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Full Length Research Paper

Economic and socio-cultural evaluation of livestock farming amid severe soil degradation in Western Kenya

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This paper analyzes, from both economic and socio-cultural perspectives, the roles of livestock in the livelihoods of western Kenya's Luo people, who live in an area facing severe soil erosion due to overgrazing. Forty-five households within the study area were surveyed and studied through participatory observation over 10 months. We classified them into five groups depending on their livestock keeping and examined the groups' socioeconomic characteristics in order to link livestock to livelihoods. The results show that households in the two groups owning the most livestock included many paternal extended families and their widows. The former group tended to live under unfavorable economic conditions, with comparatively lower off-farm incomes and negative post-food-purchase incomes. On the centrally, the latter group did not show negative post-food-purchase income due to smaller number of family members. However, these both groups' households also obtained large shares of their livestock through socio-cultural methods, such as entrustment, gifts, and marriage payments. After obtaining higher incomes by selling these livestock, they were able to pay school fees for their children, allowing them to access to a better future through education. The results demonstrate the importance of socio-cultural methods for obtaining livestock, which work through reciprocity. This has clear policy implications: when devising countermeasures to overgrazing, policymakers must consider both economic and socio-cultural roles played by livestock.

Key words: Entrustment, Livestock, Livelihood, Pastoralist, Reciprocity, Overgrazing, Socio-cultural motivation, Soil erosion.

Abbreviations used: Kenyan shilling (Ksh), meters above sea level (masl), tropical livestock units (TLU).

INTRODUCTION

In the Nyando River Basin near Lake Victoria in Western Kenya, the Luo, a group of Nilotic people, have long been pastoralists and remain engaged in livestock farming. This area is blessed with more than 1, 315 mm of rainfall annually (Kiwango and Wolanski, 2008), in stark contrast to the 80% of Kenya that is characterized by arid and semiarid conditions, with annual rainfall below 600 mm (Rarieya and Fortun, 2010). However, this rain causes severe soil erosion, which continues to worsen (ICRAF, 2006; Hoshino, et al., 2004; Sigunga, et al., 2011). Problems of overgrazing are also rife (KARI, 2004) and have produced a vicious cycle, leading to further degradation of the soil environment due to intensive land use (Conelly and Chaiken, 2000). This degradation in turn further exacerbates poverty (Kristjanson et al., 2004). As a result, the region has been the target of numerous projects supported by multiple organizations, including the World Bank (Rarieya and Fortun, 2010).

In Africa, livestock are both valuable assets for smallholder farmers with subsistence-level livelihoods and play other key roles depending on the cultural and environmental conditions (Nyasimi et al., 2007; Kristjanson et al., 2004). In previous studies aimed at promoting environmental protection and preventing overgrazing, the appropriate grazing pressures and land uses have estimated from an agronomic perspective (van Voorthuizen, 1970; Du Toit, 2000). In addition, economics researchers have estimated farmers' incomes from livestock farming in order to control livestock population sizes without incurring losses (Jarvis, 1991; Hiernaux,

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1992). Such studies tend to focus primarily on pastoralists, who hold considerable amounts of livestock (Sindiga, 1984; Livingstone, 1991).

Improvements to or changes in livestock farming in the study area might be one method to prevent further soil erosion. However, livestock have not only economic value to pastoralists but also socio-cultural meaning (Konaka, 2006; Soga, 1998). Research on the so-called moral economy argues that African economies are normally characterized by a double economy, with both a capitalist production sector and a self-sufficient economic production sector (Hirata, 2010). In the self-sufficient sector, social relationships, such as reciprocity, play important roles in ensuring the subsistence of individuals within a rural community (Sakamoto, 2006). In Nilotic society, in particular, cattle play crucial roles in both cultural and economic spheres (Kristjanson et al., 2004). The Luo people, like many pastoralists, have customs that construct social relationships through the exchange of livestock (Shipton, 2007). Therefore, any consideration of the appropriate measures to combat soil degradation in the study area must rely on more than just the economic evaluations of livestock farming that have characterized previous studies.

In this study, we thus evaluate not only the economic but also the socio-cultural roles of livestock in the livelihoods of the Luo people, who suffer from overgrazing and soil degradation. By doing so, we aim to find suitable countermeasures and detect appropriate targets for intervention. To this end, we identify several typologies of Luo households by capturing household and cultural characteristics and finding relationships between household types and the structure of livestock farming within each type of household. The following section describes the methods used, including the study area. The third section then presents results; these are discussed briefly in the fourth section before the final section concludes the paper.

METHODS

Study area

The Nyando River runs from the highlands of Nyando Province, about 2,000 meters above sea level (masl), to Lake Victoria at 1,184 masl. About 450-500 years ago, the Luo, a Nilotic people, emigrated from Sudan to the north coast of Lake Victoria, including the Nyando River Basin (Shipton, 2007). Throughout the basin, the Luo engage in mixed farming, including crop cultivation and animal husbandry (ICRAF, 2006). The area is characterized by very high population densities of 214 people/km^2 on average but reaching over 1200 people/km^2 in some areas of the basin (KARI, 2004). The study area of Jimo East sub-location in Nyando District (0.18-0.19°S, 34.59-35.23°E) varies in elevation from 1,100 to 1,300 masl. In this sub-location, several gullies have been formed, with the longest one stretching over 10 km and the deepest exceeding 20 m in depth. Mixed farming of cereal and livestock is common throughout the area (Figure 1).

The Luo people have a virilocal patriarchal society with a high rate of polygamy (Shiino, 2008). Their minimum residence unit, called a *dala,* consists of a man, his multiple wives, their children, and their grandchildren (Shiino, 2008). Each Luo village is formed as an aggregation of *dalas* occupied by people who believe they share a specific ancestry (Shiino, 2008). According to Luo custom, adult men must build their own *dala* outside of their father's *dala*. They cannot be recognized as adult men in Luo society until they have built their own *dala* (Shiino, 2008). However, in the study area, an adult man will sometimes continue to live in his father's *dala* with his family due to financial difficulties.

Social relations based on entrustment (i.e., informal agreements to exchange or lend livestock) play significant roles in every aspect of Luo society (Shipton, 2007). Livestock exchanges through entrustment-based relationships are observed throughout the Luo people. People lend livestock for many reasons, including agronomic and economic ones, such as taking advantage of better open grazing, to conserve land in heavily cropped areas, or to lessen the labor of herding (Shipton, 2007). Lending cattle also spreads the risk of disease, theft, or raiding. Through one mechanism, a cattle owner vows to give a calf to the person who took care of his cattle once there is a birth. Such practices are widespread, usually between people living in the same area, and most lenders expect the animals' eventual return (Shipton, 2007).

Surveys and analysis methods

The author (Y. Yamane) stayed with a host family in the study area for 10 months (March to May 2009; January to March 2010; February, August, and December 2011; and May 2012). The daily lives of the people and their agricultural practices were observed using the participatory observation method; surveys were also conducted. The households interviewed were randomly selected from across the study area (Figures 1).

The study area, shown in Figure 1, was in Jimo East sub-location, near the border between Nyanza Province and Rift Valley Province. The number of households in the study area was estimated using an RGB image created using GIS software (GRASS 6.4.0) on orthorectified images taken on April 14, 2009 by Digtal Globe's QuickBird satellite. On the image, the land was divided into bounded sections or "compartments." In total, 2014 compartments were detected in the study area, and houses were observed in 541 of them. These 541 compartments were thus thought to represent *dala* (Yamane et al. under submission).

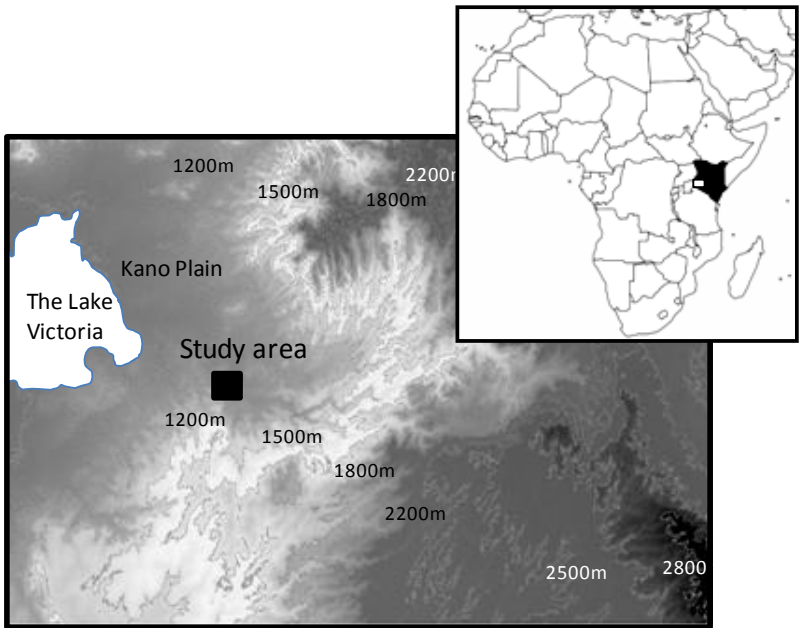

Figure 1 a. Study area located near The Lake Victoria.

Figure 1b. Distribution of investigated 45 households out of 541households in the study area.
* Compartments which were colored Wight showed surveyed households.

In May 2009, 45 of the 541 households (8.3%) were interviewed; these households were randomly selected from all those in the study area. The interview questionnaires sought information on the number of family members who could be considered a shared livelihood unit within the *dala* and about the non-agricultural activities undertaken by each member. To estimate the household food security situation, information was collected on yields of staple food crops (maize and sorghum) harvested in 2008 and 2009, sales of crop and livestock products, total income by source, and expenditures using these incomes. Information was also collected about household livestock rearing, including the number, gender, and types of cattle, small ruminants, and chickens, as well as how the livestock were obtained (e.g., purchase, birth, gift, or entrustment). In addition, information about the number and prices of cattle traded between August 2009 and July 2010 in the local market (Sondu) was collected from the county council office in Kericho in March 2010 and November 2011.

Households were classified into two basic types based on

Table 1. Family structure and livestock TLU of each household living in a dala[a]

Group	Type[b]	Dwellers of Type 1 Widow[c]	TLU	Number of consumers[d]	Age of household head	Age of wife			Children(age)					Grandchildren				Other people in the same dala[e]	
												15>							
						lst wife	2nd wife	3rd wife	>2	2-7	7-15	M	F	>2	2-7	7-15	15>		
A1	Type1	Wid	Wife and son's family	9.3	3.3	Dead	60s	-	-	0	0	1	1	0	2	0	0	0	1 Son's wife
A2	Type1			6.6	12.2	65	53	Dead	-	0	1	0	7	1	0	0	3	0	0
A3	Type2			5.5	4.8	62	56	-	-	0	0	2	0	2	0	0	0	0	0
A4	Type1			4.9	8.4	76	65	60	-	0	0	1	5	1	0	0	0	0	0
A5	Type1			4.5	7.8	70	63	-	-	0	1	1	3	1	1	2	0	0	0
A6	Type1	Wid	Elder dead son's wife and younger son	3.6	4.7	Dead	Dead	-	-	0	0	0	1	0	0	1	3	0	1 Wife of elder son
A7	Type1	Wid	Wife and divorced daughter and grandchildre	3.6	1.6	Dead	65	-	-	0	0	0	0	1	3	0	0	0	0
A8	Type1			3.0	6.3	54	38	28	-	0	1	2	1	1	0	0	0	0	0
A9	Type1	Wid	Wife and dead son's family	2.9	5.7	Dead	60s	-	-	1	1	3	1	0	0	1	0	0	1 Son's wife
		Average for Group A	**4.9**	**a**[f]	**6.1**	**a**	**65**	**56.7**			**0.1**	**0.4**	**0.9**	**2.3**	**0.9**	**0.7**	**0.4**	**0.7**	**0.0**	**0.3**	
B1	Type1			3.3	3.0	64	48		-	0	1	1	0	0	0	0	0	0	0
B2	Type1			2.7	2.8	54	46	-	-	0	0	0	1	0	0	0	0	0	0
B3	Type2			2.4	9.4	58	47	42	-	0	0	4	0	5	0	0	0	0	0
B4	Type1	Wid	Wife and dead son's family	2.4	7.5	Dead	32	17	-	0	4	3	1	2	0	0	0	0	0
B5	Type2			2.4	16.8	56	45	42	35	0	6	2	4	2	0	2	2	1	0
B6	Type2			1.8	4.2	47	42	-	-	0	0	1	0	0	1	1	0	0	2 Wife's dead younger sister's
B7	Type1	Wid	Wife and grandchildren	1.6	1.3	Dead	70	-	-	0	0	0	0	0	1	1	0	0	0
B8	Type1			1.6	5.8	70	60	-	-	0	0	0	4	0	0	0	0	0	0
B9	Type1			1.5	6.0	72	Dead	55	38	1	0	2	2	0	6	0	0	0	0
B10	Type2			1.4	15.1	49	38	30	-	2	5	4	4	4	0	0	0	0	0
B11	Type2			1.3	9.0	50	50	-	-	0	1	1	6	0	0	0	0	0	0
B12	Type2			1.1	6.2	46	40	36	-	0	0	0	2	2	0	0	0	0	0
B13	Type1	Wid	Wife and sons	1.0	5.8	Dead	67	-	-	0	0	0	5	0	0	0	0	0	0
B14	Type2	Widow		0.8	2.8	Dead	32	-	-	1	1	1	0	1	0	0	0	0	0
B15	Type2			0.8	3.5	27	23	-	-	0	2	1	0	0	0	0	0	0	0
		Average for Group B	**1.7**	**b**	**6.6**	**a**	**54**	**46**			**0.3**	**1.3**	**1.3**	**1.9**	**1.1**	**0.5**	**0.3**	**0.1**	**0.1**	**0.1**	
C1	Type2			2.1	4.8	40	32	-	-	0	3	1	0	1	0	0	0	0	0
C2	Type1			1.4	8.4	49	44	-	-	0	1	3	4	0	0	0	0	0	0
C3	Type1			1.4	9.4	80	60	-	-	0	0	0	6	2	0	0	0	0	0
C4	Type2			1.4	6.0	47	42	-	-	0	0	2	2	1	0	0	0	0	0
C5	Type2			1.4	7.5	39	37	-	-	1	1	2	3	1	0	0	0	0	0
		Average for Group C	**1.5**	**b**	**7.2**	**ab**	**51**	**43**			**0.2**	**1.0**	**1.6**	**3.0**	**1.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	

D1	Type2	0.6	6.7	45	40	-	-	1	2	3	0	1	1	0	0	0	0
D2	Type2 Widow(Widower)	0.4	1.0	41	Dead	-	-	0	0	0	0	0	0	0	0	0	0
D3	Type2	0.4	11.4	53	48	42	-	0	3	4	3	2	0	0	0	0	0
D4	Type2	0.4	5.9	46	21	-	-	1	2	3	1	0	0	0	0	0	0
D5	Type2	0.3	7.7	49	46	41	34	1	2	2	0	0	0	0	0	0	0
D6	Type2	0.2	4.1	56	55	-	-	1	2	0	0	0	0	0	0	0	0
D7	Type2	0.2	7.3	39	26	Jnknown	-	0	1	1	1	2	0	0	0	0	0
D8	Type2 Widow	0.1	3.6	Dead	68	-	-	0	0	4	0	0	0	0	0	0	0
	Average for Group D	**0.3 c**	**6.0 a**	**47**	**43**			**0.5**	**1.5**	**2.1**	**0.6**	**0.6**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**
E1	Type1	0.0	11.6	70	41	38	Dead	1	2	2	5	2	0	0	0	0	0
E2	Type2	0.0	2.8	50	45	-	-	0	2	0	0	0	0	0	0	0	0
E3	Type2 Widow	0.0	5.5	Dead	35	-	-	0	1	2	2	1	0	0	0	0	0
E4	Type2 Widow(Widower)	0.0	1.8	36	Dead	-	-	0	0	0	0	1	0	0	0	0	0
E5	Type2 Widow(Man (unmarried))	0.0	1.0	19	-	-	-	0	0	0	0	0	0	0	0	0	0
E6	Type2 Widow	0.0	2.7	Dead	32	-	-	1	1	2	0	0	0	0	0	0	0
E7	Type2	0.0	6.9	39	25	-	-	0	2	3	2	0	0	0	0	0	0
E8	Type2 Widow	0.0	4.7	Dead	37	-	-	0	1	2	2	0	0	0	0	0	0
	Average for Group E	**0.0 d**	**4.6 ac**	**43**	**36**			**0.3**	**1.1**	**1.4**	**1.4**	**0.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
	Average for all 45 households	**1.8**	**6.1**					**0.3**	**1.1**	**1.5**	**1.8**	**0.8**	**0.3**	**0.2**	**0.2**	**0.0**	**0.1**

a:Households were classified into 5 groups based on the type of keeping livestock: group A (cow+bull+small ruminant), group B (cow+small ruminant), group C (cow or bull), group D (small ruminants), group E (no livestock) and tropical livestock unit(TLU) was calculated(Wint and Bourn, 1994); One unit of TLU represents 250 kg live weight, equivalent to one camel, 1.43 cattle, or 10 small ruminants.

b:Classified by difference of family structure; Type 1 represents paternal expanded family in which father's family and sons' families lived together in a d *ala*. Type 2 represents nuclear family which is consisted with adult men, his wives, daughters and young sons who has not yet married. Type 1 Widow represents widows' households of Type 1, Type 2 Widow represents widows' households of Type 2.

c: Dweller's description is in reference to household head.

d: Number of consumer per household was calculated using the formula of Richards and Widdowson (1937). One consumer is defined to be equal to a man whose age is above 15 years, a woman above 15 years is equal to 0.8, a child whose age from 7 to 15 years is equal to 0.7 and a child from 2 to 7 years is equal of 0.5 of a consumer.

e:Information about other members who are member of a unit of livelihood was mentioned.

f: Letters shown after the TLU and consumers columns indicate a significant difference (<5%) with the indicated group, according to the Mann-Whitney test.

family composition. Type 1 represented an extended paternal family in which the father's family and his sons' families lived together within a *dala*. Type 2 represented nuclear families consisting of an adult male, his wives, daughters, and unmarried sons. Among 45 households, 12 widow-headed households (in which the father was dead) were detected (Table 1). In Type 1 Widow households, in which the head of the extended paternal family had died, various family patterns were observed. For example, in one case the household head who had built the *dala* had died, and his son and son's family lived together with his mother in the *dala*. In the other case, the son had also died, but his wives and mother lived together within his father's *dala.* Given this diversity, detailed information on household members is included for the Type 1 Widow households. In contrast, family patterns in the Type 2 Widow households were comparatively simple: most consisted of a mother and her children. In addition, three households headed by currently unmarried men (two men whose wives had died and a young man who had not yet married) were observed. These were classified within the Type 2 Widow group. In the analysis, we tested for differences between groups classified according to the different structures of livestock farming or between the types as classified by household structure using the non-parametric Mann-Whitney U-test.

RESULTS

Livestock holdings

Agriculture in the study area can be divided into crop cultivation and animal husbandry. Most families grow maize and sorghum and raise cattle, goats, and sheep in a grazing-based system. Some farmers also keep poultry. While some households keep donkeys, these are used to carry cargo and do not directly contribute to household income. Therefore, donkeys are not considered in this paper, which is focused on the roles of livestock as an income source and means to a livelihood.

Most cattle in the study area were Zebu. A few dairy breeds were kept as oxen, but no households of the 45 surveyed kept dairy cows. Households were classified into five types, based on the composition of household animals: Group A (cow + bull + small ruminants), B (cow + small ruminants), C (cow or bull), D (small ruminants), and E (no animals). In the following discussions and tables, we refer to some households by codes based on their group, as shown in Table 1 (e.g., "A4" is the fourth Group A household). Cows and bulls are kept for different purposes. Cows are kept for reproduction and milk production, though they yield only 2 L of milk per day. This milk is commonly consumed with tea in the morning. Bulls are kept for plowing crop fields: bull owners earn income from leasing their animals' labor during the cultivation period. In 2009, the rates were from 400 to 700 Kenyan shillings (Ksh) per acre (1 Ksh = 0.011 USD).

It is common to perform a headcount of cattle (cows and bulls) and small ruminants and convert this information into tropical livestock units (TLU) for ease of comparison (Wint and Bourn, 1994). One TLU represents 250 kg of live weight, equivalent to one camel, 1.43 cattle, or 10 small ruminants. TLU values were calculated across household groups (Table 1). Nine households were classified into Group A; these households' livestock holdings averaged 4.9 TLU, with values ranging from 2.9 to 9.3 TLU per household. Fifteen households, one third of the total, were classified into Group B. TLU values for Group B ranged from 0.8 to 3.3, with an average of 1.7. Five households who kept only cows were classified into Group C, for which the holdings ranged from 1.4 to 2.1 TLU, with an average of 1.5 TLU. Group D included eight households who kept 1-6 small ruminants, with holdings ranging from 0.1 to 0.6 TLU and averaging 0.3 TLU. Eight households were classified in Group E because they owned no ruminants. The average TLU holdings were statistically different across the five groups, with the exception of that between Groups B and C (Table 1).

In addition to the differences in livestock holdings among the households belonging to different groups, it was expected that the roles of livestock in household livelihoods would also be different across the groups. As such, the next subsections focus on income from both on- and off-farm activities, thereby illuminating the role of livestock within household livelihoods.

Household food needs

In the morning, people in the study area typically eat boiled sweet potato (60 Ksh per 5 kg) or bread (40 Ksh per loaf), which are cheaper than maize. At lunch and dinner, they prefer to eat *ugali*, a thick porridge made from maize or sorghum flour. However, many poor families cannot eat *ugali* even once per day. To evaluate whether households were producing sufficient staple food crops, such as maize and sorghum, to fulfill these consumption needs, the number of consumers per household was calculated using the formula of Richards and Widdowson (1936) and the data shown in Table 1. In this formula, one "consumer" is defined as equal to a man over age 15; a woman over age 15 is considered 0.8 of a consumer, a child aged 7 to 15 is equal to 0.7 of a consumer, and an infant from 2 to 7 years is equal to 0.5 of a consumer. The amount of staple food crops needed to meet daily consumption needs can then be calculated using the number of consumers per household. In our sample, the average number of consumers per household was estimated as 6.1 (Table 1). A man over 15 years old ordinarily consumes about 250 g of maize or sorghum flour per meal. Therefore, the average weight of maize flour consumed by a household was estimated as 1.53 kg (250 g × 6.1) per day.

Table 2. Household economic characteristics, calculated by household group

Group[a]	Number of households	Income from agricultural products[b]	Value of self-produced cereals[c]	Food purchased using agricultural income[d]	Total income from off-farm activities[e]	Total farm and off-farm income (T)[f]	Cost of maize flour to meet annual food needs (C)[g]	T-C
		(Ksh/year)	(Ksh/year)	(Ksh/year)	(Ksh/year)	(Ksh/year)	(Ksh/year)	(Ksh/year)
Group A	9	2865 ± 5731 a	7844 ± 10309 a	444 ± 1333 a	34,354 ± 33,172 a	42,111 ± 34,916 a	27,781 ± 14,185 a	19,820 ± 39,129 a
Group B	15	2873 ± 4594 ab	5767 ± 3624 ab	20 ± 77 a	42,000 ± 42,205 a	48,086 ± 43,145 a	30,234 ± 20,381 a	17,126 ± 43,825 a
Group C	5	128 ± 200 ac	11700 ± 16084 a	164 ± 190 a	57,360 ± 82,410 a	69,224 ± 76,293 a	32,941 ± 8,403 a	36,283 ± 63,038 a
Group D	8	28 ± 80 ac	5838 ± 5087 a	28 ± 80 a	25,980 ± 20,020 a	31,846 ± 22,228 a	27,204 ± 14,283 a	3,387 ± 18,846 a
Group E	8	0 ± 0 ac	3438 ± 2021 ac	0 ± 0 a	20,460 ± 17,778 a	23,898 ± 19,255 a	21,102 ± 15,687 a	2,796 ± 24,584 a
Total	45	1,607 ± 3,934	6,440 ± 7,563	119 ± 600	35,400 ± 40,565 [h]	41,906 ± 40,892	27,882 ± 16,125	14,509 ± 41,793

a: Refer to footnote a in Table 1.

b: Total income obtained by selling agricultural products, such as cattle, other animals, maize, or peanuts.

c: Calculated as follows: Total yield (kg) × 100 Ksh/2kg (Price of maize in the study area in May 2009).

d: Actual spending to buy maize flour from income from agricultural products.

e: Calcurated based on the data from Table 3.

f: Amount assumed to be used for purchasing food (Value of self-produced cereals+Food purchased using agricultural income+Total income from off-farm activities).

g: One consumer eats 250g of maize flour for one meal in this area, therefore, total cost is estimated as 0.25 × consumer number × 365 × 100/2 Ksh/household/year.

h: The average was calculated using the data from 42 out of 45 households due to unclear information for 3 households (two belonging to group A and one to group B).

Staple food crops such as maize and sorghum are cultivated only once a year in the study area. Nearly all households cultivated staple food crops: 26 households cultivated maize and sorghum, 15 cultivated only maize, 3 households cultivated only sorghum, and 1 household did not cultivate any cereals. The average total production of staple crops was 129 kg per household. Average per household production was higher for Group C (234 kg per household) than for other groups due to one household's very high yield (800 kg). However, this difference was not significantly significant. On the other hand, the average production in Group E (69 kg per household) was significantly lower than that of Group B (115 kg per household).

Given that households cook maize and sorghum in similar ways, it was not considered necessary to distinguish between maize and sorghum when discussing household food shortages. The average production across the 45 households was estimated as enough to satisfy consumption needs for 3.7 months. In 28 households (62%), it was sufficient for less than 4 months' worth of consumption. For Groups A, B, and E, production was estimated as meeting needs for 4.1, 3.3, and 3.4 months, respectively. The shortest period estimated was for Group D, at 2.9 months. It appeared that 39 households out of 45 would need to buy food to satisfy their needs for more than 8 months of the year. Only two households produced enough food to meet their full annual consumption needs, though one farmer in Group C harvested enough to meet nearly two years' worth of once-daily *ugali* consumption. In sum, although most farmers cultivated cereal crops, the production was usually too small to meet the household's consumption needs.

Farm income

The above analysis indicates that many farmers in the study area must purchase food to survive for more than 8 months of the year. To clarify how they obtain the money to buy their food and maintain their livelihoods, we also considered household income sources. Household income can be divided into farm and off-farm income, and farm income can be further divided into income

Table 3. Off-farm occupations and incomes of different household members.

	Household head				First wife				Other family members	
Job	Number of household head	Income[a] (Ksh/day)	(Ksh/month)	(Ksh/year)	(people)	Income[a] (Ksh/day)	(Ksh/month)	(Ksh/year)	(people)	Income (Ksh/day)
Wage labor (local)	14	50-200	NA	NA	16	50-150	NA	NA	14	50-70
Wage labor in Kisumu	1	400	NA	NA	NA	NA	NA	NA	NA	NA
Small business	3	NA[b]	3000-4000	NA	NA	NA	NA	NA	NA	NA
Acting as chief	2	NA	300	NA	NA	NA	NA	NA	NA	NA
Head teacher, secondary school	1	NA	17000	NA	NA	NA	NA	NA	NA	NA
Village government	1	NA	6000	NA	NA	NA	NA	NA	NA	NA
Teacher of primary school	1	NA	5000	NA	NA	NA	NA	NA	NA	NA
Ox-plowing	1	NA	NA	12000	NA	NA	NA	NA	NA	NA
Milling machine operator	1	200	NA	NA	1	200	NA	NA	1	200
Cattle herding	1	NA	800	NA	NA	NA	NA	NA	NA	NA
Rope production	1	NA	300	NA	NA	NA	NA	NA	NA	NA
Chair rental	1	NA	NA	640	NA	NA	NA	NA	NA	NA
Restaurant owner	1	300	NA	NA	1	300	NA	NA	NA	NA
Bike taxi driver	1	50	NA	NA	NA	NA	NA	NA	NA	NA
Kindergarten owner	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Handicrafts	NA	NA	NA	NA	3	NA	100-250	NA	NA	NA
Hair salon	NA	NA	NA	NA	2	20-100	NA	NA	1	(unknown)
Selling firewood	NA	NA	NA	NA	2	100	NA	NA	NA	NA
Remittances from son	NA	NA	NA	NA	2	NA	NA	NA (unknown)	NA	NA
Selling edible wild plants	NA	NA	NA	NA	1	50	NA	NA	1	(unknown)
Primary school teacher	NA	NA	NA	NA	1	NA	NA	5000	NA	NA
No job	2	NA	NA	NA	11	NA	NA	NA	NA	NA
	33				40				17	

a. Figures are directly referred to the answers of respondents: day, week, month or year basis.

b: NA: not applicable.

from selling crops and that from selling livestock.

Considering crop sales and expenditures using crop-based income, households in the sample cultivated just four types of crops—maize, sorghum, peanut, and kidney bean. Only three of the 45 households earned income from selling crops. Household A2 sold 20 kg of peanuts for 1,500 Ksh, household A4 sold 180 kg for 6,000 Ksh, and household B6 sold 2 kg for 600 Ksh. Household A4 also sold 360 kg of maize, earning an income of 12,000 Ksh. With the income from crop sales, the members of household A2 bought sheep, whereas those in household A4 built a house.

In 2008 and 2009, six households sold cattle; five of them belonged to Group B, and one belonged to Group A. The price of cattle varied from 4,000 to 14,000 Ksh per head. Five of the six households spent this income to pay school fees for three children, one of these (B2) also used it to pay certain cultivation costs; household A9 reported using the income to purchase food. Turning to small ruminants, five households, four from Group A and one from Group B, sold goats. The price per goat ranged from 800 to 1,500 Ksh (i.e., one-fifth to one-tenth the price of cattle). Two of these households used the income to pay school fees for their children; the others used it to buy food. In addition, one household used the money to pay for ox-plowing services. Four farmers (from Groups B, C, and D) sold chicken for prices between 75 and 300 Ksh, and all used this income to buy maize.

In sum, farm incomes were mainly obtained from livestock sales and varied across groups. The average farm incomes of households in Groups A (2,865 Ksh) and B (2,873 Ksh) were larger than other groups, particularly due to their cattle sales. All farmers who sold ruminants belonged to Groups A and B, which have more livestock than the other groups, and most income from selling ruminants was used to pay school fees.

Income from off-farm activities

Information was collected about off-farm income earned by the household heads and by each household member who earned cash (whether on an annual, monthly, or daily basis). Among the 33 living household heads, 15 were engaged in wage labor (Table 3). Most of them worked on tea plantations in the highlands of Rift Valley Province run by the Kipsigis people, and a few worked as bus drivers. Incomes from these unstable jobs were generally low, though ranging from 50 to 400 Ksh per day. In addition, the frequency of work differed widely: some worked almost every day, others only two or three days a week. In addition, three people were engaged in small businesses, such as selling timber or bread; normal monthly earnings from these occupations were 3,000 to 4,000 Ksh. One person owned a milling machine, earning 10 Ksh per 2 kg of maize milled for a total of about 200 Ksh per day. Only two people earned salaries: the highest income, 17,000 Ksh per month, was earned by the head teacher at the high school, while an elementary school teacher earned 5,000 Ksh per month.

Considering wives, the first wife did not have a job in 27.5% of households. In 40.0%, the wife was employed in wage labor, earning from 50 to 150 Ksh per day. Others engaged in low-income jobs such as collecting and selling wild vegetables or firewood (average earnings of 150 Ksh per day). Three women produced and sold carrier bags made from nylon rope, earning about 100-250 Ksh per week. One woman owned a milling machine and earned about 200 Ksh per day, and one woman earned a salary as an elementary school teacher (5,000 Ksh per month). Among other family members, 14 people (82.3%) engaged in wage labor, one sold firewood, and one worked in a mill. In addition, two mothers received remittances from their sons who were working in town (Table 3). Most people in the study area thus engaged in low-income and unstable jobs, such as wage labor and small businesses. Only three people out of 91 (3.2%) were salaried.

According to participatory observations, clear seasonal differences do not exist, even for wage labor. Therefore, annual off-farm incomes for the 42 households shown in Table 2 were estimated based on information about household income sources (Table 3). Due to unclear information, incomes could not be calculated for three households. The calculations estimated the average household income at 35,400 Ksh per year. Considering the groups, the highest average (57,360 Ksh per household) was found in Group C due to the high income of household C4 (17,000 Ksh per month). Although there was a tendency for average off-farm incomes to be higher in the groups with greater livestock (Group C > Group B > Group A > Group D > Group E), no statistically significant differences were observed.

Livelihood situations from the viewpoint of food security

We also examined whether these off-farm incomes were sufficient to purchase required amounts of staple food crops, such as maize. The price of maize fluctuated from 60 Ksh/kg in April 2009 to 50 Ksh/kg in May 2009; by July and August, harvest time for maize, the price was down to 40 Ksh/kg. We used the May 2009 price for the calculation, thus estimating the average cost of maize flour for total annual household consumption at 27,882 Ksh (Table 2). The cost in Group C was highest (32,941 Ksh per year) because of the higher average number of consumers. The lowest average cost was observed for Group E (21,102 Ksh per year). Next, values of self-produced maize were calculated by multiplying total household yields by the maize price in May 2009 (50 Ksh/kg). The average value of self-produced maize was 6,440 Ksh per household.

To examine whether the households earned enough money to buy sufficient staple foods, we calculated the

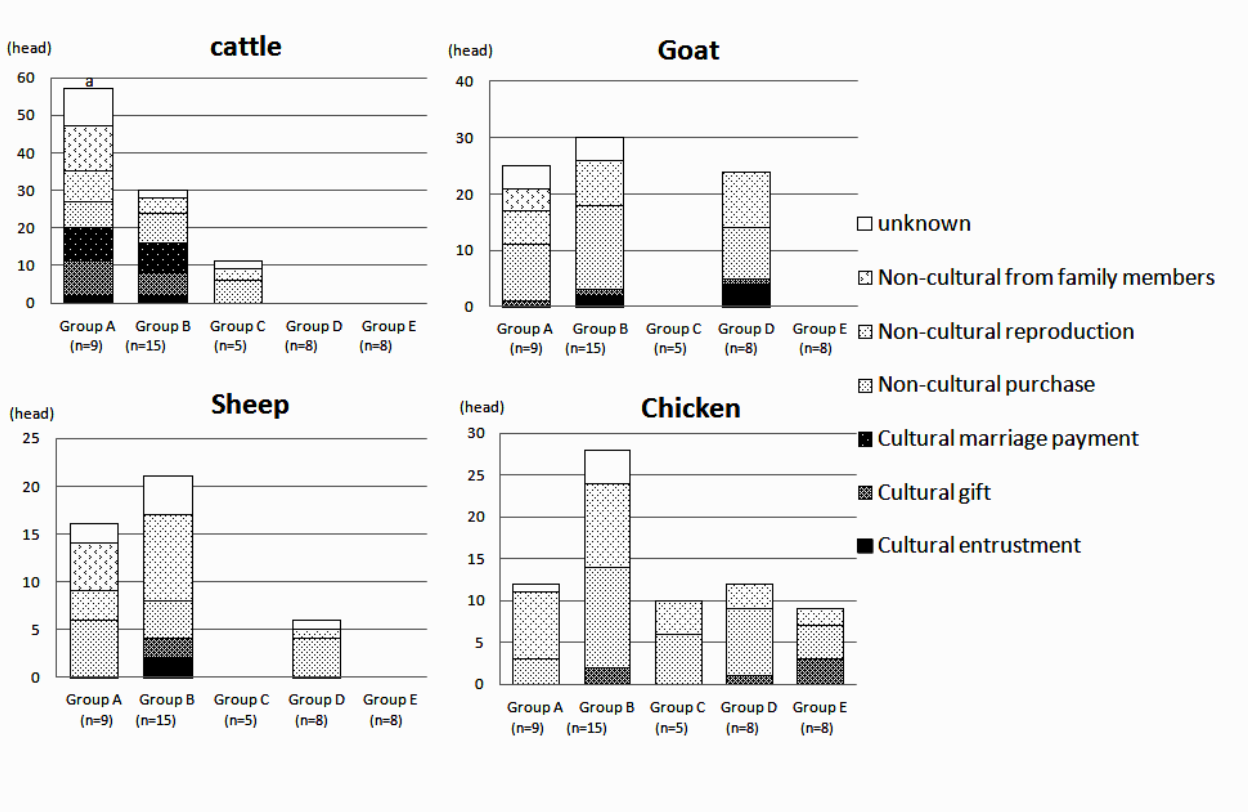

Figure 2. Number of livestock obtained by various means for different household groups. Data shown the total number of livestock for each group.

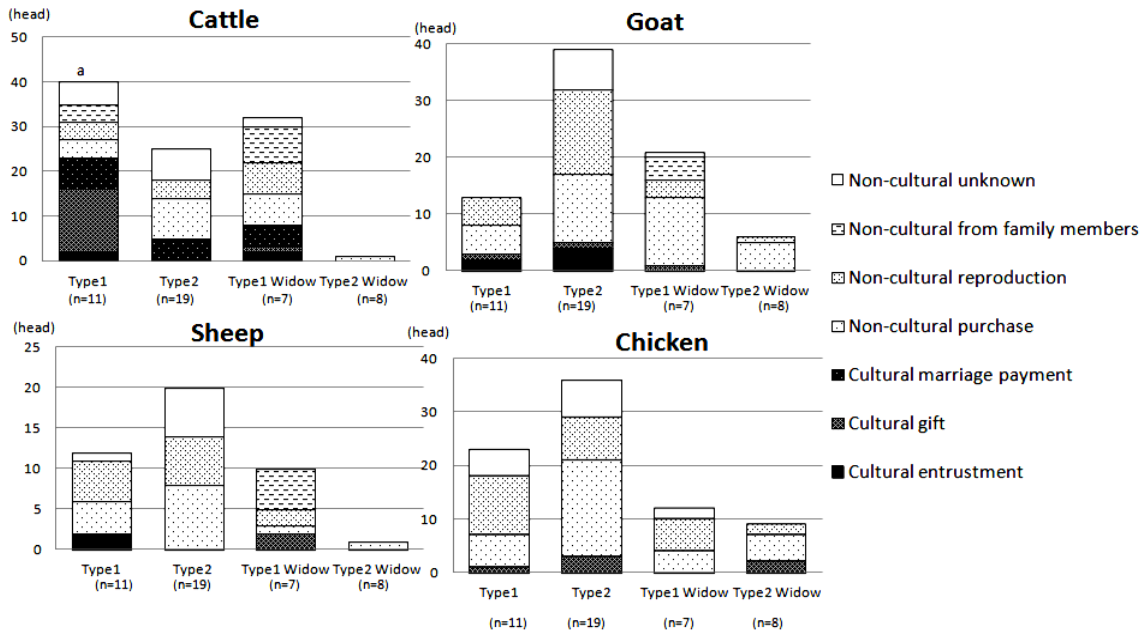

Figure 3. Number of livestock obtained by various means for different household types. Data shown the total number of livestock for each type.

difference between the cost of the maize needed for self-sufficiency and total income. These calculations revealed 19 of 42 households (45.2%) to be in deficit (data not shown). Though no statistical differences among groups

Table 4. Household economic characteristics calculated by household types

Type[a]	Number of households	Income from agricultural products (Ksh/year)	Value of self-produced cereals (Ksh/year)	Food purchased using agricultural income (Ksh/year)	Total income from off-farm activities (Ksh/year)	Total farm and off-farm income (T) (Ksh/year)	Cost of maize flour to meet annual food needs (C) (Ksh/year)	T-C (Ksh/year)
Type1	11	2,300 ± 4,263 a	5,736 ± 6,040 ab	115 ± 0 a	24,400 ± 20,232 a	29,156 ± 23,053 a	33,887 ± 13,920 ab	-3,593 ± 29,95
Type2	19	1,282 ± 2,957 a	7,926 ± 8,653 a	55 ± 135 b	48,101 ± 53,761 b	56,082 ± 52,155 b	33,690 ± 16,969 a	22,392 ± 53,58
Type1 Widow	7	407 ± 662 a	7,286 ± 10,275 ab	614 ± 1,497 a	31,440 ± 28,206 a	40,390 ± 30,747 a	19,488 ± 10,519 b	22,976 ± 28,33
Type2 Widow	8	0 ± 0 b	3,138 ± 2,102 b	0 ± 0 c	20,580 ± 17,667 c	23,718 ± 20,694 c	13,174 ± 7,511 b	9,802 ± 25,46
	45	1,607 ± 3,938	6,440 ± 7,563	119 ± 600	35,400 ± 40,565 [b]	41,906 ± 40,492	27,882 ± 16,125	14,509 ± 41,79

a. Refer to footnote b in Table 1.

b. The averages were calculated using data for 42 of 45 households due to unclear information on 3 households belonging to Type 1, Type 2, and Type 1 widow, respectively.

too young to marry were classified into Type 2 (with a related category for widow's households, Type 2 Widow). The remaining households (headed by widows and unmarried men) were classified into Type 2 Widow.

Among the nine households classified in Group A, four (44.4%) were classified as Type 1 in terms of family structure, a higher portion than for other groups (Table 1). In addition, households A1, A6, A7, and A9 were Type 1 Widow households. In the cases of A1 and A9, the mother of the family was still alive, and the son's family stayed within the father's dala. In the case of A7, the wife of the household head lived together with her divorced daughter and her daughter's children in a dala. In household A6, the household head, his wife, and his older son had died; now the son's wife, children, and younger brother lived in the dala. In Group B, a higher percentage of households belonged to Type 2 (46.7%) than Type 1 (26.7%). In addition, three Type 1 Widow households were observed. Type 1 and Type 1 Widow households thus tended to also be Group A and B households. Seven Type 1 Widow households and 11 Type 1 households kept livestock, with an average of 3.5 TLU and 2.8 TLU per household, respectively. On the other hand, of the 19 Type 2 and 8 Type 2 Widow households keeping livestock, the averages were only 1.2 TLU and 0.2 TLU per household, respectively. These differences were statistically significant.

In total, 36 of 98 cattle (36.7%) owned by the sample households had been obtained through cultural means; 23 (23.5%), 5 (5.1%), and 8 (8.1%) of these belonged to Type 1 households, Type 2 households, and Type 1 Widow households, respectively (Figure 3). For other livestock, such as sheep and goats, less than 10% were obtained through cultural ways; most goats obtained through cultural ways were owned by Type 2 households. Only 4 sheep out of 43 (9.3%) were obtained through cultural ways, split evenly between Type 1 and Type 1 Widow households. Chickens, as previously mentioned, were often given as rewards for labor; even Type 2 Widow households thus obtained them through cultural exchanges.

Livelihood situations of different household types

To add to the result that the number and means of obtaining livestock varied significantly among different types of households, we examined broader household livelihood situations. Type 1 household heads and their first wives tended to be older than those of Type 2 households (average ages of 63.3 and 51.8 years versus 47.3 and 39.9 years, respectively). It can thus be concluded that older household heads tended to own more livestock; indeed, even Type 1 Widow households generally owned cattle. The average number of consumers was the same in Type 1 and Type 2 households (7.4 people), whereas both types of widow households had fewer average livelihood consumers (4.3 for Type 1 and 2.9 for Type 2).

As mentioned earlier, Type 1 and Type 1 Widow households kept more livestock (3.5 TLU and 2.8 TLU on average, respectively) than other household types (Type 2: 1.2 TLU; Type 2 Widow: 0.2 TLU) and also earned more income from farm-produced products, mainly from selling livestock (Table 4).

However, they did not generally use this income to buy food. Indeed, the average value of food purchased using on-farm income was only 115 Ksh/year for a Type 1 household and 614 Ksh/year for a Type 1 Widow household, even under severe conditions. This suggests that livestock rearing did not contribute significantly to securing food. The values of cereals produced by Type 2 (7,926 Ksh) and Type 1 Widow households (7,286 Ksh) were significantly higher than those produced by Type 1 (5,736 Ksh) and Type 2 Widow households (3,138 Ksh).

Off-farm income was the highest for Type 2 households (48,101 Ksh); Type 1 (24,400 Ksh) and Type 1 Widow households (31,440 Ksh) also had significantly higher off-farm income than Type 2 Widow households (20,580 Ksh). The total income was also the highest for Type 2 households (56,082 Ksh), whereas the average income of Type 2 Widow households was significantly lower than that of Type 1 and Type 1 Widow households.

In general, Type 1 households included many adult men, with an average of 3.5 men per household. However, these people generally did not earn any income: some were still students while the others did not work or obtained paltry wages of just 50-150 Ksh per day. An example is the case of household A2, in which the household head was a member of the local government but did not earn any set salary for this work. Through village meetings, he was able to earn occasional income of about 300 Ksh per month. His two wives also had only minor sources of income, such as collecting and selling wild grasses. Among his seven sons older than 15 years, four were still students and the remaining three were not working enough to earn regular incomes, with one of them being ill. In other cases (e.g., households B9, B8, and A8), sons were forced to remain in their father's *dala* even though they were old enough to build their own *dalas* because of economic difficulties. Such households were included in the Type 1 household group of paternal extended families, marking one reason why the balance of total income minus cost of the maize flour required for self-consumption (T-C) balance was negative for this group.

On the other hand, the Type 2 households included a household (C3) within which a member earned his livelihood by managing a store selling wood and three households including people who received regular salaries (B11 included two primary school teachers, whereas C4 was headed by a high school principal). In addition, the household head of C1 undertook wage labor but obtained more than double the normal income (400-500 Ksh per day) by working in the suburbs of Kisumu city. The heads of Type 2 households were typically younger than those of Type 1 households, and many of them earned higher off-farm incomes. Similarly, in the case of Type 1 Widow households, the son of household A1 owned a maize-milling machine, from which he earned about 200 Ksh per day. Among the others in this household, the son's wife and daughter tried to earn income, but it was low.

The cost of meeting household maize flour needs for Type 1 (33,887 Ksh/year) and Type 2 (33,690 Ksh/year) households was significantly higher as a result of the difference in household size. Finally, the (T-C) balance was significantly higher for Type 2 households and for Type 1 Widow than for the other two types; indeed, Type 1 households showed an annual deficit of 3,593 Ksh due to low off-farm income and a large number of consumers. They thus appeared to be vulnerable to food shortages. Though the difference in off-farm income between Type 1 and Type 1 Widow households was not large, the difference in the number of consumers in the household led to differences in the (T-C) balance-of payments.

DISCUSSION

The results showed a tendency for extended paternal families (Type 1) to keep large numbers of livestock; though these households earned more than the others from selling livestock, the amount was less than one-tenth of off-farm income (Table 4). Overall, Type 2 households tended to be wealthier than the other three types of households due to high off-farm incomes.

Type 1 and Type 1 Widow households were found to obtain many of their livestock through socio-cultural means such as entrustment and marriage payments. In previous reports, these livestock were not found to contribute to income but rather to maintain social status (Ade Freeman et al., 2004). According to Shipton (2007), a Luo person who uses entrustment relationships more heavily is a person of high social status; the elderly and adult men, for example, have sufficiently high social status to obtain livestock through entrustment. Indeed, the present study showed that the heads in extended paternal family households tended to be older than in nuclear family households and such needs also tended to have higher social status.

In Luo society, women cannot enter into entrustment relationships; therefore, the cases in which widow's households owned livestock through entrustment likely refer to situations in which the household heads had obtained the livestock before their death. Overall, social aspects played a greater role than economic aspects in influencing household livestock holdings. In the study area, those who own many livestock are not necessarily rich, as the animals do not contribute to household revenue; their purpose is enhancing social status. Therefore, Type 1 households may be economically poor when compared to Type 2 households but still have higher social status.

Additionally, the income from livestock is used less to enhance household food security than to obtain education: most people in the study area believe the only way out of poverty is to obtain a salaried job, which is difficult to do without being educated (Kristjanson et al.,

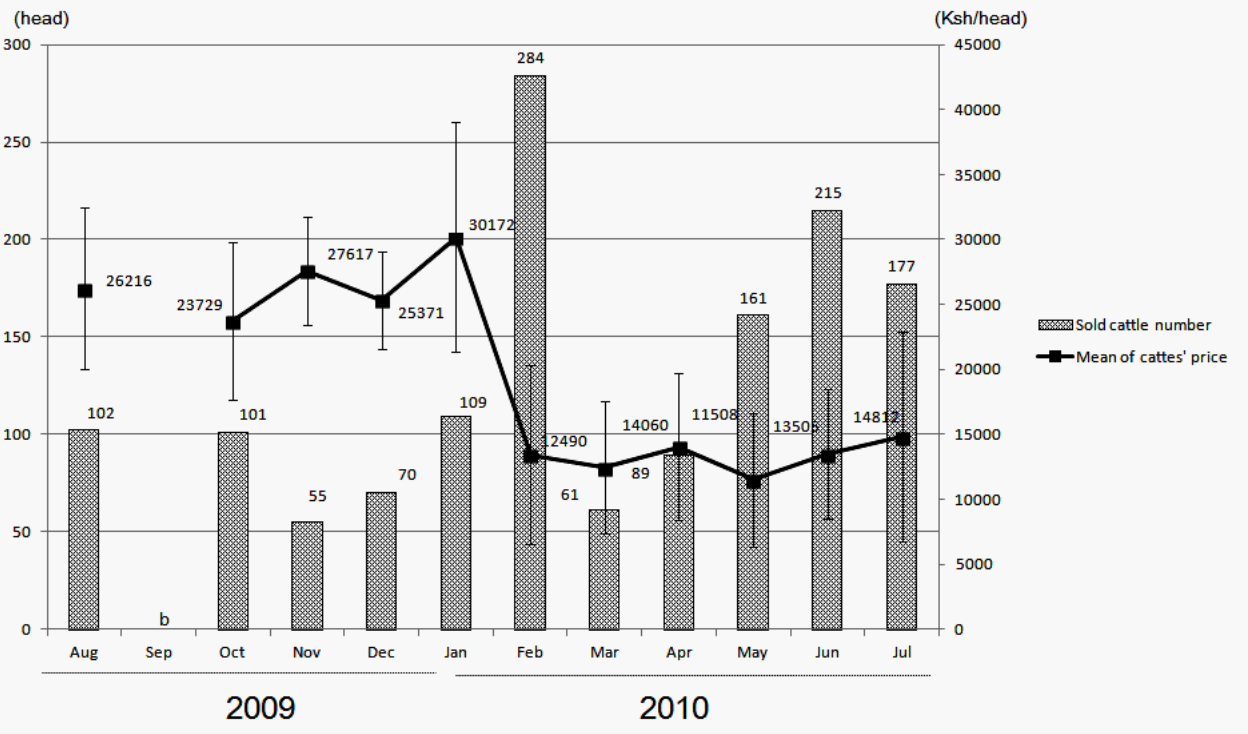

Figure 4. Mean cattle's price and head count trading in Sondu market from August 2009 to July 2010[a].
a: Each bar represent standard deviation of price of cattle.
b:Market was closed because of foot and mouth disease and data was not available.

2004). This can be seen clearly by examining market trends. More than half of the people who sold livestock in the study area did so at the market in nearby Sondu; the average price and total number of cattle that were traded in this market from August 2009 to July 2010 are shown in Figure 4. The number of cattle transactions was the highest in February, when the price of cattle had fallen to less than half the price of one month earlier. February is the time for secondary school enrollment, which requires about 20,000 Ksh in cash to pay the entrance fees and purchase school supplies such as textbooks and uniforms. In order to raise this cash, many people in this region choose to sell their cattle.

CONCLUSION

Overall, our research results revealed that possession of livestock was not tightly linked to a household's economic well-being in the study area. While farm incomes from selling livestock were higher for Groups A and B (which possessed more livestock) than for the other groups, the amount of cereals produced for own consumption and the value of cereals produced were lower than for Groups C and D. In addition, Group C had only one-third the livestock holdings of Group A but had the highest average income from non-farm activities.

There were significant differences in the number of livestock owed by households depending on the household type, as classified based on Luo culture's household structures. Extended paternal families tended to have more livestock than nuclear families: among Groups A and B, 62.5% of households were extended paternal families (i.e., Type 1 and Type 1 Widow). Families with more livestock (i.e., households in Groups A and B and Type 1 and Type 1 Widows) also tended to acquire them through socio-cultural ways. Income also varied across household types, especially for non-farm activities. Nuclear family household incomes were significantly higher than those of extended paternal families and their widows.

Many households in this region suffer from food shortages due to marginal local climate conditions (Rarieya and Fortun, 2010), low incomes, and high vulnerability. Many are thought to be unable to obtain enough food to have full meals even once a day. However, some households (e.g., those of Type 1) that lack sufficient money to buy food can obtain livestock through socio-cultural ways.

Previous researchers have argued that it should be possible to control the number of livestock as long as livestock have only economic value; certain measures can be used to compensate for the lost economic value, such as the introduction of commercial crops or guaranteed

payments. However, the reality is that livestock farming in the study area is deeply entwined with social relationships, making it more difficult to prevent soil erosion by limiting or reducing the number of livestock.

In the self-sufficient economic production sector, social relationships such as reciprocity play important roles in the subsistence of individuals within a community confronting unstable and fragile national infrastructure (Sakamoto, 2006). Social relations based on entrustment relationships, as widely observed in pastoralist societies, have also been described as exhibiting aspects of reciprocity (Sugimura, 2012). In the study area, Type 1 households received livestock without purchasing through socio-cultural channels; after selling these, they invested in school fees to secure higher educational attainment (and thus better futures) for their children. This underlines the importance of focusing on the socio-cultural aspects of the value of livestock in addition to the economic value. Only by understanding the dual values of livestock, economic and socio-cultural values, in the lives of pastoral people, policymakers could find more appropriate and applicable ways to prevent the expansion of soil erosion. In the study area, preventing soil erosion through ensuring the availability of appropriate grazing land for the households of extended paternal families and their widows are relevant strategies for preventing the expansion of soil degradation. To find suitable countermeasures and detect appropriate targets for intervention, policymakers need to understand structure and social relationships of the communities to make relevant strategies for implementations.

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