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Contribution of Rangelands to Household Food Basket and Income in a Pastoral Area in Uganda

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Abstract Rangelands are important ecosystems as they offer livelihood options and food security to many people in Uganda. There is barely any study that has analyzed the intricate relationship between household food basket, income and rangelands in Uganda. This study determined the contribution of rangelands to household food basket and income in Nakaseke district, Uganda. A cross-sectional survey using semi-structured questionnaires was conducted among 180 randomly selected households. The survey was aimed at determining the relationship between rangeland resources, food basket and income. Results showed that rangeland resources contribute significantly ($p<0.05$) to household food basket and income during both dry and wet seasons. Water, grass and shrubs were the most important rangeland resources in the area. On average, a household expended US$ 4.29 and US$ 4.04 daily on milk during the wet and dry seasons respectively. This accounted for the largest household expenditure on household food items. The household food basket is constituted by milk, meat from cattle and goats, posho, cassava, beans, vegetables, fruits, honey, sugar and oil. Four months; January-March and July-August were observed to have the lowest resource availability during the year. On average, households earned US$ 20.07 per month translating to US$ 240.84 annually. This average is lower than the US$571.9 national estimated per capita income. The average monthly income of the households during the wet and dry seasons was US$ 22.4 and US$ 17.7 respectively. Seasonal differences in income were however non-significant ($p>0.05$). The logistic regression results showed that size of land owned significantly influences cattle numbers and income at household level but does not influence the number and type of crops cultivated and available food reserves. Seventy three percent (73%) of the households attributed their livestock herd sizes to the presence of vast expanses of the rangeland. These findings show that rangelands are the most important contributors to household food basket as well as household assets such as livestock that have influence on household food security.

Keywords: *food reserves, food security, land ownership, dry and wet seasons, Uganda*

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1. Introduction

Rangelands world over contribute to food security and poverty alleviation for millions of people [20]. They also have potential to alleviate vulnerability of pastoral communities to food insecurity through continuous provision of various resources; particularly feed resources, and livelihood options [20,32]. Further, rangelands for example provide Wild Edible Plants (WEP) greatly contributing to household food baskets and livelihood of subsistence based communities in sub-Saharan Africa [32]. Grass for livestock, green belts for crop production and shrubs for browse are a host of important resources at disposal within the rangeland ecosystems; these resources support various functions including provisioning of firewood and charcoal and regulating services such as water, all of which have important implication on household wellbeing [9-18,37].

Rangelands in sub-Saharan Africa are synonymous with the pastoral production system and this has by far remained the mainstay supporting approximately 26 million people. The system is predominantly based on consumption and sale of livestock and livestock products, mostly cattle, goats, sheep and camels. The flexibility of this system permits its existence as the only efficient means of exploiting available resources under ecologically marginal conditions, available technologies and the prevailing economic constraints to enhance food security in the rangelands [7]. Rangelands are an integral component of pastoral household food security by influencing household food production as well as consumption patterns. Owing to the fact that rangelands are susceptible to extreme climatic events particularly drought; their contribution to household food basket and income varies from season to season [17,38,39], but has largely been under studied. Transitions occurring in the rangelands though threaten the viability of rangelands to contribute to household food needs [14,21]. Rangelands

have significant potential to contribute to improvements in the household food basket and income in the pastoral areas when they are well managed [23]. They have for long provided for pastoral and agro-pastoral populations in a number of ways including as feed resources and for various fruits and vegetables as well as medicinal purposes [18,33],. These are not necessarily consumed at home but used to source for income which is used to provide other basic needs to the households [25].

Like other rangeland areas in East Africa, rangeland areas in Uganda are known to be faced with climate variability as one of the major challenges that affects the availability of rangeland resources such as grass and water and other resources that influence the regular supply of food and non-food requirements [9,10,37]. Highly productive rangeland ecosystems now and in the future greatly contribute to better food availability through high milk yields, reduced milk and meat prices as well as availability of more wild edible plants [14,32]. Besides land use transitions, rangelands are facing unprecedented current climate variability and change that threatens to make the natural ecosystems less predictable and thus less reliable in food production and ecosystem services support [21]. Amidst these challenges of climate change, land use transitions, rangeland degradation and environmental change [4,5,35]; rangelands have continued to support pastoral communities to meet their household food needs and income partly through secured pastoralism [26]. However, there is a dearth of information regarding the depth to which rangelands contribute to the household food basket and income. This study sought to bridge this gap with a perspective of further supporting efforts towards better rangeland management.

2. Methodology

2.1. Description of the Study Area

This study was conducted in Nakaseke District in central Uganda (1.1349° and 32.4854°). The district lies along the cattle corridor of Uganda; a region mainly occupied by pastoral and agro-pastoral communities. On the average rainfall is about 1300 mm but highly variable and sporadic in character. Maximum temperature is in the region of 27.5°C-30°C while minimum temperature ranges between 15°C-17.5°C annually. Minimum temperature in the district has however been rising faster than the maximum temperature. This pattern has seen the mean temperature of the district rise. Projections of temperature in the district show that under both near future and mid-century periods, mean annual temperature will increase by 2.5°-4.4°C in the near future and 4.5°-6.0°C in the mid-century relative to the 1981-2010 period [27]. These increases will certainly impact the performance of the rangelands in the district. At present, the district is mainly covered by savannah grasslands with occasional occurrences and patches of woodlands. Communities mainly rely on livestock production as the major livelihood activity augmented with sale of livestock and livestock products as well as subsistence crop cultivation.

Figure 1. Location of Nakaseke District, Uganda

2.2. Data Collection

Data were collected through a cross-sectional household survey using a semi-structured questionnaire administered to 180 respondents that were randomly selected across three Sub Counties of Ngoma, Wakyato and Kinoni in Nakaseke district. The respondents included 159 males and 21 females aged between 27-78 years of

age with a ratio of 7:53. Semi-structured questionnaires were administered by way of guided interviews. The interviews covered; rangeland resources extracted by households, resource availability across the year, household food basket during the dry and rainy season, daily food consumption for pastoral households across the different sub counties, perceived household income during the dry and wet season and influence of rangeland resources on household assets and food reserves

2.3. Estimation of Resources Availability throughout the Year

Respondents were asked to describe perceived status of resources across the year based on a binary dummy (1, 0) response. In the perception assessment, 1 represented perceived availability and 0 represented perceived limited availability. The respondents were required to assess perceived resources availability across the year based on their recall and experience. The utilisation of perception and community knowledge in rangeland resources assessment has been successfully utilised by various researchers [28,29]; and found to be useful in eliciting quality data and information. The responses were summarized using descriptive statistics.

The study used a t-test to determine the significance of the differences between the contribution of rangelands to household food basket and income in Nakaseke by determining the relationship between income and household food basket [39]. To determine the contribution of rangelands to household food basket, the study used the basic foods consumed by a household to arrive at different food proportions. This was done by summing up reported proportions of the food consumed by households daily. These proportions were then multiplied by their current market prices and their share in household food expenditure derived. Finally, these shares were converted to percentages using the total cost of the reported food basket. The contribution of rangelands to household income was directly derived from the total household income. The equation of t-test is given below:

$$t = \frac{X_1 - X_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

Where,

X_1= Mean of first set of values
X_2= Mean of second set of values
S_1= Standard deviation of first set of values
S_2= Standard deviation of second set of values
n_1= Total number of values in first set
n_2= Total number of values in second set.

2.4. Influence of Rangeland Resources on Household Assets and Food Reserves

A multiple logistic regression was run in SPSS to predict the influence of rangeland resources on household assets and food reserves. Land was used a proxy variable that influences number of livestock, available food stocks, cultivated crops and income. The equation of the regression model is described below:

Formally, the model logistic regression model was that

$$\log \frac{p(x)}{1 - p(x)} = \beta + x.\beta$$

While solving for p, this gave

$$p(x; b, w) = \frac{e\beta_{0^+} x.\beta}{1 + e\beta_{0^+} x.b} = \frac{e\beta + x.\beta}{1 + e - (\beta_{0^+} x.b)}$$

Where p is the probability while *x*, *b* and *w* where input variables.

This multiple regression model was used because of its accuracy on input-output relationships and therefore provides an accurate analysis of socio-economic relationships.

3. Results

3.1. Rangeland Resources Extracted by Households

Water, grass, trees, shrubs, herbs, wild animals, clay, soil and honey are the major rangeland resources used by the households in Nakaseke district (Figure 2). Most of the respondents (98.3%) indicated that water was their most critical resource in the rangeland; this was followed by grass, trees, and shrubs at 98.9%; 87.2%; trees and 82.1% of responses respectively. Other resources included herbs 35%; honey 22.9%; soil 22.3%; wild animals 14% and clay 14%. These patterns did not significantly ($p<0.05$) vary between and within the different sub-counties in the district.

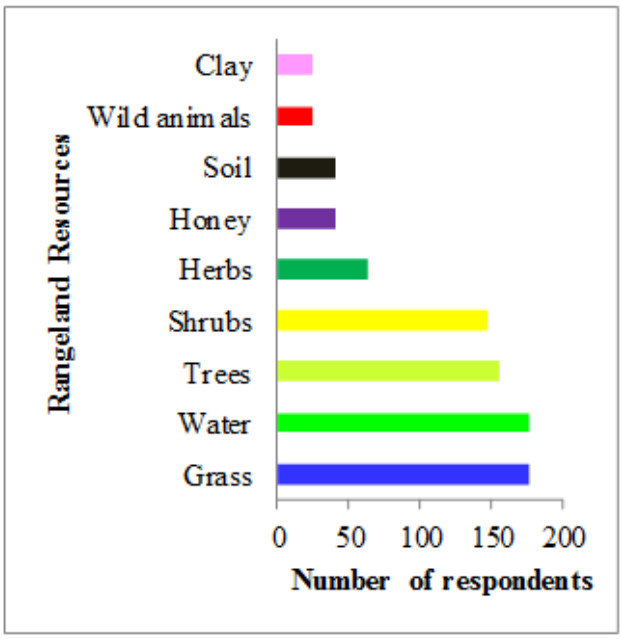

Figure 2. Resource use as reported by the respondents

3.2. Resource Availability across the Year

Rangeland resources availability as perceived by the community in Nakaseke district was assessed and these were found to vary by month across the year. January–March and July-August were perceived to have the lowest resources. Peak resource availability period was noted to occur between April-May and October-November (Figure 3).

Shrubs were perceived to be generally available throughout the year even though they also varied across the year. Whereas rangeland resources peak was perceived to be in the months of May and November, they also represent the months within which the decline begins to occur (Figure 3).

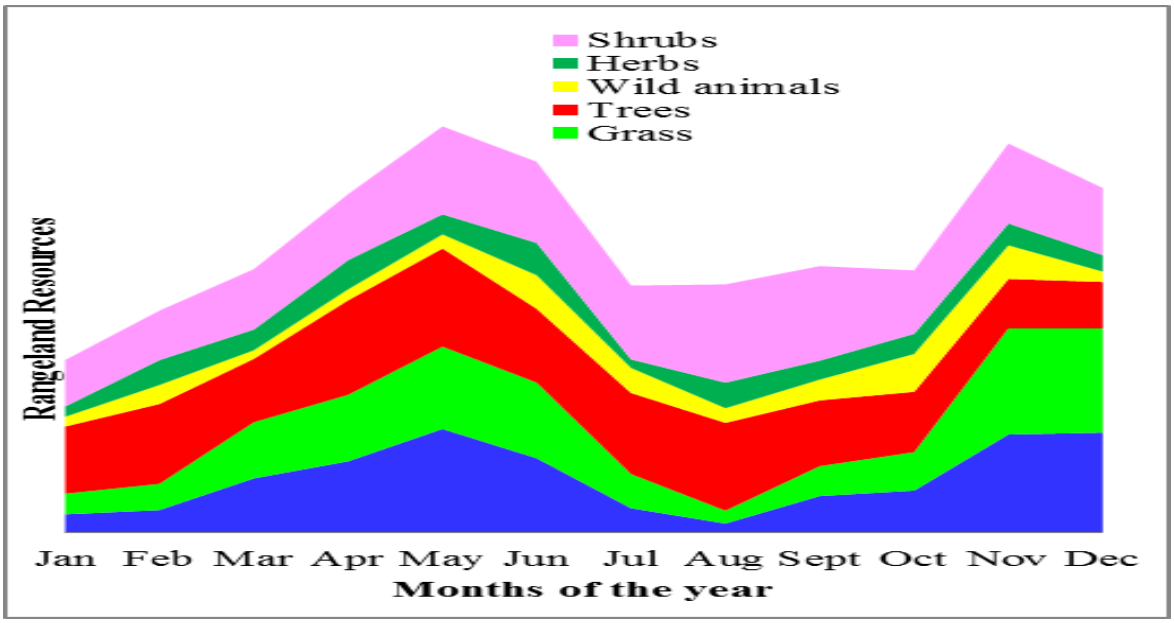

Figure 3. Monthly variations in resource availability across the year

3.3. Household Food Basket during the Dry and Rainy Season

The household food baskets during wet and dry seasons are presented in Table 1. The average daily expenditure of the households during the wet and dry season was US$ 4.29 and US$4.04 equivalent respectively. The quantity of foodstuffs consumed does not significantly vary between dry and wet seasons even though there are visible differences in figures. During the wet season the average quantities of milk consumed per day per household was 7.4 litres but this reduced slightly to 5.3 litres per day during the dry season. Milk consumption accounted for the highest daily expenditure in the households during both seasons (48.5% and 45%) respectively. The average quantity of animal products consumed across the seasons varied by 2.1L for milk, 0.07kg for cow meat and 0.03kg for goat meat. As for non-livestock products, posho (maize meal) and cassava were the most consumed food items in both seasons. In spite of the fact that prices for these two items significantly varied between seasons; their consumption did not change significantly. This was the case with other food items that showed a decrease in quantity consumed during the dry season.

Table 1. Wet and dry seasons food basket for pastoral households

Food item	Wet season				Dry season				
	Daily consumption (kg/litre)	Average price/kg/litre US$	Expenditure US$	Proportion %	Daily consumption kg/l	Average price/kg/litre US$	Expenditure US$	Proportion %	Chi-square
Milk	7.4	0.28	2.09	48.5	5.3	0.34	1.81	45.0	0.01
Cow meat	0.32	2.01	0.64	14.9	0.25	2.04	0.51	12.6	0.03
Goat meat	0.15	2.29	0.34	7.9	0.18	2.31	0.42	10.3	0.21
Posho	0.45	0.50	0.22	5.1	0.61	0.58	0.35	8.8	0.002
Cassava	0.43	0.52	0.22	5.2	0.52	0.50	0.26	6.4	0.04
Beans	0.21	0.57	0.12	2.7	0.13	0.67	0.09	2.2	0.00
Vegetables	0.11	0.65	0.07	1.6	0.03	1.22	0.04	0.9	0.07
Fruits	0.10	0.63	0.06	1.4	0.02	1.47	0.03	0.7	0.93
Honey	0.05	2.83	0.14	3.2	0.07	2.68	0.19	4.7	3.21
Sugar	0.29	0.97	0.28	6.5	0.24	0.99	0.24	5.9	0.001
Oil	0.07	1.52	0.11	2.4	0.06	1.65	0.10	2.5	0.382
Total			**4.29**				**4.04**		

3.4. Daily Food Consumption for Pastoral Households across the Different Sub Counties

Results show that the daily consumption across all the sub counties was higher in the wet season than in the dry season. Ngoma Sub County had highest daily consumption (kg/litre). Inter sub county comparisons using t-Test showed that there was no significant difference ($p>0.05$) in the daily food consumption across all the sub counties apart from the comparison between Kinoni and Wakyato whose consumption significantly varied ($p<0.05$) during the wet season. This means that the daily food consumption did not vary significantly across the rangelands even though there appears to be observable differences in the table.

Table 2. Daily food consumption per sub-county

Food item	Wet season			Dry season		
	Ngoma (kg/litre)	Wakyato (kg/litre)	Kinoni (kg/litre)	Ngoma (kg/litre)	Wakyato (kg/litre)	Kinoni (kg/litre)
Milk	8.7	6.1	6.4	6.2	3.3	5.1
Cow meat	0.42	0.22	0.42	0.45	0.15	0.35
Goat meat	0.11	0.25	0.35	0.28	0.12	0.24
Posho	0.35	0.35	0.55	0.71	0.44	0.51
Cassava	0.63	0.23	0.23	0.62	0.32	0.42
Beans	0.41	0.31	0.41	0.23	0.11	0.22
Vegetables	0.01	0.12	0.14	0.09	0.02	0.08
Fruits	0.06	0.09	0.15	0.04	0.04	0.05
Honey	0.06	0.02	0.03	0.05	0.06	0.04
Sugar	0.41	0.11	0.42	0.14	0.13	0.34
Oil	0.17	0.05	0.04	0.08	0.04	0.05

3.5. Perceived Household Income during the Dry and Wet Season

On average a households earned 20.07 US$ per month which accumulates to 240.84 US$ annually. The average monthly income of the households during the wet season was 22.4 US$ and in the dry season it was 17.7 US$. The income earned during the dry and the wet season did not significantly differ ($p>0.05$). The sale of livestock and milk contributed the biggest percentage to the income of households. This was over 55% for livestock and over 36% for the milk during both seasons. The rest of the livelihood activities (sale of charcoal, casual labour, formal employment and others such as sale of firewood, grass and water) accounted for less than 5% of the household income during the dry and wet season.

Table 3. Seasonal income from livelihood activities

Livelihood activity	Wet season		Dry season	
	Average Income/per month (USD)	Average percentage of income	Average Income/per month (USD)	Average percentage of income
Sale of livestock	86.35	55.06	69.05	55.59
Sale of cow milk	61.22	39.04	45.50	36.63
Sale of charcoal	5.77	3.68	6.28	5.06
Petty trade	0.23	0.15	0.14	0.11
Casual labour	0.09	0.06	0.09	0.08
Formal employment	3.12	1.99	3.12	2.51
Others	0.03	0.02	0.03	0.02

3.6. Influence of Rangeland Resources on Household Assets and Food Reserves

Seventy three percent (73%) of the respondents attributed their livestock flocks to the available water and grass in the rangelands. They further indicated that as the animals increase, milk also increases and their sales for livestock and milk increases significantly ($p<0.05$). This gives them income to purchase other food items. This would be different if the grazing land was small and their cattle had no space to expand. Over 53% of the respondents could directly relate their income to utilization of rangeland resource. Utilization of basic resources such as sale of trees or sale of charcoal had an influence on the income of the pastoralists as some pastoralist earned up to approximately US$ 90.9 per month. A multiple logistic regression showed that size of land owned significantly influences cattle numbers ($p=0.004$) and income ($p=0.02$). The 95% confidence interval for the odds ratio for cattle numbers is very wide (1.673 to 29.949). However, from the table it can be observed that size of land owned does not influence crops cultivated and available food reserves.

Table 4. Influence of rangeland resources on household assets and food reserves

Household assets and food reserves	Regression Coefficient	P-value	Odds Ratio (95% CI)
Cattle numbers	2.191	0.004	8.948 (1.673, 29.949)
Available food stocks	0.0586	0.9046	1.060 (0.104. 3.698)
Cultivated crops	-0.0252	0.55	0.975 (0.898, 1.059)
Income	-0.1053	0.028	0.9 (0.286, 2.829)

4. Discussion

4.1. Rangeland Resources Extracted by Households

This study identified; water, grass, trees, shrubs and herbs as the most commonly used rangeland resources in the area. This is by no means a surprise. However, it reinforces the argument of natural resource dependence of pastoral communities on rangelands resources for their provisioning function to support livestock rearing and meet their food security needs. This for a fact that all the resources identified are closely associated with livestock production. It also provides a perspective of resources that are revered by the communities in Nakaseke district as these are greatly identified by the majority of respondents.

In their studies on the pastoral communities of Karamoja and Kiruhura; communities within the cattle corridor of Uganda; [10,21] identified a range of rangeland resources particularly grass species that the pastoral communities in these areas rely upon. In addition, [19,22] opine that pastoral communities are natural resources dependent and the healthier the rangeland and more diverse the rangeland resources available the more resilient are communities to food scarcity in those areas [30].

The rangeland resources identified in Nakaseke such as herbs and shrubs are key resources in pastoral production system for ethno-veterinary and ethno-pharmacology as exercised by several tribal communities across East Africa [13]. Further, additional resources including; soils, honey and wild edible plants were identified and documented. While these featured with a low level of ranking, it does not imply that they are less important or have no impact on food security but shows that other resources prioritized are either highly contentious in terms of access or their absence creates a fundamental challenge to their existence as is a common occurrence with rangeland resources variability. Wild edible plants per se have previously been documented as vital rangeland resources that contribute to food supply in Africa rural communities [32]. This study also documented the use of trees for charcoal burning as a supplement to household income; this represents a mal-adaptation of communities. Decimation of trees for charcoal burning rapidly alters the rangeland ecology and begins to allow the thriving of invasive and undesirable grass and browse species in the range [6,15,31]; it further weakens the capacity of the range to perform its ecosystem functions.

4.2. Status of Rangeland Resources across the Year

Rangeland resources' availability in the Nakaseke depicted variability across the year. The trends observed coincide with the seasonal variations in rainfall in the area revealing a stochastic relationship between rangeland resources and rainfall in the district. These patterns are however not unique to Nakaseke district, but generally characteristic of most of the rangeland ecosystems in East Africa [28,29] and Ethiopia [2,29]. The peak period occurring in the month of May, corresponds to the peak period of the long rains period generally in Uganda. Similarly, the decline between the months of July-September corresponds to the short rainfall withdrawal that often occurs mid-year in Uganda. These rainfall variabilities in Uganda have been found to influence rangeland resources patterns and food security in Uganda [8,10,16]. This development however provides two important insights; first the rural communities are able to recall patterns of resource availability in their localities; secondly, these patterns correspond to potential determinants and therefore offer insights to better management of rangelands during peak and off-peak periods. This will particularly be vital in addressing challenges such as livestock losses associated with periods of low grass and water availability during the dry seasons in the semi-arid areas. This has potential to guarantee food availability since livestock is the main source of food in the cattle corridors [23].

4.3. Household Food Basket and Income During the Dry and Rainy Season

Most products showed a decrease in quantity consumed during the dry season although the expenditure did not decrease too. This signifies that in the dry season big sums of money buy little food due to food scarcity [7]. The decrease in the average expenditure of household food basket during the dry season is an indicator that pastoral households spend less on food during the dry spells [23]. This is possibly as a results of less income generated from land-based livelihood activities as well as the relative increase in prices during such period [39]. This is exacerbated by the problem of inadequate or shortage of storage facilities which has compounded the problem of food basket in the area [11,36]. The situation is made worse by the dearth of any storage facilities at household level. It has also created a discouraging effect on the household as they struggle to sell most of their yields immediately after harvest resulting in very unprofitable competition and lower prices [11]. For instance, dry periods are mostly associated with inadequate grass and water which are the primary inputs for livestock production; thus the output of this system is usually affected negatively. The income generated from livestock production is also affected negatively, this is coupled with the relative increase in prices, forcing households which rely heavily on livestock as the main source of income to cut their expenditures on food by amounts that are equivalent to the reduction in their incomes and the increase of various foodstuff prices [18,34]. In other words, pastoral households tend to consume less whenever they experience any reduction in their incomes and increase in foodstuff prices.

In typical prolonged dry seasons and drought periods, most animals are significantly affected by the lack of water and feed resources [1,24]. In many pastoral areas in Uganda (Nakaseke pastoral area inclusive), the availability of food depends on seasonal fluctuations [37]. This in most cases might result in a food supply gap, particularly during prolonged dry season and drought, whereby the animals fail to produce enough products for domestic use as well as for exchange [12,39].

A close analysis of the perceived household income during the dry and wet seasons revealed that livestock contributes significantly to household income as compared to other livelihood activities carried out in the rangelands. This exposes the dominance of livestock raring over the rest of the livelihood activities in the rangelands [23]. The dominance of livestock raring as the major activity in the rangeland further reveals the pivotal role of rangelands in providing space, grass, water and shrubs to animals grazing. This means that indeed, rangelands immensely contribute to household income. Since income influences the household food basket [37], it is also in order to indicate that rangelands contribute to household food basket. In some households, charcoal trade played a significant role in the income but these were few. Even though the charcoal trade was perceived by households to be low, reports reveal a growing trend of charcoal trade in the rangelands of Uganda [25]. This is likely to frustrate climate change adaption efforts such as use of trees as drivers of rainfall availability in the rangelands and may result in deterioration of key rangeland resources such as

grass, water and shrubs due to rainfall scarcity which are the key drivers of livelihood activity (livestock raring) are hinged on [16].

4.4. Influence of Rangeland Resources on Household Assets and Food Reserves

There are socio-cultural factors that influence ownership of resources especially land in many parts of the country. In this study, cattle numbers and income matched with size of land owned. This could be attributed to the vast size of land that has water, grass and shrubs which facilitate availability of livestock and in turn increases income [3,23]. However, cultivated crops and available food stocks are not influenced by size of land. This is because; pastoralists have low interest in crop cultivation despite possessing large quantities of land. Hence, households have continued to rely on other sources of income in order to meet household food demand and other needs [24]. Denoting that pastoralists perceive land utilization as a means to multiply and expand their livestock. Pastoralists are always on the move in search of water and grass especially during dry seasons, which are regarded as their most critical resources. They do not pay attention to crop growing as this does not favour their mobility which is critical for responding to spatial and seasonal rangeland resources variability [1,37].

5. Conclusion and Recommendations

Rangeland resources contribute strongly to household food basket and income. Water, grass, trees and shrubs are the resources mostly contributing to household food basket in the Rangelands of Nakaseke. The peak of resource productivity and utilization in the rangelands is often between April/May and October/November. Dry seasons are marked by low resource availability thus causing the utilization to be low which also reduces income. On the other hand, the wet season favours their growth and availability which increases resource utilization thus increasing the income as well. The dry season is characterized by low income and high levels of expenditure as compared to the dry season. Based on these findings, there is need to invest in improved management of rangeland resources especially water, grass and trees to boost productivity and income. It would be appropriate also if the District authorities used these findings about the status and contribution of rangeland resources for long-term planning in order to improve food security as well as targeting policies that aim at improved food security that promote conservation of rangeland resources as a suitable strategy to build pastoral household resilience.

As such, the study suggests that, it would be proper to promote pastoralism while ensuring sustainable land management which caters for both livestock and crop growing as a copying strategy.

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Statement of Competing Interests

The principle author is self-financed master student at Makerere University. The other authors declare that they have no competing interest.

Note:

1. 1.00 US$ was equivalent to Ugandan shillings 3300 by February 2016.

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