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Food insecurity in pastoral communities of Ngorongoro conservation area, Tanzania

John G. Safari[1*] , Moita K. Kirwa[2] and Christina G. Mandara[2]

Abstract

Background: Food insecurity increases the risks of hunger and malnutrition and remains a formidable health challenge in resource-poor settings. Pastoral communities, which are largely restricted to marginal lands, tend to experience heightened levels of food insecurity. However, empirical evidence of food insecurity for communities living on the edge of conservation areas is limited. This study assessed the prevalence and determinants of food insecurity in pastoral communities of Ngorongoro, Tanzania.

Methods: Data were collected through a household survey ($n = 238$), key informant interview and field observation. Food insecurity was measured through Household Food Insecurity Access Scale (HFIAS). Data were subjected to descriptive statistics, principal component analysis, and multivariate regression analysis.

Results: Based on three HFIAS domains, the surveyed communities experience anxiety and uncertainty about food supply (77.3% of the households), insufficient quality in terms of variety and preferences (74.1%), and insufficient food intake (55.9%). Overall, more than half (55%) of the households are food insecure. Multivariate logistic regression models adjusted for socio-demographic characteristics show that household food insecurity is independent of socio-demographic factors. Culture, environmental factors, and production system determine food access, food consumption practices, and overall household food security. The odds of food insecurity are higher in households whose location to the market exceeds 5 km [AOR (95% CI) = 6.20 (1.66–9.09)] and those reporting limited access to water [AOR (95% CI) = 1.09 (0.17–6.43). A similar pattern is recorded in households not owning small stocks [AOR (95% CI) = 1.12 (0.41–1.65)] or donkeys [AOR (95% CI) = 1.19 (0.18–7.65)].

Conclusion: Empirical evidence shows that the prevalence of food insecurity in the study community is high. This situation emanates from a wide range of factors including those linked to culture, physical environment, and production system. Thus, interventions are needed to leverage nutrition education, promote sustainable energy technologies, and develop strategic social service infrastructure in the community development zone. There is also a need to look into long-term settlement plans with the view to improve the welfare of the pastoral communities.

Keywords: Food insecurity, Prevalence, Determinants, Pastoralism, Maasai, Ngorongoro

Introduction

Food insecurity is a public health concern especially in sub-Sahara Africa [1, 2]. The condition of food insecurity occurs when people experience limited or uncertain physical and economic access to safe, sufficient, and nutritious food to meet their dietary needs or food preferences for a productive, healthy, and active life [3]. It is generally taken to mean a dietary intake of insufficient and appropriate food to meet the needs of growth, activity, and the maintenance of good health. This condition relates to food production and distribution systems which are vulnerable and sensitive to economic and climate-related shocks [4, 5]. There is increasing evidence

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that prolonged exposure to food insecurity is associated with poor physical, psychosocial, cognitive, and other negative health outcomes including diabetes, hypertension, and cardiovascular diseases [6–9]. The factors influencing food security vary across populations, geographical location, culture, socio-economic status, and food production system [10, 11]. Studies have also shown that food insecurity disproportionately affects the poor and underserved [4, 12].

Pastoralism, a predominant livelihood strategy in the Ngorongoro Conservation Area (NCA), derives more than half of household income from livestock and livestock products [13]. However, this system raises concerns over food security because it is restricted to marginal lands where climate change is having its highest impacts [14, 15]. Pastoral systems are themselves diverse; depending on the degree of mobility, gender, ethnic group, wealth, engagement in non-livestock-based activities, and bio-climatic conditions [16–18]. Their adaptive capacity depends on the suite of environmental, social, economic, and political entitlements communities can mobilize to meet the needs for maintaining the system [19]. Pastoralism in the NCA presents a semi-nomadism experience of co-existing with wildlife in a multiple land-use model. Until 2009, this system entailed mixed economic activities that largely involved pure pastoralism or pastoralism with subsistence farming.

Later, the Government of Tanzania prohibited subsistence farming and restricted cattle grazing because of the ecological importance of the NCA. The burning of farming in the area was also a result of the swelling number of inhabitants which in part sprang from rapid immigration. In 2017, for example, about 87,000 people were estimated as resident pastoralists [20], representing approximately 11 times the number in 1959, the year NCA was established. Under conditions of high population density and in a system that allows freedom of the commons, pastoralism poses a challenge towards achieving optimal levels of co-existence between humans and wildlife. It has been argued that humans face the dilemma of preventing exhaustion of natural resources and sharing a commons in which individuals seek to maximize gains [21]. This dilemma is associated with two ethical reasoning, each sufficient by itself [22]. The first is the view that nature has intrinsic value and should, therefore, be conserved for its own sake. In the second reason, human welfare is a motive for conservation. Implicit in this reason is that ethic nature deserves moral consideration because how nature is treated affects humans.

In light of the present study, these ethical scopes mean that the NCA could be ruined if access to the area was to remain open, without limit. It also means that the household welfare of communities living in the area may be at stake as human activities are restricted. That, in essence, signifies varied impacts on nature and humans depending on the choice of ethical reasoning. In this regard, there are claims, for example, that restrictions on human activities to avoid damage to the NCA have increased the vulnerability of household food insecurity [23]. However, knowledge of the degree to which food insecurity prevails and the factors associated with it is limited. Empirical evidence of these aspects is especially lacking for communities living on the edge of conservation areas. Data from this study may give insights into scant literature regarding food insecurity and pastoral life. This study, therefore, aimed at assessing the prevalence and determinants of food insecurity in pastoral communities of Ngorongoro District, Tanzania.

Methods

Study area

This study was conducted between July and August 2019 in a pastoral community of Ngorongoro district in Northern Tanzania. Data were collected from Nainokanoka ward located within the NCA. The area receives annual bimodal rains ranging from 500 to 1700 mm and most of it falls from April to May and November to December. The Maasai people form a dominant tribe in these villages. At the time of this study, the total population was 14,780 distributed within the ward. Traditionally, the Maasai are semi-nomadic pastoralists who migrate within semi-arid lowlands and more humid uplands in search of water and pasture. The Maasai mainly keep cattle, goats, and sheep. Cultivation within the NCA is prohibited as an initiative for preserving wildlife. Thus, this community is dependent on food produced from the neighbouring districts. Pastoralism is a major livelihood strategy in the area. Nevertheless, the native inhabitants engage in non-livestock-based activities including petty business, tourism ventures, and wage labour. The Maasai live in units of *boma* or homestead, each of which consists of a grouping of houses for multiple families.

Sampling procedure

The sample size (n) was calculated using a formula $z^2 \times p \ (1-p)/d^2$ [24]; where $z^2 =$ critical value (1.96 for 95% confidence level); $p =$ percentage of food-insecure households, assumed to be 50%; $d =$ maximum error of 0.05 and a design effect of 2. Additional 44 households were enrolled to cover for possible dropouts and/or non-response. Thus, a sample of 238 households was selected from three purposively selected villages based on the distance to the market centre as follows: Nainokanoka (3700 inhabitants, located at the centre), Erkeepusi (4329, about 9 km away from the centre), and Bulati (6751, about 20 km away from the centre). Households from

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each village were randomly selected with Probability Proportional to Size (PPS) procedure. In this technique, larger clusters have a higher probability of selection and smaller clusters have a lower probability of selection. As a result, from a sample of 238 households, 60 (25.2%) were selected from Nainokanoka, 70 (29.4%) from Erkeepusi, and 108 (45.4%) from Bulati. A unit of analysis was a household which for the pastoral communities, Homewood [25] defined it as a male-headed polygamous unit with multiple dependents and potential contributors to household entitlements such as wage, labour, and education. A pre-test on a small number of respondents was conducted followed by a survey of the estimated sample for each village. In addition to the household survey, twelve key informants were interviewed. These included village chairpersons, village executive officers, and traditional leaders.

Data collection

Household food security status was measured using Household Food Insecurity Access Scale (HFIAS) version 3 questionnaire. This instrument details information on the frequency-of-occurrence of nine food insecurity-related conditions in the preceding 4 weeks as described in the food security indicator guideline [26]. The conditions are: worry about food, unable to eat preferred foods, eat a few varieties of foods, eat food they do not want to eat, eat a smaller meal, eat fewer meals in a day, no food of any kind in the household, go to sleep hungry and go day and night without eating. Each indicator was given a 1-point score for each form of food insecurity that a household experienced or zero if a given form of food insecurity was not experienced. An affirmative answer was then followed by a frequency-of-occurrence question to determine if, during the previous 4 months, the condition never occurred or happened rarely (1–2 times), sometimes (3–10 times), or often (> 10 times).

Overall, these self-reported indicators of food security represent respondents' perceived anxiety over the adequacy of food access in their households [27]. Scores of food insecurity conditions range from 0 to 27 with higher values indicating severe food insecurity. The HFIAS conditions were then reduced into three domains of occurrence of food insecurity as described in the guideline: anxiety and uncertainty about the household food supply (condition 1); insufficient quality which includes variety and preferences of the type of food (conditions 2–4); and insufficient food intake and its physical consequences (conditions 5–9). Data on factors potentially influencing food access were collected using a semi-structured questionnaire. These included age of household head, sex of household head, education level of household head, household size, main livelihood activity, type of livestock, distance to the road, and distance to the nearest market.

Data analysis

Data were analysed using Stata and Statistica software. Descriptive statistics (frequencies and percentages) were used to analyse household characteristics and the occurrence of household food insecurity access-related conditions. Three domains of food insecurity were computed as the number of households that responded "yes" to any of the conditions in the specific domain/total number of households responding to any of the specific conditions. The scores on the nine questions were used to calculate the HFIAS index (0 to 27) from which, households were categorized as food secure (higher access) if HFIAS < 17 or food insecure (lower access) if HFIAS ≥ 17. Household food security status formed the dependent variable. Each of the following binary variables takes the value 1 if; the age of household head is above 35 years, sex of household head is male, the respondent is married, household head attended school, household size is large (seven or more members) and household has diversified livelihood activities (pastoralism, petty business, and beekeeping). Other variables take the value of 1 if a household has no small stocks (sheep and goats), no donkeys, or no chickens; and if the distance to the road/market exceeds 5 km.

Principal component analysis (varimax rotation) was performed to obtain a pattern that clearly describes data and maximizes variance on perceived food insecurity conditions. The Kaiser–Meyer–Olkin value of 0.75 with $p = 0.00$ for Bartlett's test of sphericity indicated that the selected set of variables was suitable for structural analysis. Using the Kaiser criterion, principal components with eigenvalues > 1 were retained. Data were also subjected to regression analysis to explain as much variation as possible in original data using few dimensions. Diagnostic procedures for regression were performed before running the analysis. Multicollinearity test results indicated values ranging between 1.12 and 2.31 which is within the acceptable level of < 10. A binary logistic regression model was constructed to examine the relationship between each independent variable and food security status as a dependent variable. The food security status was modelled as 1 = food secure and 0 = food insecure. To control for the effect of confounding factors, variables with $p < 0.25$ in the bivariate model were fitted into a multivariate logistic regression to identify the main determinants of food insecurity with adjusted odds ratios at 95% confidence interval.

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Results

Household characteristics and food insecurity

This study involved households of varied socio-economic and demographic characteristics (Table 1). The majority of respondents were above 35 years. Most of the household heads were males, married, and had not attended school. The distribution of the respondents by household size indicates that a larger segment of the households had seven or more members. The mean household size was 6.6 persons per household. The percentage distribution of household activities shows that over half of the households subsisted on pastoralism only. The rest of the households combined pastoralism with petty trading or beekeeping (13.9%). A substantial proportion of the households (48.5%) kept donkeys as draft animals. Slightly over a quarter of the households kept chicken while three-quarters kept sheep and goats. The household location of 54.6% of the sampled households exceeded 5 km from the local market. Comparison of food insecurity levels between villages showed that Nainokanoka village had the least proportion of food-insecure households followed by Erkeepusi and Bulati. Note that distance to the local market also follows that order. Overall, 55% of the surveyed households were food insecure.

Household food insecurity conditions

Household food insecurity conditions are presented in Table 2. More than three-quarters of the households worried about food inaccessibility while 98.3% of the households were not able to eat the kind of food they preferred. Most of the respondents recounted that they ate a few varieties of food (99.6%), ate food they did not want to eat (72.2%), ate smaller meals than they should (89.9%), or ate fewer meals a day (87.0%). Households reporting no food of any kind in the households, sleeping hungry, or going day and night without eating were 52.1, 39.1, and 11.3%, respectively. The overall affirmative responses to the nine HFIAS questions decreased sequentially with the increasing severity of food insecurity conditions. However, there are some deviations in FIC1 and FIC4 which received lower responses than those for their subsequent conditions. The reduction of the HFIAS conditions into three domains of occurrence of food insecurity was structured as follows: Anxiety and uncertainty about food supply (77.3% of the households), insufficient quality in terms of variety and preferences (74.1%), and insufficient food intake and its physical consequences such as eating fewer meals in a day (55.9%).

Based on the Varimax method with Kaiser Normalization, all the nine conditions loaded on principal components with a clear factor structure. The eigenvalues

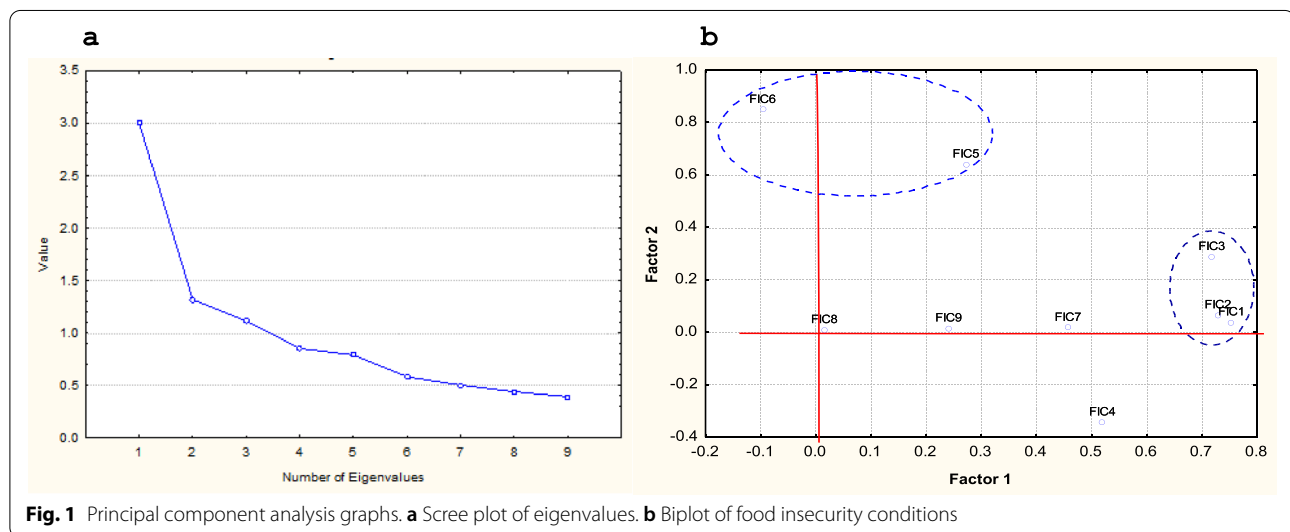**Table 1** Descriptive statistics for study variables

Variables	Food secure	Food insecure	Total
Age (years)			
< 35	38 (35.8)	54 (41.2)	92 (38.8)
35 +	68 (64.2)	77 (58.8)	145 (61.2)
Sex of household head			
Male	87 (82.1)	108 (82.4)	195 (83.2)
Female	19 (17.9)	23 (17.6)	42 (17.7)
Marital status			
Married	84 (78.5)	97 (74.0)	181 (76.1)
Other	23 (21.5)	34 (26.0)	57 (23.9)
Household size (persons)			
< 7	41 (38.3)	40 (30.5)	81 (34.0)
7 +	66 (61.7)	91 (69.5)	157 (66.0)
Attended school			
Yes	49 (45.8)	43 (32.8)	92 (38.7)
No	58 (54.2)	88 (67.2)	146 (61.3)
Economic activities			
Pastoralism only	51 (47.7)	74 (56.5)	125 (52.5)
Pastoralism/petty trading/beekeeping	56 (52.3)	57 (43.5)	113 (47.5)
TLU			
< 44	36 (33.6)	47 (35.9)	83 (34.9)
44 +	71 (66.4)	84 (64.1)	155 (65.1)
Owns donkeys			
Yes	41(38.7)	73 (56.6)	114 (48.5)
No	65 (65.3)	56 (43.4)	121 (51.5)
Owns chickens			
Yes	39 (86.4)	26 (19.8)	65 (27.3)
No	68 (63.6)	105 (80.2)	17 3(72.7)
Food storage facility			
Present	88 (83.0)	67 (51.1)	155 (65.4)
Absent	18 (17.0)	64 (48.9)	82 (34.6)
Distance to the market (km)			
≤ 5	72 (67.3)	58 (44.3)	130 (54.6)
> 5	35 (32.7)	73 (55.7)	108 (45.4)
Village			
Nainokanoka	37 (61.7)	23 (38.3)	60 (25.2)
Erkeepusi	33 (47.1)	37 (52.9)	70 (29.4)
Bulati	37 (34.3)	71 (65.7)	108 (45.4)
Total	107 (45.0)	131 (55.0)	238 (100)

Per cent in parentheses; Total Livestock Unit (TLU) was computed based on conversion factors of 0.7 and 0.1 for cattle and sheep/goat, respectively [28]

displayed in Fig. 1a appeared to level off after the second principal component. Thus, two constructs (factors) emerged as the main food insecurity sub-scales. These two factors explained 48.1% (33.3%, Factor 1; 14.8%, Factor 2) of the total variance. Only food insecurity conditions with the absolute factor loadings above the cut-off point of 0.5 were considered to have significant

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Table 2 Per cent of households experiencing food insecurity conditions 30 days preceding the survey ($n = 238$)

HFIAS conditions (FICI–FIC9)	Occurrence		Frequency of occurrence		
	Obs	%	Rarely	Sometimes	Often
Worry about food (FIC1)	184	77.3	16.8	62.7	20.5
Unable to eat preferred foods (FIC2)	234	98.3	1.7	49.1	49.1
Eat a few varieties of foods (FIC3)	237	99.6	2.5	40.1	57.4
Eat food they did not want to eat (FIC4)	172	72.2	68.3	25.0	6.7
Eat smaller meal (FIC5)	214	89.9	16.7	74.4	8.8
Eat fewer meals in a day (FIC6)	207	87.0	22.1	65.9	12.0
No food of any kind in the household (FIC7)	124	52.1	82.4	16.0	1.6
Go to sleep hungry (FIC8)	93	39.1	92.8	7.2	0.0
Go day and night without eating (FIC9)	27	11.3	94.1	5.9	0.0

Fig. 1 Principal component analysis graphs. **a** Scree plot of eigenvalues. **b** Biplot of food insecurity conditions

contributions to the factor variance. During analysis, however, FIC4 exhibited cross-loadings on Factors 1 and 3. This condition was included in Factor 1 as it is more related to this factor. The rest of the food insecurity conditions loaded exclusively on one component. This means that these components are separable and non-overlapping. As shown in Fig. 1b, FIC1–FIC3 loaded on Factor 1 while FIC5 and FIC6 loaded on Factor 2. In light of the interview responses, these results suggest that Factor 1 represents food insecurity associated with insufficient food quality (limited access to preferred food of animal origin). Meanwhile, Factor 2 depicts food insecurity resulting from insufficient food intake.

Determinants of food insecurity

Results of the bivariate and multivariate analysis of factors determining household food insecurity (access) are presented in Table 3. Of the 14 explanatory variables included in the regression analysis, six were significant

determinants in the bivariate model and four factors in the multivariate model. The results show that most of the independent variables have higher odd ratios (OR > 1). The higher the odds ratio values, the higher the probability of a household with a given characteristic to be food insecure due to change by one unit of the independent factor (continuous variable) or from "0" to "1" (categorical variable) holding other model variables constant. The six variables from the bivariate model that significantly contributed to increased food insecurity are: having no small stocks, no donkeys, no chickens, or limited water supply for domestic use. Others are distance to the road and distance to the market.

The results on the four factors that emerged as the main determinants of food insecurity after adjusting for potential confounders are summarized as follows: households owning no small stocks were 12% more likely to be food insecure than did households with small stocks [AOR (95%CI) = 1.12 (0.41–1.65)]. Similarly, not owning

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Table 3 Parameter estimates of bivariate and multivariate logistic regression models determining the odds of household food insecurity

Variable	Bivariate		Multivariate	
	OR	95% CI	OR	95% CI
HH head age above 35 years	0.78	0.46, 1.33	0.86	0.39, 1.91
The sex of HH head is male	1.01	0.52, 1.98	1.83	0.50, 6.71
Respondent is married	1.28	0.69, 2.34	2.19	0.64, 7.42
HH head attended school	0.42	0.34, 0.98[*]	0.67	0.32, 1.41
HH size has seven members or more	1.36	0.82, 2.28	1.31	0.62, 2.74
HH diversified livelihood options	0.70	0.41, 1.17	1.43	0.72, 2.82
Livestock holding, TLU (ln)	0.92	0.61,1.79	0.86	0.42, 1.76
No small stocks	1.52	0.28, 2.82[**]	1.12	0.41, 1.65[*]
No donkeys	3.20	0.99, 9.75[**]	1.19	0.18, 7.65[*]
No chicken	2.06	1.18, 3.58[**]	1.11	0.73, 3.07
Water collection time (min) (ln)	0.22	0.12, 0.41[**]	0.09	0.08, 0.43[**]
Distance to the road exceeds 5 km	3.46	2.01, 5.95[**]	1.02	0.31, 3.41
Distance to the market exceeds 5 km	5.10	2.83, 9.20[**]	6.20	1.66, 9.09[**]
Member of a saving group	1.29	0.77, 2.17	0.93	0.47, 1.84

HH household, diversification included petty business and beekeeping; *TLU* total livestock unit; *OR* odd ratio; *CI* confidence interval

[*] $p < 0.05$; [**] $p < 0.01$

donkeys is associated with 19% higher chances of being food insecure compared with their counterparts [AOR (95%CI) = 1.19 (0.18–7.65)]. In this perspective, livestock diversity rather than total livestock holding has a positive contribution to household food security. Distance to the food market is another factor that determines food security. Households located in areas exceeding 5 km from the market are 20% more likely to be food insecure [AOR (95% CI) = 6.20 (1.66–9.09)]. In the rainy season, poor road conditions present a critical challenge to food access. Finally, the odds of food insecurity are 9% higher for households that spent more than 4 h a day collecting water compared with those using less time [AOR (95% CI) = 1.09 (0.17–6.43]. The results also show that household food insecurity is independent of socio-demographic characteristics such as age, gender, marital status, household size, and education level of the respondent.

Discussion

The results from this study have shown that the prevalence of food insecurity is high with a wide range of factors responsible for the condition. First, food insecurity resonates around food culture (food preference, access, and choice). Analysis of food culture shows a high level of dissatisfaction with access to preferred food as shown by high factor loadings and variance of the first principal component. It is worth noting that the capacity of local

people to utilize food depends on their access to food that is acceptable to them including varieties available to make choice [29]. However, culture is known to influence food preference [30], food choices [31], and food habits [32]. Food preference and the perception of what food is, affect social access to food and eating patterns [33]. Indeed, the local market in the area has a limited supply of food varieties suggesting that food distribution is also culturally determined. Poor physical access to food has been considered a risk factor for food insecurity, health, and dietary outcomes [34].

In the context of the present study, the Maasai culture places a very high preference on meat, milk, and raw blood. In this culture, food sources such as wildlife, fish, chickens, eggs, vegetables, and fruits are not considered as proper meals albeit their nutritional importance. Food sources not preferred are often labelled names of the culturally more unacceptable or low-value sources. Chicken, for example, are simply regarded as wild birds (*Imotonyik*, in Maasai language), fish as snakes (*Alasuray*), and sardines as insects (*Irkur*). Similarly, vegetables are perceived to be only good as livestock feed [35]. A study detailing Maasai food symbolism reported that Maasai dietary ideal excludes and strongly devaluates all plant food [36]. The supply of livestock products, however, is erratic and unpredictable. This situation often emanates from seasonal variation of feed resources. Besides, the economic constraints also hinder the accessibility of livestock products because such products are relatively more expensive than plant-based foods. A study involving the same community found that more than four in ten households (43.3%) consumed less than the minimum recommended four groups of food and that only 18% of the households were in the upper quartiles of the dietary diversity [37].

These results are consistent with the observations of the current study about a narrow range of preferred diets. This means that households in the study community are more likely to experience food insecurity, suboptimal levels of nutrient adequacy, and related health consequences such as acute malnutrition and stunted growth [38–40]. The results of the current study might also explain the observed higher prevalence of food insecurity than the estimates reported from agricultural communities [41, 42]. A study involving three communities in Tanzania [43] found that 57% of Maasai children were stunted and that this rate was nearly three times as high compared to the neighbouring children from Meru (21%) and almost double from Sukuma (32%) ethnics. In general, culture forms an essential part of understanding the complexity of household food insecurity, its consequences, and in many ways the necessity of nutrition education.

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Second, the results of the current study have shown that environmental factors (access to water, cooking fuel, and food market) have a stronger influence on food security (access) than the socio-economic factors (main occupation, total livestock holdings, and education level) or demographic variables (age, gender, marital status, and household size). Elsewhere, pastoral livelihood has been reported to increase time demand on women for collection of water and fuelwood [44]. Like in many other pastoral lands, the supply of feed resources is highly seasonal-dependent. In this perspective, the lean season (*Olamey*) in the study area is particularly a challenging period for pastoral activities due to the limited availability of water and feed resources. During this period, the Maasai men adopt flexible herding strategies that allow the mobility of livestock. This involves migrating to other places to take advantage of better grazing opportunities, leaving women and children behind. Implied in this living arrangement is the challenge women face in supporting households and the role they play as heads of households during the season. This scenario exacerbates household food insecurity because migration separates household members from livestock products. In addition, during such periods, women have to spend more time collecting water and fuelwood which further limits their ability to provide food for their families.

In line with our observation, it has been reported that domestic works in the Ngorongoro Conservation Area involve strenuous walking for up to 10 km per day, carrying 10 to 20 L ($\sim$12 to 25 kg) of water and collecting 20 to 25 kg of firewood twice per week which together potentially affect food security [45]. Thus, the results of the current study suggest a strong relationship between water, energy, and food security. The plausible explanation for the observed interconnectedness is that the three services have a common stressor of rainfall shortage with unpredictable patterns due to variability [46]. Available literature also shows that water, energy, and food security services affect each other and have become the three most prominent problems in human survival and sustainable development [47]. The observation that household food security is independent of the socio-demographic factors contrasts the results from previous works conducted in non-pastoral communities [48, 49]. This discrepancy suggests that the determinants of food insecurity are context-specific and relatively more sensitive to the production system.

Third, it is intriguing to note that significant associations were recorded when comparing livestock diversity (production system) and food security. Livestock diversity involving small stocks and donkeys rather than cattle alone improved household food security. It is argued that small stocks have a significant contribution to household

nutrition and other services including cultural and religious roles [50]. Their fast and high reproduction rates are convenient in terms of insurance, saving, sell, and exchange for food [51]. A study in Ethiopia [52] showed that women prefer to own small stocks for food security-related benefits and other immediate needs. In the discussion with the Maasai women in the present study, the lack of a reliable transport system was cited as a key factor that hindered food access. Nevertheless, donkeys provided important means of transport and haulage of goods such as grains, water, and packs of firewood. Thus, this particular species is an important part of the social and cultural fabric and plays a critical role in supporting the livelihoods of the pastoral communities. Through this role, therefore, it is clear that donkeys reduced the burden of work, especially among women who play key roles in household chores. While the exact mechanism linking donkeys and food security is less obvious, it may be reasonable to assume that households owning donkeys were able to allocate more time for productive works and welfare services including family nutrition. However, the importance of donkey-hide in traditional Chinese medicine (*Ejiano*) has triggered donkey slaughtering at unprecedented levels [53, 54]. If not over-turned, this practice may lead to a future deprived of the services that donkeys provide. Finally, the results of this study should be interpreted with consideration of the following limitations. First, data were collected in a single round during the dry season. Thus, this study cannot determine causality but rather the associations between variables. Second, food access is often dependent on seasonality. The current study, however, does not capture seasonal variations of food insecurity. Data for the wet season would provide a more nuanced description of the patterns of food insecurity in pastoral communities. Despite these limitations, the study contributes to understanding the challenges of achieving food security to communities in which pastoralism defines survival, culture, and identity.

Conclusion

This study has assessed the prevalence and determinants of food insecurity in the relatively obscure area of food insecurity among communities in Ngorongoro conservation areas. It builds on the scant literature on household welfare in areas where human activities are restricted. The results show that the prevalence of food insecurity is high. This situation emanates from a wide range of factors including those linked to culture, physical environment, and production system. Both short-term and long-term efforts are needed to mitigate the consequences of food insecurity. These may involve setting up programmes to leverage nutrition education, promote sustainable energy technologies while developing strategic social service

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infrastructures Including water supply and food markets in the community development zone. Women's involvement in such interventions is particularly important, not least because of their role in society as caregivers and the staggering amounts of time and effort they put into household nutrition. The results in this study also underscore the need to look into long-term settlement plans with the view to improve the welfare of the pastoral communities.

Availability of data and materials
Data can be provided on request.

Declarations

Ethics approval and consent to participate
Approval to conduct the study was obtained from the Ethics Committee of the Institute of Rural Development Planning. In addition, a permission letter was obtained from the Local Government Authority. In the villages, respondents were informed about the purpose of the study and that participation was voluntary. Informed verbal consent was sought from respondents before proceeding with the interviews. The confidentiality of the respondents was maintained throughout the study period.

Consent for publication
All authors read and approved the final manuscript.

Competing interests
The authors declare that they have no competing interests.

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