assumptions of PCA that variables should have at least an interval level of measurement and should be linearly related to one another. The Bartlett's test of sphericity and Kaiser-Meyer Olkin (KMO) measure of sampling adequacy were used to test the variables' suitability for PCA. The scores generated from PCA were used to determine the indicator weights for the variables. Once the indicator weights have been estimated and the index of resilience constructed, the index is applied to the individual households and a score for each household is calculated using the formula below:

$$A_j = f_1 x(a_{j1} - a_1)/(s_1) + \ldots + f_N x(a_{jN} - a_N)/(s_N) \quad (2)$$

where A_j is the resilience score for household j, f_1 is the component loading generated by PCA for the first variable, a_{j1} is the j^{th} household's value for the first variable, and a_1 and s_1 are the mean and standard deviation, respectively, of the first variable over all the households [4].

This can be summarized as:

$$R = \sum_j w_j F_j \quad (3)$$

where the resilience index is a weighted sum of the factors.

To assess the factors that affect household resilience, an ordered

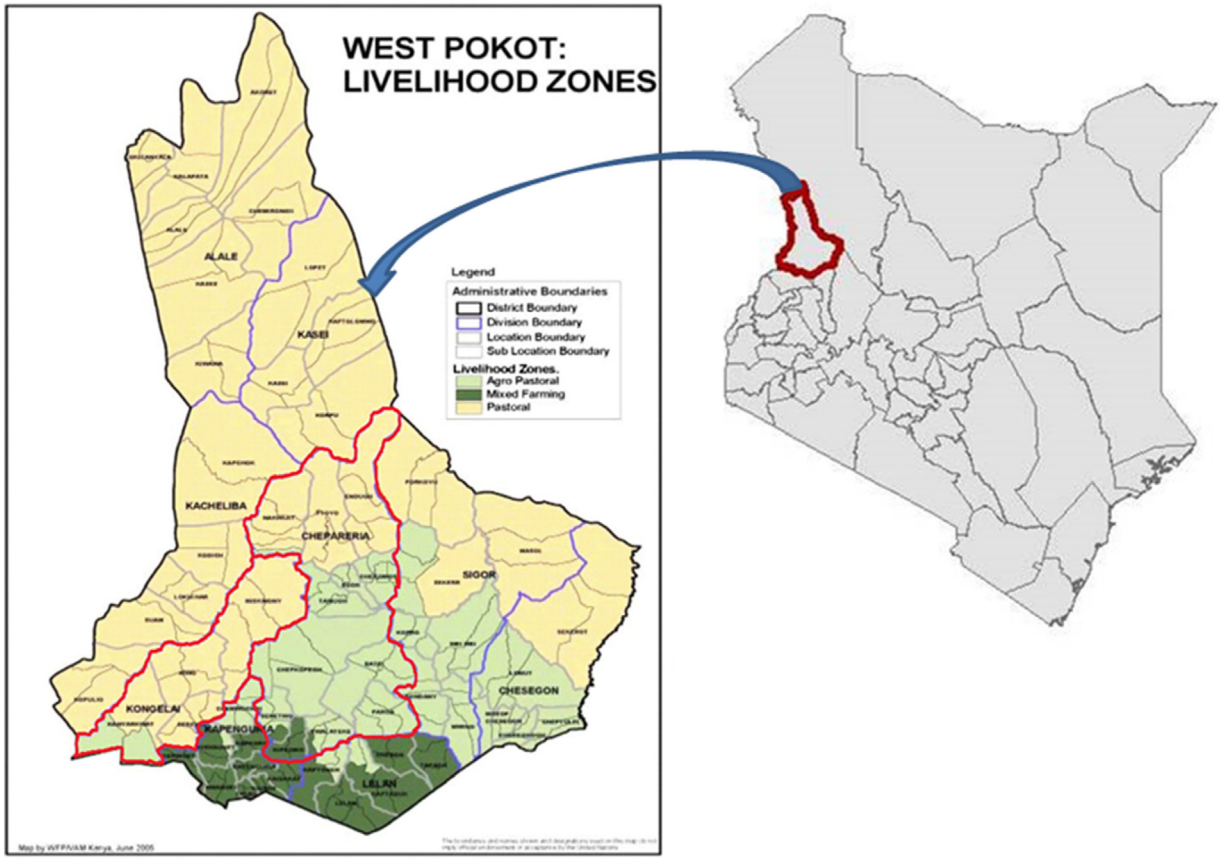

Fig. 1. Map of West Pokot County showing different livelihood zones.
Source: County Integrated Development Plan (2013).

Table 1
Sample characteristics.
Source: Household Survey Data (2017).

Variable	*Data category*		
	Arid area n = 104	*Semi-arid area n = 87*	*Pooled sample n = 191*
Average age (years)	45.7	47.0	46.2 (10.88)
Gender of respondents (percentage male respondents)	80.0	83.0	82.0
Average number of years of completed formal education	3.9	6.4	5.0 (4.3)
Average dependency ratio	0.60	0.55	0.58 (0.008)
Average per capita annual income (Kshs)*	16,109.0	23,093.0	19,290.4 (17,033.23)
Average Tropical Livestock Units (TLUs)	15.8	8.5	12.5 (10.43)
Ownership of title deed for the land used			
Households accessing communally owned pasture grounds (% yes)	89.0	9.0	52.0
Planned transhumant migration (% yes)	82.0	10.0	71.0
Average transhumance distance (kilometers)	29.1	5.5	18.4 (15.4)
Average distance to the nearest water source	2.3	1.4	1.9 (0.11)
Average distance to the market	6.2	5.1	5.7 (0.29)
Access to credit (% yes)	49.0	68.0	58.0
Access to extension services (% yes)	52.0	68.0	60.0
Households receiving social support (% yes)	97.0	94.0	95.0
Households participating in governance institutions (% yes)	64.0	78.0	70.0
Households participating in vaccination campaigns (% yes)	60.0	76.0	67.0
Households established enclosures on land (% yes)	30.0	92.0	58.0
Households stocking improved livestock breeds (% yes)	4.0	48.0	24.0
Households adopting camel in their herds (% yes)	10.0	0.0	5.0
Households adopting bee keeping (% yes)	34.0	9.0	22.5
Households growing fodder (% yes)	5.0	42.0	22.0
Households planting drought tolerant crop varieties (% yes)	49.0	50.0	49.0
Households adopting agro forestry (% yes)	16.0	49.0	31.0

* Kshs 103 were equivalent to 1USD$ at the time of survey.

probit with three levels of resilience (1 being least and 3 most resilient) was employed after the indices were computed.

The ordered probit is derived from the latent variable model specified as follows:

$$y^* = \beta_1 + \beta_2 x_2 + \ldots \beta_k x_k + \epsilon \quad (4)$$

For generalization and simplicity of mathematical notations, Eq. (4) can be reduced to Eq. (5) below:

$$= x_i\beta + \epsilon \quad (5)$$

where ϵ is an error term, which follows standard normal distribution, with a normalized variance equal to one.

$$\epsilon N(0, 1) \quad (6)$$

The model defines *j* threshold parameters, α whereby $\alpha_1 < \alpha_2 < \ldots\ldots \alpha_j$

The latent variable y* is not observable but we can observe the resilience categories according to the following:

$$y = 1 \text{ if } \alpha_1 < y^* \leq \alpha_2$$

$$y = 2 \text{ if } \alpha_2 < y^* \leq \alpha_3$$

$$y = J \text{ if } \alpha_j < y^* \quad (7)$$

4. Results and discussion

4.1. Socio-economic characteristics of the respondents

Table 1 below shows the socio-economic characteristics of the respondents. Most respondents were men above 40 years old. The average number of years of schooling was 5 years. This implies low endowment in formally trained human capital. The dependency ratio measures the ratio of economically active people to the total household population. The dependency ratio in the sampled population was 0.58. The household average annual per capita income is slightly over Kshs 19,000. On average, this translates to Kshs 53 per day, which is approximately half a dollar.

Over 80% of the respondents from arid areas and about 10% in the semi-arid regions move their animals to communally shared pasture grounds in times of pasture scarcity. This shows that pastoralism is more sedentary in the semi-arid areas but transhumance is still important in the arid areas. The proximity of a household to basic services has an effect on its resilience. In this study, distance to the households' water sources, markets and health facility was considered.

The county government of West Pokot together with other partners (FAO, VI agroforestry together with Triple L project) have invested in programmes promoting agro forestry, bee keeping, camel rearing, livestock vaccination, improved livestock breeds and establishing enclosures on grazing land and planting fodder trees to help rehabilitate degraded landscapes. These activities present opportunities for improving farm productivity and enabling households to build their resilience.

4.2. Vulnerability to shocks and effects on livelihoods

Fig. 2 below shows pastoralists' vulnerability to shocks in the order of their severity.

Drought and livestock diseases are ranked as the most severe shocks by most households. About 50% of the respondents were affected by market shocks due to price fluctuations of livestock and basic food stuffs such as maize. Agro-pastoralists' had incidences of crop loss due to erratic rains and crop pests and diseases. About 30% of the respondents were affected by conflicts with the neighboring communities over water and pasture. In the arid regions, about 20% of the respondents cited livestock loss due to wildlife attack.

The shocks have many negative effects. Due to the unavailability of pasture and water during drought, livestock become emaciated and the quality of their products deteriorates. In extreme cases, these livestock die. Livestock are important assets to pastoralists' households and quality deterioration or worse still, death becomes a huge blow to livelihoods of the affected households [28,29].

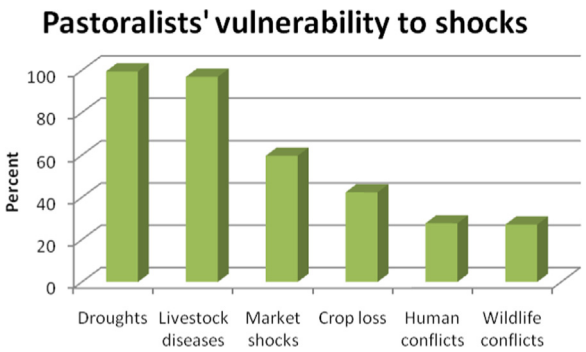

Fig. 2. Pastoralists' vulnerability to shocks.
Source: Household Survey Data (2017).

Some shocks occur concurrently. From the FGD, it was noted that over 80% of the households experience livestock diseases during dry seasons, when they have to move their animals to shared pasture grounds. Moreover, the FGD participants indicated that inter-community conflicts over water and pastures heightened during dry seasons. These conflicts result in cattle rustling and loss of human lives. Opiyo et al. [21] similarly noted that resource conflicts are high in dry seasons among the Turkana pastoralists in Kenya and these conflicts have multiple negative effects on households.

4.3. Household resilience index

Following the RIMA framework (see Eq. (1)), households' resilience index was constructed. Table 2 below shows the factor loadings of the variables used in PCA to compute the household resilience index.

The Bartlett's score of sphericity had a *p*-value of 0.000, which is significant at 5%. Thus, the null hypothesis was rejected since the variables were inter-correlated and this justified the use of PCA. The KMO statistic was above the recommended minimum of 0.70 and this implied that unbiased inference can be drawn from the indices constructed using these variables [30].

In this analysis, income had the highest impact than other variables

Table 2
Factor loadings of variables used in PCA.
Source: Household Survey Data (2017).

Variable	Factor score
Income	
Log of total income (farm and off farm income)	0.38
Food security	
Months that the household was unable to meet food requirements	−0.34
Assets	
Log of value of farm implements	0.34
Log of value of tropical livestock units	0.29
Log of value of land	0.34
Access to basic services – Health	
Health expenditure	0.31
Agricultural Practice and Technology	
The number of adaptive practices: afforestation, terracing, enclosures,	0.32
Adaptive Capacity	
Dependency ratio	−0.24
Proportion of losses incurred during shocks to total income	−0.31
Increase savings to cushion against shocks	0.29

Chi-square = 1110.236, Degrees of freedom = 45, *p*- value = 0.000.
H_0: Variables are not intercorrelated.
Kaiser-Meyer Olkin (KMO) measure of sampling adequacy = 0.908.

in building resilience. It comprised of income derived from selling livestock, other farm products and income from formal and informal employment. A diverse income-base cushions households against drought related shocks. It is also an important base for other resilience indicators since cash income can be converted into assets. Income also enables households to access basic services such as healthcare and food, all which explain resilience [6].

Food security in this study was explained by the number of months in a year that the household could not meet its annual food requirement. Results showed that over 53% of the respondents could not meet their annual food requirements due to poor harvest and high food prices. The average number of meals per day was 1.5. Other studies such as Alinovi et al. [1] and Ciani and Romano [6] used the number of meals and expenditure on food to explain food security. However, these indicators vary across households, for example, a household having most of its food and livestock on the farm may have a lower expenditure for food items but may not be food insecure. In order to fully account for own-farm derived food security when food expenditures are low or absent, we analyzed the number of months in a year a household is unable to meet its food requirement over the last 12 months. As expected, less resilient households had longer periods of food insecurity and this explains the negative factor coefficient.

Assets are a key element of a livelihood. They give a household the opportunity a solid base to build an activity upon. By employing assets in various activities, households raise both their on- and off-farm incomes [11]. This in turn, has a positive outcome on the households' resilience. Consistent with the findings of other studies such as Alinovi et al. [1] and Ciani and Romano [6] the assets used in this analysis; value of farm implements, value of land and value of the TLUs all had positive factor values on the resilience index (0.34, 0.34 and 0.29, respectively). It is worthwhile to point out that though previous studies did not include TLUs, we incorporated it because of the important role that livestock play in pastoralists' households; and this is our innovative contextual contribution to the RIMA framework.

Access to basic services such as health, schools and extension support are vital for building productive capacity and sustainable livelihoods. Stifel and Minten [24] show that geographic isolation hinders access to productive resources through increased transaction costs. Households that are located relatively far from basic services such as health and education centres, water and institutional support services such as extension, information and marketshare more vulnerable to shocks. Health expenditure was used to compute factor variable for access to basic services. This variable had a positive factor value implying that more resilient households can afford to spend more money on health services because they can travel to better equipped hospitals for quality service.

Agricultural adaptation and production technology is crucial as it enables farmers to counter the effects of shocks in a system [15]. In this study, the number of adaptive farming and livestock husbandry practices employed by the household was used to compute the factor score of 0.32. The individual practices are treated as explanatory variables of resilience. The adaptive capacity was explained using dependency ratio, proportion of losses incurred during shocks and savings. A high dependency ratio implies that few economically active members have to meet the needs of all the other people in the household. This reduces savings and creates immense pressure on economic resources of a household. This has negative implications on the household resilience index and that explains the negative factor score of - 0.24.

As noted by Carter et al. [5], a household that loses most of its assets during a shock becomes more vulnerable to subsequent shocks. This may lead the household to be trapped into perpetual poverty,which requires lots of external interventions to get out. This explains the negative factor value of - 0.31 of the value of income and assets lost during shocks in this analysis. Savings was a dummy variable captured as whether the household sets apart some income and assets to be used in the event of shocks. This has a positive effect on the household resilience index (factor value of 0.29).

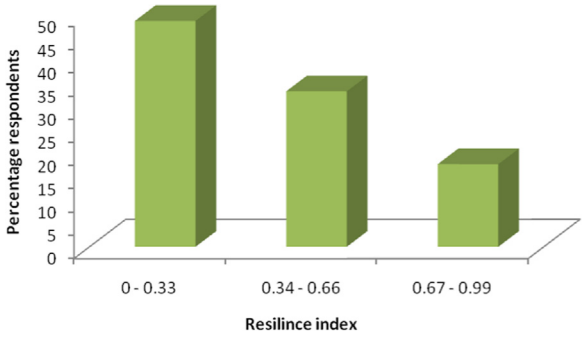

Fig. 3. Distribution of households' resilience indices.
Source: Household Survey Data (2017).

Income and monetary value of assets was taken in the logarithm form in order to reduce the range of variables and thus reduce outliers [30]. Following Giuseppe et al. [11], the resilience indices were re-scaled to the range between 0 and 1 for ease of analysis. The average household resilience index for the entire sample was found to be 0.39. On a scale of 0–1, this is below average. Other studies also found that pastoralists in other contexts had the lowest resilience scores compared to other enterprises [1,6]. Respondents from the arid region had a mean of 0.31 compared to 0.50 from those in the semi-arid region. Fig. 3 shows the distribution of the household resilience indices to shocks.

4.4. Factors that contribute to pastoralists' resilience

Table 3 below shows the results from the ordered probit regression. The dependent variable (resilience index) was measured as a categorical variable taking three possible values derived from the PCA results reported in Table 1 and Fig. 3. In this section, we present the results of the variables that influence the probability of a household's resilience index being in any of the three categories ($Y = 1$: 0 – 0.33; $Y = 2$: 0.34 – 0.66; $Y = 3$: 0.67 – 0.99).

The results showed that male-headed households were less resilient compared to female-headed households. The probability of female-headed households having a resilience index ranging between 0.67 and 0.99 was 14.4%. This contradicts previous studies such as Opiyo et al. and Tesso et al. [21,25], which found that female-headed households were less resilient largely due to bias in resource allocation and decision making that leans towards males in most pastoral communities. Our results can be explained by the observation by the IIRR and CTA [12] which noted that there are emerging trends in pastoralists communities where women are increasingly taking charge of managing livestock enterprises such as poultry, thereby putting them in a position to build their resilience sometimes even better than men.

On formal education, results showed that an additional year of schooling increases the probability of a household having a resilience index ranging between 0.67 and 0.99 by 1.5%. Livelihood diversification through off-farm activities has a positive impact on household resilience by spreading risks across enterprises. Results showed that households augmenting farm income with off-farm income increased the probability of a household having a resilience index ranging between 0.67 and 0.99 by 35.2%.

Access to extension advice raises pastoralists' awareness on issues that affect pastoralists such as climate-related shocks, land constraints and ways through which the shocks can be mitigated and thus have a positive effect on household resilience [29]; IIR and CTA, 2013). Results showed that households' access to extension advice increased their probability of having an index ranging between 0.67 and 0.99 by 34.5%. Credit access helps in making available the capital needed to undertake investments and thus facilitate the acquisition and use of innovative practices [15]. In this analysis, a household's access credit

Table 3
Ordered probit regression results.
Source: Household Survey Data (2017).

Variable	Coefficient	Marginal Effects		
		Prob (*Y* = *1*)	Prob (*Y* = *2*)	Prob (*Y* = *3*)
Age	0.03 (0.13)	− 0.01	− 0.01	0.03
Gender (1 = Male-headed household)	−1.47** (0.68)	0.079**	0.064	− 0.144**
Years of schooling of the household head	0.15*(0.07)	− 0.08**	− 0.06**	0.02**
Ownership of title deed for the land	0.78 (0.63)	− 0.04	− 0.03	0.08
Proportion of off-farm income in total income	3.59**(1.30)	− 0.20**	− 0.16*	0.35**
Distance to the nearest water source	−0.01 (0.21)	0.02	0.02	− 0.05
Distance to the nearest market	0.08 (0.07)	− 0.01	− 0.01	0.01
Distance to the nearest health centre	0.03 (0.03)	− 0.01	− 0.01	0.01
Access to extension advice	3.50** (0.87)	− 0.19**	− 0.15*	0.35**
Access to credit	0.36**(0.16)	− 0.02**	− 0.02**	0.04**
Access to social safety support	−1.05*(0.58)	0.06	0.05	− 0.10*
Participation in governance institutions	0.68 (0.58)	− 0.04	− 0.03	0.07
Livestock vaccination	0.78 (0.77)	− 0.04	− 0.03	0.08
Pasture conservation	0.31 (0.47)	− 0.02	− 0.01	0.03
Planting drought tolerant crop varieties	1.26 (0.15)	− 0.07	− 0.06	0.12
Post-harvest use of crop fields	2.53**(0.86)	− 0.14**	− 0.11	0.25
Ethno-veterinary treatment of livestock	1.40**(0.54)	− 0.08**	− 0.06**	0.14**
Enclosing grazing land	3.162**(0.84)	− 0.17**	− 0.14**	0.31**
Agro forestry	0.65*(0.39)	− 0.04*	− 0.03	0.07*
Stocking improved livestock breeds	1.75**(0.51)	− 0.095**	− 0.077**	0.172**
Incorporating camels in the herd	0.52 (0.59)	− 0.03	− 0.22	0.05
Bee keeping	0.76*(0.41)	− 0.42*	− 0.03	0.08

α_1 = 14.298(2.398); α_2 = 20.498 (2.947); Wald Chi-Square (22) = 79.55.
Log Pseudo likelihood = -30.538. *Pseudo* R^2 = 0.7256.
Marginal effects were calculated as a discrete change from 0–1 for dummy variables and at means for continuous variables.
Robust standard errors are in parentheses. Statistical significance levels.
** 5%.
* 10%.

was found to increase their probability of having a resilience index ranging between 0.67 and 0.99 by 3.6%. Other studies similarly showed that access to credit and extension enabled pastoralists to be more resilient to shocks [2,17].

Pastoralists' participation in governance institutions such as local rights groups gives them avenues for sharing their concerns and collaborating with other partners in prioritizing development projects that aim at building their resilience [9,16]. Pasture and forage conservation helps to stabilize livestock feed availability, which is important in reducing fluctuations in milk production thus enhancing food security at the household level and building resilience. However, these two variables were insignificant in this study perhaps due to data limitations.

Social safety nets help to cushion households in the event of shocks [1,6]. However, contrary to findings by other studies [17,25] the results of this study showed that households receiving social support were less resilient compared to those that did not. This support was mainly received in form of cash and food from family members, friends, relatives and the county government. The reason why the cash received as social safety net was not contributing to building resilience was because it was mainly used by households to smoothen their consumption rather than being invested in long term development initiatives.

Post-harvest use of crop fields for grazing helps to augment locally available livestock pasture and feed during the dry season. Households doing so were found to be have a 25% probability of recording a resilience index ranging from 0.67 to 0.99. Ethno-veterinary knowledge and practice play an important role in livestock treatment thus averting effects of livestock diseases [8]. This is important since most pastoralists live far away from modern veterinary and pharmaceutical services and may not have access to modern treatment [12]. From this study, households employing etho-veterinary practices had a 14% probability of having a resilience index ranging from 0.67 to 0.99.

Enclosures are fenced establishments on grazing land that restrict grazing of animals for sometime to allow vegetation to rejuvinate. The animals are allowed to graze on different enclosures on a rotational basis [27]. Grass and other pasture species can be grown on these enclosures. Enclosures ensure that there is enough livestock feed to last through all seasons. From this analysis, it was found that investing in enclosures increased the probability of a household having a resilience index ranging between 0.67 and 0.99 by 31.1%.

Improved livestock breeds that are suitable in the area are more marketable as they take a shorter time to mature and their meat is more tender [12]. Nearly 10% of the respondents stocked improved Sahiwal cattle breeds, 8% cross-breeds, 15% dopper goat breed, 3% cross goat breed, 16% dopper sheep breed and 3% cross sheep breed. The main challenge noted with these breeds was that unlike their indigenous counterparts, they were more susceptible to diseases and could move long distances [29]. For those with these stocks, the study showed that their probability of having a resilience index ranging between 0.67 and 0.99 was 17.2%. Moreover, households that kept bees had a 7.5% probability of having a resilience index ranging between 0.67 and 0.99.

Afforestation and fruit growing contributes positively to resilience. Fodder trees grown supplement livestock feed thus enhancing milk productivity and quality livestock which when sold earn higher revenues. Fruits such as mangoes, consumed at the household level complement other diets leading to better nutrition, an important component of food security which in turn builds household resilience. It was found that households that planted trees and grew fruits had a 6.5% probability of having a resilience index between 0.67 and 0.99.

5. Conclusions and implications to policy

Building pastoralists' resilience to shocks is an important aspect in achieving sustainable livelihoods. This study has shown that improved livestock husbandry practices such as investments in enclosure of grazing lands, ethno-veterinary treatment and prevention of livestock diseases, pasture conservation and diversification into emerging enterprises such as bee keeping, coupled with external institutional support in form of credit and extension services have a significant effect in

building resilience. Investment in these interventions can significantly reduce disaster risk mitigation expenditure.

While the responsibility of reducing disaster risk lies primarily with both the national and county governments, it can be effectively addressed through appropriate collaboration with other relevant stakeholders. Non-government actors can support the counties in implementing investments aimed at reducing risks due to shocks by lending their expertise, goodwill and resources. This includes research collaborations on felt needs by community members and disseminating research findings to all stakeholders for necessary action. The governments, both national and county need to invest more in programmes that enhance people's livelihoods. These programmes should be clearly indicated in the County Integrated Development Plans with specific and measurable objectives and their outcomes compared with a reduction in disaster risk expenditure. This will result in more vibrant drylands that will not only sustain the livelihoods of pastoralists but contribute to sustainable development.

Additionally, institutional support in the forms of credit and extension need to be strengthened in the pastoralists' areas. Formal credit can be embedded with livestock insurance to cushion both the lender and the pastoralists in the event of catastrophic loss of livestock. Extension programmes and campaigns such as livestock vaccination can be implemented during seasons when pastoralists are more likely to be settled so that many households can benefit. Finally, for research and development purposes, there is a need to document indigenous knowledge and practices that build resilience so as to increase their adoption and sustainability.

Declaration of interest

None.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ijdrr.2018.12.012.

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