Are Livestock Keepers in and Around Forests Key Stakeholders in Forest Management? Experiences from Mabira Central Forest Reserve, Uganda

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Abstract Globally, forests play an important role in supporting livelihoods of local communities that surround them. However, livestock rearing is hardly considered an important livelihood activity supported by forests. Forests can be a source of pastures which are key feed resources for livestock especially ruminants. There is little information on how a forest reserve affects livestock production especially in sedentary systems. In the current study, the status of livestock production in and around Mabira forest reserve, Uganda, was studied, to characterize the livestock production systems and determine the level of reliance on the forest for forages. A cross-sectional survey was conducted using a structured questionnaire, and a total of 80 households were interviewed. Results revealed that over 70% of the respondent farms had more than one livestock type. Cattle (71%), pigs (49%), chickens (47%) and goats (40%) were the most frequently kept livestock types. Most respondents fed cattle (54%) and pigs (81%) under the stall-feeding system, while 68% of the farms tethered goats. Chickens are mainly fed under free ranging feeding system (66%). Firewood, water, poles for construction and forages were the four forest products of significance importance to households rearing livestock around Mabira forest. Among the key determinants of level of reliance on forages from Mabira forest was negatively and significam, household's distance to Mabira forest (P <0.01), household size (P <0.05) and landholding size owned by the household (P <0.05) were the variables found to be statistically significant. In conclusion, livestock farmers in and around Mabira forest rear a diversity of livestock types. Forest forages contribute substantially to the feed resource base of a significant proportion of

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households rearing livestock in and around Mabira forest. Therefore, livestock keepers in and around this Forest reserve are important stakeholders in the forest estate since they depend substantially on it for livestock forage.

Keywords Livestock production · Forage resource · Forest communities · Co-benefits

1 Introduction

Forests in the tropics and the developing world are threatened and are declining in extent of area cover. Between 2000 and 2010, there was a net forest loss of 7 million hectares per year and a net gain in agricultural land of 6 million hectares per year (FAO 2016). The main causes of this trend are population growth and agriculture. In Uganda, forested areas are declining rapidly. The country's annual forest loss over 15 years (1990–2005) was approximately 90,000 ha/year (NFA 2009). This has resulted in a reduction of forest cover from an estimated 4.9 to 3.6 million ha in the country. The loss of forests has very dire consequences on human welfare and the global environment. For example, this status presents a risk to food security, energy security and income generation and has significant negative effect on climate change. For this reason, the global world has undertaken many interventions and developed a number of policies and strategies to conserve forests. Among which is the REDD+ multilateral policy. REDD+ is aimed at mitigating climate change and also supporting livelihoods and converting biodiversity (Brown et al. 2008). The implementation of REDD+ is expected to have costs for the people that live in and around forests. However, such policies must tread carefully not to restrict access to forest products for local communities (Brown et al. 2008). It is important to manage and reduce these costs if people are going to participate and support mechanisms like REDD+. To be able to do this requires identification of key stakeholders who depend on forest resources for consultation. Forest stakeholders in and around forests are many. They include livestock keeping small-scale farmers, hunters and loggers (García-Nieto et al. 2015). These depend on forests for the gathering of many different products. In many parts of the world, livestock ranching is known as a key driver for deforestation (Hosonuma et al. 2012). In Africa, fuelwood is the most important driver (Ahrends et al. 2010), but the contribution of livestock farmers is not well known (Rudel 2013). Such information would be necessary to guide the designing of appropriate and efficient strategies for decreased dependence on forests and emissions reductions. This study sought to answer two research questions: (1) What livestock production systems exists in and around Mabira Forests Reserve? (2) To what extent does the livestock community depend on the forest for forage?

2 Materials and Methods

2.1 Description of Study Area

Mabira forest reserve (Fig. 1) is located in Buikwe District, 54 km from Kampala City and 26 km from Jinja town (0°24′ and 0°35 N and 32°52′ and 33°07′E), at an altitude of between 1070 and 1340 m above sea level. It covers an area of 306 sq. km (31,293 ha). The study was conducted in two sub-counties of Buikwe District (Najjembe and Kawolo). The two sub-counties were purposively selected based on the existence of livestock production activities. According to the local government administrative system in Uganda, the lowest administrative unit is a village; several villages constitute a parish, and several parishes constitute a sub-county. The reserve is predominantly occupied by tropical high-forest communities classified as type D1 *Celtis–Chrysophyllum* medium altitude, moist, semi-deciduous forest, while the rest is classified as *Piptadeniastrum–Albizia–Celtis* medium altitude, moist, evergreen forest (Langdale-Brown et al. 1964). The Mabira forest reserve is divided into compartments according to the forest working cycles, namely, the strict nature reserve, recreation/buffer zone, production (low impact) and production (encroachment area). According to Baranga 2007, signs of former human activities such as cultivation are still obvious within the forest and especially in the recreation/buffer zone. Abandoned banana plantations (*Musa sapientum*) and jackfruit (*Artocarpus heterophyllus*) form an integral part of the forest. Timber is logged mainly from

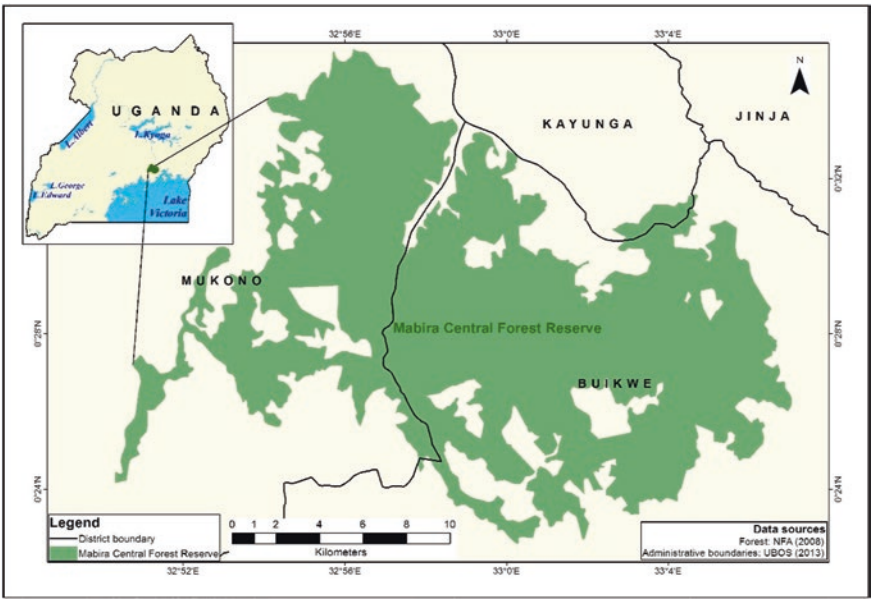

Fig. 1 Mabira forest reserve

M. eminii and *Cordia africana*, while *F. elastica* is harvested to provide building poles and firewood. *Pseudospondias macrocarpa*, *Bridelia micrantha* and *Albizia zygia* are tree species cut for charcoal burning. Wood is also extracted for domestic firewood and commercial purposes, poles for building and construction of various household items and shrubs for fencing and boundary marking. Residents in the village enclaves extract various medicinal plants from the forest. Nontimber products include materials for basket weaving, forest food items (mushrooms, honey, etc.) as well as food crops harvested from many abandoned cultivations within the forest.

2.2 Selection of Respondents

The study population consisted of households rearing livestock. According to the local government administrative system in Uganda, the lowest administrative unit is a village; several villages constitute a parish; and several parishes constitute a sub-county.

With the help of the district extension workers, two sub-counties one within Mabira forest (Najjembe) and another around Mabira forest (Kawolo) were identified as the study areas basing on their livestock rearing activities. Three parishes were purposively selected from each sub-county. This resulted in a total of six parishes. For sample selection purposes, extension workers were asked to provide lists of all households rearing cattle, goats/sheep, pigs and chickens (irrespective of herd size) from the selected parishes in their respective sub-counties of jurisdiction. Based on these lists, a sample of households to be interviewed was randomly selected for each sub-county. A total of 80 households from 23 villages distributed in the 2 sub-counties were interviewed.

2.3 Data Collection

A cross-sectional survey was conducted using a structured questionnaire. From each selected household, only one respondent, the key person involved in the daily feeding of the animals, was interviewed. The data collected included respondent characteristics, such as gender, age, education level, status in the household, years at the current home, whether one had ever undergone any training in livestock production and awareness about any forest laws and regulations for protecting and conserving forests. The questionnaire also asked about household characteristics, including the following main occupation of the household head, distance from Mabira forest, household size and main source of income for the household. Finally, the respondents were asked to provide the following farm characteristics: farmland ownership, total landholding size, herd/flock size and composition, feeding system, main reason for rearing livestock and manure handling system. Questions were also

asked to obtain information on access/extraction of forest resources (including forages for feeding livestock). The contribution that forest resources make to the household requirements was estimated using a rating of "negligible contribution", "little contribution", "moderate contribution" and "substantial contribution".

2.4 Statistical Analysis

The data were analysed using the SPSS 18.0 statistical package (2010). The analysis included Pearson chi-square tests of association. The key determinants of level of reliance on forages from Mabira forest were explored using the regression equation: $\text{LevelReliance} = b_0 + b_1 Education(secondary) + b_2 HhOff\text{-}farmEmp + b_3 HDistance + b_4 HSize + b_5 Sex\ of\ respondent + bRuminantOwn + b_6 HMainIncome + b_7 FarmSize + b_8 CattleOwn + b_9 GoatOwn + b_{10} PigOwn + b_{11} ChickenOwn + e$. The variables used in the regression equation are defined in Table 1.

Table 1 Definition of variables included in the regression model

Variable	Definition
Dependent	
LevelReliance	Level of reliance on forages from Mabira forest (little, moderate or much = 1; otherwise = 0)
Independent	
Sex	Sex of respondent
Respondent characteristics	
Education(secondary)	Respondent education level (completed secondary level = 1; otherwise 0)
AwareFLaws	Respondent awareness about forest laws and regulations (aware = 1; otherwise 0)
Household characteristics	
HhOff-farmEmp	Household head off-farm employment (off-farm employment = 1; otherwise = 0)
HDistance	Household's distance to Mabira forest
Hsize	Number of household members
HMainIncome	Main contributor to total household income (livestock = 1; otherwise = 0)
Farm characteristics	
RuminantOwn	Household owned cows or goats (yes = 1; otherwise = 0)
FarmSize	Total landholding size owned by the household
CattleOwn	Household owned cattle (yes = 1; otherwise = 0)
GoatOwn	Household owned goats (yes = 1; otherwise = 0)
PigOwn	Household owned pigs (yes = 1; otherwise = 0)
ChickenOwn	Household owned chickens (yes = 1; otherwise = 0)

3 Results

3.1 Respondent and Household Characteristics

Respondents were composed of 64% men and 36% women. The average respondent age was 44.7 ± 13 years. Over 90% of the respondents had been residing at their current homes for 5 and above years. All the respondents, except one, had some kind of formal education, see Table 2. Almost half of the respondents (48%) had ever attended at least one training in livestock production. The majority of households (55%) were located within 1 km from Mabira forest. On average each household consisted of 7.5 ± 4 members, with over 60% of the households having 5–10 members. The main contributors to the total household income were livestock, crops, salaried employment, business/trading, casual labour, sale of firewood from Mabira forest and hand-outs from relatives as shown in Table 2.

4 Farm Characteristics

4.1 Land and Livestock Ownership

Close to 76% of the respondent households owned their farmlands under the "Kibanja" (squatter) tenure category. The other households either leased (17%) or hired on a seasonal basis their farmlands (7%). Nearly one half of the respondent farms (48%) operated on more than 1 acre of land; only 19% operated on less than 0.5 acres. Over 70% of the respondent farms had more than one livestock type. Cattle (71%), pigs (49%), chickens (47%) and goats (40%) were the most frequently

Table 2 Respondents and household characteristics

Respondent characteristic	Percentage	Household characteristic	Percentage
Relation to household head		Distance of household from forest	
Household head	71	Within forest	15
Spouse	23	Within 1 km from forest	55
Son/daughter	4	Beyond 1 km	30
Other relative	1		
Education		Main source of household income	
No formal education	1	Livestock	47
Lower primary	8	Crops	22
Upper primary	32	Salaried employment	11
Lower secondary	41	Business/trading	10
Upper secondary	8	Casual labour	5
College	8	Firewood from Mabira forest	4
University	8	Handouts from relatives	1

kept livestock types. The herd sizes ranged between 1 and 10 (for cattle), 1 and 13 (for pigs), 3 and 1000 (for chickens) and 1 and 10 (for goats). The main reason for rearing the different livestock types (cattle, goats, pigs and chickens) was cash income generation either through the sale of live animals or their products (particularly milk and eggs). Slaughtering for family consumption was more common among respondent farms with chickens (32%). Nearly all respondent households (95%) were also involved in crop farming.

4.2 Livestock Breeds and Feeding Systems

The major cattle breed categories were undefined crossbreeds (75%), indigenous breeds (21%) and pure exotic breeds (12%), in that descending order of predominance (Table 2). The goat herds and chicken flocks were predominantly composed of indigenous breeds (86 and 88%, respectively). Only 18% of the respondent farms had exotic chicken breeds. About 45% of the respondent farms had indigenous pig breeds, and 56% had undefined crossbreeds. Only 12% of the farms had exotic pig breeds.

Stall feeding and tethering were the major feeding systems for cattle, pigs and goats, while free ranging and total confinement were the major feeding systems for chickens. Majority of respondent farms fed cattle (54%) and pigs (81%) under the stall-feeding system, while 68% of the farms tethered goats. Only 6.0, 3.1 and 7.1% of the respondent farms allowed cattle, pigs and goats (respectively) to scavenge (free range). Chickens were kept under the free ranging feeding system (66%), total confinement (24%) or under the semi-confinement feeding system (10%).

Various feed resources were cited by the respondents, of which elephant grass, naturally growing plants (grasses, legumes, herbs and shrubs), sweet potato vines and banana pseudo-stems were the most commonly used feed resources for cattle (in that order of importance). For goats, naturally growing plants, elephant grass, banana peels and paper mulberry (*Broussonetia papyrifera*) foliages from Mabira forest were the most commonly used feed resources. The naturally growing plants were mainly harvested from roadsides (58%), farmers' own lands (21%), Mabira forest (11%) or neighbours' lands (11%). Pig farmers cited maize bran, cocoyams (*Colocasia* and *Xanthosoma* species), sweet potato vines and brewer's waste, whereas chicken farmers cited scavengeable feed resources, compounded feeds and maize bran as their most commonly used feed resources.

4.3 Housing and Manure Management

In the majority of the farms, night-time housing structures were specifically constructed for goats (50%), cattle (56%), chickens (65%) and pigs (80%). The kitchen was used in 22.6% and 17.9% of the farms for chickens and goats, respectively.

In some farms, the cattle (19%), goats (18%) and pigs (15%) would be tethered under trees for night shelter. Only 3.6% and 3.2% of the farms accommodated goats and chickens (respectively) within their family houses. Different practices were reported in the handling of livestock manures. The vast majority of respondent farms spread/incorporated the fresh manure from cattle (65%), goats (80%), pigs (61%) and chickens (73%) directly into the soils in their gardens. A few farms composted the manure (less than 15%) or used it for biogas production (only 2%) (Table 3).

Table 3 Livestock ownership characteristics

	% of responses			
	Cattle	Goats	Pigs	Chickens
Breed				
Indigenous breeds	21	86	44	88
Undefined crossbreeds	75	24	56	12
Exotic breeds	12	3	12	18
Feeding system				
Stall feeding/zero-grazing (total confinement)	54	25	81	24
Free ranging (scavenging)	6	7	3	66
Tethering	34	68	16	–
Communal herding[a]	4	–	–	–
Semi-stall feeding (semi-confinement)	2	–	–	10
Reason for keeping livestock				
Milk/eggs for cash income	63	–	–	14
Milk/eggs for family consumption	26	–	–	5
Live animals for cash income	11	86	100	50
Slaughter for family consumption	–	7	–	32
Slaughter for cultural ceremonies	–	4	–	–
Livestock manure	–	4	–	–
Housing for livestock				
Under a tree	19	18	14	–
Animal structure	56	50	80	65
Backyard kraal	25	4	6	–
Within family house	–	4	–	3
Kitchen	–	18	–	23
Balcony	–	4	–	–
Store on family house	–	–	–	10
Livestock manure handling system				
Composting (aerobic degradation)	6	12	9	14
Biogas production (anaerobic degradation)	2	–	–	–
Spreading/incorporation of fresh manure in soil	67	80	61	73
Stacking before spreading/incorporation in soil	18	4	30	–
Sell to fellow farmers	4	–	–	14
Simply ignore	2	4	–	–

[a]A herder is paid (either on a daily or monthly basis) to graze several herds on open access lands (roadsides, undeveloped plots, etc.)

4.4 Reliance on Forest Forages

Besides firewood, water and poles for construction, forages were the fourth forest product of significant importance to households rearing livestock in and around Mabira forest (Table 4). The level of reliance on forages from Mabira forest was indicated as negligible 49.2%, little 21.3%, moderate (9.8%) and much (19.7%). Naturally growing plants, foliages of paper mulberry (*Broussonetia papyrifera*) and Ficus tree species were the most frequently cited forages (in that order of importance) extracted from Mabira forest. These forages were used in the cut-and-carry system (forages are cut and carried to the animals but not fed from within the forest).

Results of the regression equation developed to explore the key determinants of level of reliance on forages from Mabira forest are presented in Table 5. Household's distance to Mabira forest ($P < 0.05$), household size ($P < 0.01$) and landholding size owned by the household ($P < 0.05$) were the variables found to be statistically significant. The regression coefficient of awareness about household size, sex of respondents and maximum level of education was positive, while the coefficients of distance to the forest, ownership of ruminant animal and landholding size were negative.

5 Discussion

5.1 Farm Characteristics

Most of the respondents owned more than one livestock type, the majorly consisting of cattle, pig, chicken and goats. This is a common practice in mixed farming communities in Africa. Keeping more than one livestock type is regarded as a financial security and risk response, especially in cases of disease outbreak. This result is in accordance with earlier studies (Malla et al. 2003) who indicated that livestock is a

Table 4 Respondents' perceived level of reliance on resources from Mabira forest

	% of responses			
	Zero or negligible	Little	Moderate	Much
Firewood	39.4	1.5	0.0	59.1
Water	53.7	1.9	7.4	37.0
Poles for construction	59.3	7.4	9.3	24.1
Forages	49.2	21.3	9.8	19.7
Wild foods	70.0	12.0	6.0	12.0
Timber	86.3	2.0	7.8	3.9
Medicinal plants for animal	85.2	1.9	9.3	3.7
Medicinal plants for humans	71.4	7.1	17.9	3.6
Hunting	96.1	2.0	2.0	0.0

Table 5 Key determinants of level of reliance on forages from Mabira forest

Variables	Coefficient	*t*-value	*P*-value
Education(secondary)	0.143	0.885	0.318
HhOff-farmEmp	0.063	0.509	0.613
HDistance	−0.275**	−2.821	0.007
HSize	−0.035*	−2.130	0.038
HMainIncome	0.035	0.283	0.778
FarmSize	−0.183*	−2.044	0.047
CattleOwn	0.166	1.103	0.276
GoatOwn	0.065	0.507	0.615
PigOwn	0.173	1.346	0.185
ChickenOwn	0.146	1.346	0.185
RuminantOwn	−0.028	−0.232	0.817
Sex	0.145	−1.117	0.270
Constant	1.037*	2.420	0.019
Model statistics			
R^2	0.392		
Adjusted R^2	0.249		
F-value	2.750		
P-value	0.008		

*, **Significance at 5% and 1%, respectively.

major capital asset among forest communities. In addition to livestock production, almost all respondents were involved in crop production. This is an indication that the community has alternative activities they rely on for food and income as opposed to depending on the forest products solely. Alternative activities are known to reduce pressure on the forest and thereby promote the restoration and conservation of natural resources (Fisher 2004). This could also mean that the forest products available to the community may not necessarily be those products which are most needed by the people or may not be equitably distributed in the case were they are needed (Timsina 2002; Neupane 2003).

5.2 Livestock Breeds and Feeding Systems

Stall feeding and tethering were the major feeding systems for cattle, pigs and goats in this community. This finding is similar to that reported by Prabhu et al. (2003) in Zimbabwe. This result implies that these animals are not freely grazed in the forest; rather, forage is cut and carried to the livestock, or the livestock are tied around a particular tree so they can graze on the nearby vegetation in the radius of the rope. This reduces on the effect of trampling on the forest, overgrazing, uncontrolled grazing and the likelihood of cutting down trees to create grazing land. This finding is contrary to Delcurto et al. (2005), who indicated that livestock exert a lot of pressure on the forest through their grazing behaviour. This study has demonstrated that

livestock production can be practiced in forest communities without threatening the degradation of the forest if pasture harvesting is practiced sustainably. This should be benchmarked by other forest communities that have been grazing directly in the forest. The study further proves that livestock production is an alternative economic activity that can be adopted by forested communities' in order to reduce pressure on the forests. This component should further be included in the training programmes on forest sustainability use, restoration and co-existence with humans.

5.3 Housing and Manure Management

Manure from the livestock was incorporated into the soils of the gardens while fresh by the majority of the respondents. This practice is detrimental to the environment due to its potential to emit carbon gases to the atmosphere. According to Hao et al. (2005), manure disposal practices are one of the avenues through which livestock contribute to the increase in carbon gases. These carbon gases (N_2O and CH_4) are produced when anaerobic (without oxygen) decomposition of manure takes place. When manure is handled as a solid or deposited naturally on grassland, it decomposes aerobically (with oxygen) and creates little methane emissions. These greenhouse gases can be directly or indirectly produced and emitted at each stage of the manure management process, including manure stores, manure pits, manure treatment and manure spreading/incorporation to land (Chadwick et al. 2011).

Therefore farmers should be trained in manure handling practices that are friendly to the environment such as creation of energy through biogas, frequent and complete manure removal (Johnson et al. 2007) and recycle to form other animal feeds. This will contribute to the clean climate mechanisms while improving incomes, food security and ultimately better livelihoods for the communities.

5.4 Reliance on Forest Forages

Besides firewood, water and poles for construction, forages were the fourth forest resource of significant importance to households rearing livestock in and around Mabira forest. Extraction of forest forages has also been reported by previous studies on forest dependency by local households (Adhikari et al. 2004; Mamo et al. 2007; McElwee 2010). Results of this study indicated that the contribution that forages from Mabira forest make to the livestock feed resource base decreased with household's distance to Mabira forest ($P < 0.01$), number of household members ($P < 0.05$) and landholding size owned by the household ($P < 0.05$). As expected, distance to the forest was negatively and significantly associated with the contribution that forages from Mabira forest make to the livestock feed resource base ($P < 0.01$). This implies that the closer a livestock farmer is from Mabira forest, the more likelihood to rely on forest forages. The negative and significant relationship observed for

distance to Mabira forest is in agreement with previous studies (Mamo et al. 2007; Illukpitiya and Yanagida 2008; Kamanga et al. 2009) on extraction of forest resources or income from forests. Generally, increasing distance to the forest reduces extraction of forest resources.

Farm size was found to be negatively and significantly associated with the contribution that forages from Mabira forest make to the livestock feed resource base ($P < 0.05$), implying that households with better access to farmland are better able to circumvent the feed scarcity constraint, compared to households with smaller land acreages. However, the negative association observed contradicts previous forest dependency studies in Ethiopia (Babulo et al. 2008) and Nepal (Adhikari et al. 2004), whereby livestock rearing households with more access to grazing land had the likelihood of greater dependence on forest fodder. Unlike intensive farms (where livestock are under total confinement), extensive farms (where livestock are let out to the grazing areas) tend to be highly dependent on freely available environmental resources. Thus, in extensive systems (as in many parts of Ethiopia and Nepal) more access to grazing land tends to be related to bigger livestock herds, which in turn implies greater use of environmental resources such as forest forages. In this study, the vast majority of the respondent farms had small herd sizes and were particularly based on zero-grazing and tethering systems. Thus, in intensive systems, larger acreage households are more likely to access forages from their own farms as opposed to lower acreage households and hence the likelihood of lesser dependence on forest forages.

6 Conclusion

Livestock farmers in and around Mabira Central Forest Reserve rear a diversity of livestock types. Forest forages contribute substantially to the feed resource base of a significant proportion of households (29.5%) rearing livestock in and around Mabira forest. Therefore livestock keepers in and around this reserve are important stakeholders in the forest estate since they depend substantially on it for livestock forage.

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