

Economic vulnerability, beer and HIV/AIDS: The struggle to sustain farmer livelihoods and indigenous sorghum varieties in eastern Uganda

Cecilia Scurrah-Ehrhart

Department of Geography, University of Dar es Salaam, Dar es Salaam, Tanzania

Correspondence: Cecilia Scurrah-Ehrhart (email: cecilia@auberon.org)

Drawing on a case study from eastern Uganda, this paper describes how social and environmental factors combine to affect the sustainability of both sorghum landraces and the farmers who depend on it for food and income security. It delineates how changing regional patterns of agricultural production and consumption, institutional neglect, economic hardship, natural resource degradation and a labour supply crisis precipitated by the HIV/AIDS pandemic, may be conspiring to place sorghum landraces at risk of extinction and, thus, undermine already precarious livelihoods. The paper therefore challenges the common assumption that marginalized rural women – by virtue of having diverse varieties and species under their care – can be expected to conserve that diversity.

Keywords: sorghum, eastern Uganda, *in situ* conservation, beer, women farmers, HIV/AIDS

Introduction

Sorghum is an important cereal grain feeding millions of people in Africa and Asia. In East Africa, in particular, it helps many poor people cope with environmental degradation, socioeconomic isolation, hunger and micronutrient scarcity. Despite its importance to small-scale farmers, sorghum is undervalued and neglected by formal institutions in the region. The resultant decline in the net area planted to sorghum in East Africa suggests current and future losses in its genetic diversity.

Various sociological and environmental factors, operating at different scales, affect the sustainability of sorghum varieties in eastern Uganda specifically and the wider East African region. This paper examines the relationship between sorghum morphotypes – more colloquially, the varieties under cultivation – and the livelihoods of small-scale Adhola and Iteso women farmers in eastern Uganda. It highlights the role of these farmers' dynamic cropping systems, culinary traditions and rituals in maintaining indigenous crop varieties that motivate crop diversity and sustain rural livelihoods. Conversely, it calls attention to the increasing economic hardship of farming households, women's lack of decision-making authority over the allocation of productive resources, a labour supply crisis precipitated by HIV/AIDS and changing regional patterns of sorghum production and consumption, among other factors, as conspiring to place sorghum seed resources at risk, and with it, farmers' food and income security.

Among both the Adhola and Iteso people, women are the exclusive custodians of sorghum; therefore this study contributes to the debate about gender and the *in situ* management of biological resources – in particular, farmer-bred crops, or landraces.¹ In the wake of the 1992 United Nations (UN) Convention on Biological Diversity, urging nations to support existing practices contributing to the sustainable use of biological diversity, a number of studies have attributed *in situ* conservation practices to local and indigenous women (Hardon & de Boef, 1994; Tapia, 1996; Bellon *et al.*, 1997; Sachs *et al.*, 1997; UNEP, 2004). However, these observations are often based on superficial evidence, such as the number of varieties or species of a given resource noted in local

women's homes, fields or homegardens. It is also often assumed that these women automatically value and conserve that diversity by virtue of their role in household subsistence production and processing. But this is not necessarily the case in a rapidly changing world where values, management practices and resource habitats are shifting – often with negative consequences for crop biodiversity. Moreover, the balance of power in the household, community or nation may preclude women from making critical decisions about long-term resource conservation. As a result, there is a need for more thorough research and analysis of the complex mix of environmental, biological and socioeconomic factors affecting women farmers' *in situ* maintenance of plant and animal diversity.

Methodology

Study location

Most of the evidence for this paper stems from an intensive, small-scale study of Adola and Iteso women's management of sorghum landraces in an eastern Uganda parish (the administrative level above the village level) during one season in 2001. Nyankole Parish in Rubongi Subcounty, Tororo District (Figure 1) was selected as the research site because of its geographically and ethnically representative farming systems. Nyankole is located in the rift valley, with growing conditions similar to small farmers in other parts of the district.² The area is home to the Adhola, a tribe of Nilo-Hamitic ethnolinguistic origin now extensively intermarried with a related Nilotic group, the Iteso. Given that there have been no previous studies of *in situ* sorghum diversity management in Uganda, it was deemed important to carry out the surveys where soil types and tribal background were constant, to prevent multiple and potentially confounding ecological and cultural factors from entering into interpretations about the distribution of sorghum diversity in the area.

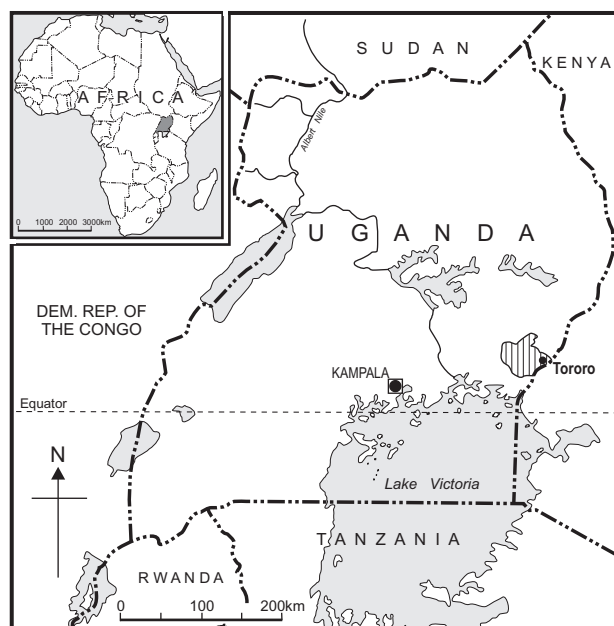


Figure 1. Map of Uganda showing Tororo District, where the study site in Nyankole Parish is located.

Research methods

The research questions were determined through a framework of consultative participation (following the categorization in Biggs, 1989). The overall research design comprised survey/correlational³ and participatory social methodologies (Bryman & Cramer, 1994; Pretty *et al.*, 1995), backed by qualitative plant specimen descriptions (Damania & Rao, 1980; Porceddu & Damania, 1991; IBPGR & ICRISAT, 1993). The specific methods employed included survey-based comparisons between households, various types of information sharing and a collection and description of sorghum samples. The survey was conducted in 108 households, which represented 13.4 per cent of the parish total ($n = 806$).

Fieldwork in 2001 was timed to coincide with the length of an agricultural season (five to six months) beginning at harvest time, which is generally in June. The survey, administered through systematic random sampling, recorded indicators of socioeconomic change and social differentiation based on those used in previous research studies (Bellon & Taylor, 1993; Bellon & Brush, 1994; Meng, 1997; Meng *et al.*, 1998; Van Dusen, 2000). The household⁴ was the unit of analysis, although intra-household resource allocation was taken into account in the design of the survey (Haddad *et al.*, 1997). Thus, some data, such as that on income and education, were collected for men and women separately. In addition, the survey was used to collect agronomic information on the farm in general and the sorghum plot/s in particular. Plot size, location, intercrops, who selected and planted the seed for the season, seed storage methods and use of previous season's sorghum grain and seed were recorded. For each sorghum variety under cultivation, current seed lot size and length of tenure, sources of seed and intended use were documented. Finally, women farmers were asked to give each sorghum variety under cultivation a score from one to five for 13 agronomic, production and processing qualities.

Defining and measuring diversity

Crop diversity is considered in this paper not only for its immediate use value, but also for the genetic reserve it contains that could be of assistance to future generations. The definition of diversity used here is based on Caudatum race sorghum varieties as identified and named by farmers. Plot-level sorghum diversity was measured as the number of farmer-identified varieties cultivated in a plot at a specific time. The research design relies on farmers' perceptions as the basis for varietal differentiation in order to understand better their motives for acquiring, modifying and maintaining diversity. Analyses of inter- and/or intraspecific genetic-level diversity was beyond the scope of this study.⁵

Caudatum populations and people in East Africa

The role of caudatum sorghums in sustaining livelihoods across East Africa

The sorghum subpopulations studied here belong to one of five races of sorghum in Africa (De Wet, 1972; Harlan, 1992). Caudatums are found in North, Central and East Africa, but are believed to have been domesticated somewhere in the north-central African savanna by seminomadic Nilotic and Nilohamitic pastoralist tribes (Stemler *et al.*, 1975; Harlan, 1992). These sorghums would have spread south and east via successive human migrations over many centuries, the Adhola and Iteso included.

The traditional management practices for caudatum sorghums across East Africa continue to foster a solid gene pool of crop diversity, just as they further culinary and spiritual traditions. Indeed, food and drink prepared from indigenous sorghum, and its 'sister crops' finger and pearl millet, not only constitute an important dietary component, but

also represent key symbols of identity for Nilotic and Nilo-Hamitic tribal communities such as the Alur, Luo, Acholi, Adhola and Iteso. Homemade beers, sometimes brewed with sorghum, are especially valued components of tradition. Their presence has been recorded in sub-Saharan Africa since at least the third millennium BCE and they continue to be a central element in sacred rituals, celebrations and daily socializing (Colson & Scudder, 1988; McAllister, 1993). The sale of beer is a source of household income and, more pertinently, an income-earning opportunity for women (Mbilinyi, 2000; Holtzman, 2001). As this study shows, where beer plays multifaceted economic and social roles, these roles can reinforce each other, creating a vibrant culinary tradition that also promotes an indigenous crop.

The existence of diverse sorghum populations spread over a wide territory bodes well for sorghum sustainability. In the short term, this guarantees a source of seed for households, communities and regions, and in the long term, this provides a wide genetic pool of sorghum traits with which to recuperate from significant seed losses incurred in any one area.

Changing patterns in sorghum production, consumption and infrastructural supports

A critical look at indigenous sorghum populations in the region reveals a far from certain future. One factor is the growing cultural and economic dominance of rice and maize, cereals of Asian and Mezo-American origin. Despite being less ecologically hardy than sorghum, maize's ability to tolerate heat and some dryness, if not poor soils, means that the two crops are often grown in similar conditions. Furthermore, maize fits easily into the sorghum niche due to its short maturing time, morphology and place in the seasonal cycle. Like rice, which also enjoys middle class status, maize is becoming the staple of choice for urban populations in eastern and southern Africa, selling in mainstream regional and national markets.

The problem is compounded by the undervaluation and neglect of indigenous cereals by dominant cultures and institutions within East Africa. Sorghum is regarded as 'poor man's food', or even worse, 'poor woman's food', and excluded from the dietary choices of aspiring middle classes. In Uganda this exclusion is illustrated by the fact that national law prohibits the sale of traditional brews in any urban centre, including district capitals. Simultaneously, regional and national research and extension support for sorghum as a food grain is dwindling. Since the mid-1990s, economic restructuring and liberalization policies in Uganda, Kenya and Tanzania have gone further towards minimizing state intervention in agriculture. In Uganda, breeding programmes for indigenous crops at Serere Research Station, which is located in remote Soroti District and serves East Africa as a whole, have been marginalized through funding cuts dictated by the 2000 Plan for the Modernization of Agriculture, one of a series of recent agricultural reform programmes (a director, Serere Research Station, pers. comm., 2000). Moreover, the latest phase of agricultural modernization in East Africa, spearheaded by the New Economic Plan for African Development 'Comprehensive Africa Agricultural Development Programme 2003', involves the introduction of state-of-the-art biotechnology, information systems and academic training to boost African economies and end hunger. While the value of biotechnological research is undeniable, it is unlikely that donors (which include the USA, Germany and France) will extend their research funding beyond the conventional 'commercially viable' staples such as maize, wheat and rice.

Finally, regional patterns of change among rural communities are also undermining sorghum at the local level. More specifically, land privatization, continuing sanctions for men's ownership of land and increased dependence on commercial agriculture for

income among men have succeeded in sidelining women's traditional agricultural activities, including the food crops under their care. To make matters worse, rates of HIV/AIDS infection are significant enough in some rural areas to have devastating consequences – indeed, recent studies report general reduced crop output associated with the epidemic (FAO, 1995). The consequences for the productivity of non-mainstream crops may be even more severe. Whatever the cause, national yield statistics for sorghum show that (in contrast to maize) production levels in East Africa (no figures are available for Uganda alone) have remained low and erratic since 1960 (various annual figures available at <http://www.fao.org/statistics>). Factoring in population growth, these trends suggest that the extent of localized farmer-bred sorghum populations are decreasing and becoming more isolated. As a result, genetic replenishment and exchange through seed networks will be compromised, placing all varieties at risk.

Gender, farming systems and sorghum diversity

The changing face of the farming system in Nyankole parish

Tororo District is a relatively politically and economically marginal district in Uganda, itself one of the poorest countries in the world (World Bank, 2001). The district's relative proximity to Lake Victoria, however, results in a milder climate and higher annual rainfall than is the norm for the north to south semiarid grain belt of eastern Uganda. In the relatively recent past, this supported lush animal pastures and the production of crops such as plantain (*Musa spp.*) and finger millet (*Eleusine coracana* subsp. *coracana*). Cattle and finger millet are, in theory, the pillars of the Adhola and Iteso farming system.

In terms of carbohydrate staples, in 2001, most cultivated household plots in Nyankole parish were dedicated to cassava (*Manihot esculenta*) and sorghum (*Sorghum bicolor*) – both characterized by their resistance to drought and relatively low labour requirements.⁶ Where additional soil moisture, land and labour were available, families diversified into small plots of maize (*Zea mays*), sweet potatoes (*Ipomea batatas*) and brewing bananas, which although more resource demanding than sorghum or cassava are still relatively hardy and labour saving compared to finger millet and plantain (Drinkwater, 2003). According to various interviewees (including the district environment officer and elderly villagers from three subparishes in Nyankole), these cropping system changes have occurred in the last 20 or so years. The switch in staple carbohydrates is associated with declines in soil fertility, moisture and available labour (falling cattle numbers are due more to the advent of new diseases and increased sales of cattle to meet the increased necessity for cash).

Forever a visitor: women and the gendered division of labour, land tenure and resource access

As in most of the world, agricultural production in Tororo is a gendered activity. This applies not only to responsibility for the work itself, but also for specific crops. In its simplest rendition, the gendered division of labour and responsibility among the Adhola and Iteso can be equated to the division between subsistence and market-oriented activities, often denoted as the non-commodity and commodity sectors (Guyer, 1988). Typically, women are said to manage small plots of sorghum, cassava, pigeon peas, sweet potatoes and indigenous vegetables destined for home consumption while men cultivate marketable crops such as cassava, maize, occasionally finger millet and small cash crops. In practice, however, the distinctions are never so clear. Adhola and Iteso women can access a small informal produce market by selling a portion of the harvest from subsistence crops that fall under their domain, and women's almost exclusive responsibility for beer

brewing gives them access to a relatively significant source of cash from local beer sales. Conversely, the small size of landholdings (a mean size of 1.78 ha was recorded) means that men are often forced to cultivate food crops, the greater proportion of which is consumed by their immediate families.

Men clear land for all crops at the beginning of the season and often participate in harvesting; women plant, weed and harvest in all fields. Where timing is important and labour scarce, wives are expected to prioritize labour for their husbands' crops over their own. This can create tensions when planting and harvest times of crops coincide, as is the case for sorghum and maize. Ultimately, all crops belong to the men heads of households because they own the land on which they are cultivated. Traditional customary laws sanctioning patrilineal inheritance and land tenure in the parish mean that women neither own nor inherit land, nor have the right to allocate land for production. In practice, they are often 'left' free to make management decisions pertaining to the land and crops they are allowed to use, although this freedom is conditional on not digressing from accepted gendered practices. Moreover, when disagreements between couples do arise, the final decision about what crops to grow, in what quantities and with what labour, belongs to the husband. Indeed, Adhola and Iteso women were often referred to, and even referred to themselves, as 'visitors' in their husbands' land, underscoring their lack of ownership and/or decision-making power over productive resources.

Coping with the work burden and fostering sorghum diversity

Adhola and Iteso women's sorghum management practices in Nyankole parish suggest that they actively encourage varietal diversity. As many as 15 farmer-named varieties were sampled, all belonging to seven broad population groups. Because the physical habitat for sorghum is homogeneous across the parish and most of the district, this indicated that people grow diverse varieties for reasons other than ecological necessity/edaphic differentiation (adaptation and tolerance to different ecological habitats). Indeed, the local folk taxonomy for sorghum in Rubongi subcounty, Tororo, reflects a focus on their varied gastronomic uses (Figures 2,3). Accordingly, each of the seven locally-named broad groups of sorghum landraces is associated with one or two culinary uses. For example, the group 'Bel mwenge' (sorghums for banana beer) are characterised by a red colour, small open or closed panicles and the fact that these varieties are used to brew *mwenge* (banana) beer. The 'Atong' (spear) group represents varieties with a narrow, tall panicle, which can be either red or white: if red, it is used for brewing *mwenge*; if white, it can be used to make *kongo* beer, or pounded into flour to make the staple dish *khalo*, a stiff porridge combining cassava and sorghum/finger millet. What is significant about this folk taxonomic system is its inherent flexibility. Thus, varieties are allowed to migrate from one named category of sorghum to another if they hybridize over time – if their panicle shape and colour changes, for instance. Moreover, any new sorghum variety can be included so long as it fits the simple category requirements of colour and panicle shape. This simplicity and flexibility has great advantages for women farmers who are always already overloaded with daily household maintenance activities over and above their agricultural work (FAO, 1995).

While the naming category reflects a desire for two or three kinds of sorghum for culinary purposes, it does not explain why there are so many varieties. Part of the answer lies with women's traditional management practices. Adhola and Iteso women typically scatter sow their sorghums in mixtures of two to 12 varieties per plot, with an average of 2.9 varieties per plot. Monocropping was recorded in only 8 per cent ($n = 9$) of surveyed plots and intercropping was almost nonexistent. Although the number of sorghum varieties

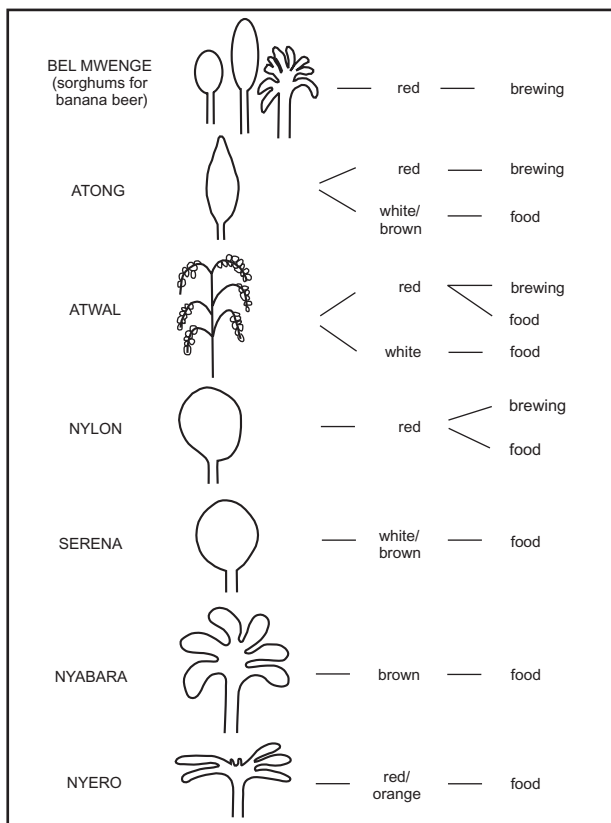


Figure 2. Folk taxonomy of seven broad groups of sorghum populations or 'name categories' in Rubongi Sub-county, Tororo District, Uganda.

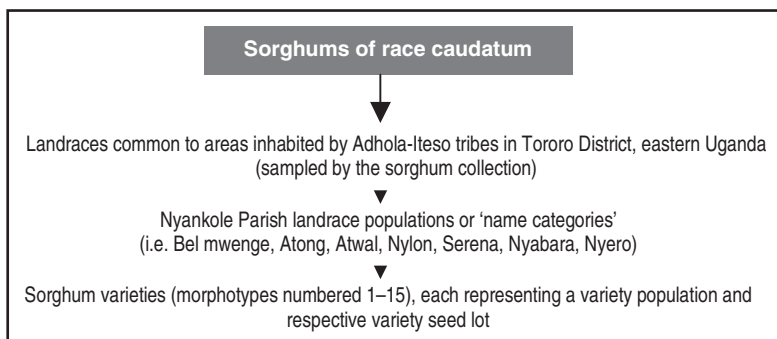


Figure 3. Sorghum terminological hierarchy.

per plot varied considerably, plot sizes remained within a narrow size range, on average 0.217 ha, suggesting that a small plot was not a deterrent to planting different varieties. At the same time, there was no indication that women separated their varieties in space or time, to avoid cross-pollination or for any other reason. Thus, it seems that farmers were relying on the selfing (self-pollinating) nature of sorghum to limit out-crossing and hybridization between varieties, an effective labour saving device, in contrast to findings

in other studies in Africa and Latin America.⁷ A minimalist approach was also applied to seed selection, the bulk of which was carried out post-harvest, in or near the kitchen. Thus, it only took a few seconds for a woman to pick a good looking panicle from the assortment ready for the evening meal and toss it over the shoulder into the seed pile. Criteria for selection were similarly simple: namely the size and appearance of the panicle, and the use-value for beer or food. Nonetheless, if a variety was known, it could also be selected for possessing good post-harvest processing characteristics such as taste, ease of milling and storability.

The laissez-faire attitude towards selection, hybridization and cross-pollination not only serves to foster diversity in a selfing plant, but also suggests a management system that prioritizes savings on labour and time. Such practices would appeal to most rural women, but become increasingly vital considerations for HIV/AIDS-affected households and communities.

Beer and food: Motivating diverse varieties and preserving livelihoods

Brewing as an impetus for planting diverse varieties

Women farmers do not consciously maintain varieties of sorghum for diversity's sake. The two highest priorities in the choice, or selection, of specific varieties for planting concern their perceived use-value for beer and/or food. Other secondary post-harvest uses, including mulch, animal feed, fodder and minor construction, do not require the cultivation of specialized varieties. Yet, the beer and food post-harvest uses for sorghum should have fostered cultivation of at most two varieties per woman's plot. A woman who prepared food as well as beer with sorghum could, for example, choose to plant a single, high performance, dual use variety (such as a 'nylon') allowing her to feed her family and make beer while still planting a monocrop. In fact, it was found that the women who also used sorghum for brewing (all respondents planted sorghum for food) had a significantly larger number of distinct sorghum varieties in their individual plots than any other group of women, whether definable by age, education, size of land, marital status, family size, post-harvest preferences for sorghum or economic activity. Table 1 displays the variables depicting brewing activities and their correlation with sorghum diversity at the plot level,

Table 1. Sorghum diversity by women's beer brewing practice.

			F-value	P-value
	<i>Brewed with sorghum</i>	<i>Did not brew with sorghum</i>		
Mean no. varieties per plot	0.4673 [†]	0.3398	7.45	0.007 [‡]
SD	0.2281	0.2395		
N	42	64		
	<i>Brewed for sale</i>	<i>Did not brew for sale</i>		
Mean no. varieties per plot	0.4439 [†]	0.3451	4.59	0.034 [‡]
SD	0.2441	0.2282		
N	52	53		
	<i>Engaged in brewing</i>	<i>Did not brew</i>		
Mean no. varieties per plot	0.4235 [†]	0.3387	3.07	0.083
SD	0.2401	0.2420		
N	65	40		

[†]Indicates the higher mean. [‡]Indicates significant difference between means.

Note: Results are for a one-way unbalanced ANOVA; response is number of varieties per plot, variables log transformed.

which together with other results (not shown) led to the conclusion that brewing with sorghum was the single greatest indicator of sorghum diversity at the plot level.⁸

Looking at the raw figures, it is not clear why women farmers who brewed with sorghum planted significantly greater numbers of varieties. However, the correlation does make more sense if we consider this to be the result of habits and choices acting in combination: in this case, that the cultural prerogative to plant sorghum in mixtures, the tendency for farmers to select for traits which are spread across varieties, as well as the decision to cultivate with more than one culinary end-use in mind may be mutually reinforcing push factors for varietal diversity.

Food and income security: the motivation to plant food and beer varieties

Given the impact of brewing and cooking on sorghum seed diversity, it is worth exploring what cultural and socioeconomic incentives exist for such activities. Cultivation of sorghum food varieties (at least ten of the 15 sampled) is virtually guaranteed by the need for a reliable food source with which to prepare *khalo*. Indeed, sorghum's low-maintenance requirements and ecological hardiness make it an ideal food security crop and a great agronomic companion for the other ingredient in *khalo*, cassava, which is also an excellent drought resistant carbohydrate crop (Loomis & Connor, 1992). Nutritionally, however, compared to cassava, the mix of proteins, carbohydrates, minerals and micronutrients found in sorghum make it a far superior food choice and, importantly, give it a particular role as a weaning food for children. The significance of sorghum for food security is underscored by the fact that all of the households surveyed cultivated sorghum for food.

Compared to the role of sorghum food varieties, the beer varieties (at least seven of the 15 sampled) are 'non-essential' items. The considerable time and effort it takes to prepare sorghum brews therefore call for an additional incentive, which in Tororo appears to be both cultural as well as monetary. Survey results showed that sales of homemade brews, an activity carried out by 49.5 per cent ($n = 73$) of those surveyed, were the most remunerative source of income for women; in particular, 64 per cent ($n = 33$) of the women brewing with sorghum as an ingredient also sold beer for a living (see Table 2). Significantly, 66 per cent of women stated that their income from beer sales made a greater contribution to the household than income from other family members. (By contrast, sorghum grain sales accounted for only a fraction, some 4 per cent in 2001, of women's incoming earning activities.) It would follow that women who brewed with sorghum also planted their own preferred brewing varieties.

Thus, the lack of dependable income-earning alternatives renders selling beer a worthwhile investment for women while the widespread popularity of cultural and culinary brewing traditions creates a reliable demand for the product – indeed, increased deaths from HIV/AIDS may even be raising demand for the beer consumed during funeral ceremonies (FAO, 1995). The existing informal beer market is a lively one in

Table 2. Main source of household income for women farmers surveyed.

Main income provider	Frequency	Percentage of total
Husband	26	24.53
Self	70	66.04
Own relatives	5	4.72
Husband and self equally	5	4.72
Not reported	7	–

which women participate fully. It is the informality of the local beer market that actually facilitates sorghum diversity by accepting product 'lack-of-uniformity'. This cultural synchronicity between sorghum production and consumption preferences allows mixture sowing to continue unchallenged.

Seed flow dynamics

Without an analysis of seed flow and distribution between households, pertinent information about the role of local social safety nets for sorghum seed and the conservation status of the sorghum varieties themselves may be missed.

Seed exchange networks

Social networks for exchanging sorghum seed among the Adhola and Iteso also reflect women farmers' dependence on gender-based social safety nets and their social and economic marginality *vis à vis* the Ugandan economy and dominant culture, and wider global economy. Women farmers were almost entirely self-reliant in seed supplies, evidenced in this study by the complete absence of improved varieties among the 15 sorghum samples collected and the low frequency of recorded seed sales and purchases made by women (see Table 3). Adhola and Iteso women even admitted that few among them had ever set foot in the local agricultural supply shop (village focus group discussion, Mudodo, Tororo; supply shop salesperson, field interview). Instead, women depended on gifts or exchanges with their own female family or kin, to the extent that most women preferred to walk three miles to their mother's or sister's compound rather than take the risk of being denied seed by a neighbour. But the fact that kin members often resided a fair distance away served to spread the risk of seed loss, and Adhola and Iteso seed supply networks for sorghum appear to be fairly dependable. A look at variety population dynamics reveals a more precarious situation.

Size and turnover of seed lots

Two simple measures were used in this study to obtain additional insights into the distribution patterns and status of sorghum populations – the size and turnover of individual variety seed lots.⁹ These revealed that few households can realistically be considered dependable suppliers of sorghum seed and that some varieties are at severe risk of extinction. Two varieties, 1 and 5, dominated seed lots in Nyankole parish and can be termed 'abundant': both occupied more than 20 per cent of the total sorghum seed lot sampled for the season (see Table 4). Both varieties were popularly desired for traits such as high yield, good taste and being easily processed into flour. The variety belonging to the Nylon group has good taste and can be used to brew *mwenge* beer, attributes that are ordinarily mutually exclusive. Furthermore, its high tannin content gives it a strong taste, which allows women to skimp on the proportion used in *khalo*

Table 3. Proportion of women farmers who purchased sorghum seed.

	Purchased sorghum seed this season	Did not purchase sorghum seed this season	Ever purchased any part of their sorghum seed lot	Never purchased any part of their sorghum seed lot
Frequency	10	95	43	60
Percentage	9.5	90.5	41.7	58.3

Table 4. Variety seed lots (relative proportions of total seed lot by variety) and percentage of households cultivating each, for one season in 2001.

Sorghum varieties (most to least common)	Average seed lot per plot (kg) [†]	Total seed lot (kg)	Percentage of total seed lot cultivated	Percentage of households reporting cultivation
1	1.10	73.107	27.7	62
5	1.12	64.290	24.4	53.7
2	0.97	32.037	12.2	30.5
4	0.70	22.334	8.5	29.6
9	0.70	22.334	8.5	13.0
10	0.66	19.786	7.5	27.7
3	0.46	11.008	4.2	22.2
6	0.37	3.287	1.3	8.3
12	0.46	3.253	1.2	6.5
14	0.36	2.876	1.1	7.4
11	0.30	2.112	0.80	6.5
8	0.30	2.05	0.80	6.5
Unknown	0.90	1.8	0.70	1.9
13	0.40	1.555	0.59	3.7
7	0.36	1.075	0.41	2.8
15	0.20	0.608	0.20	2.8
Total	N/a	263.512	100	100

[†]The calculation of seed lot size is derived from the size of farmer's plots. A uniform density/area ratio was applied to all. This ratio was slightly conservative compared to farmer's actual density/area ratios. However, it allowed for accurate *relative* comparisons between households.

preparation; thus, the variety fills more stomachs and helps sorghum grain supplies last a little longer.

In combination, varieties 1 and 5 took up more than 50 per cent of the seed planted in the first season of 2001, suggesting that the least common varieties have such small populations as to place them at risk of extinction, at least within the parish. The small population of many varieties should not be taken as an indication that these are undesirable to women farmers. To the contrary, some of the least common varieties, such as 12 and 15, were important food security backups¹⁰ while others, such as 14, had specialty brewing qualities. Indeed, varieties 1 and 5 did not account for the total number of preferred agricultural and post-harvest traits mentioned by farmers, nor could they be substituted for all the varieties required to cover the range of Adhola and Iteso traditional brews.

The varieties present in the smallest quantities can be labelled 'rare' and their distribution patterns varied considerably. For example, varieties 4 and 9, with the same size seed lot, were present in roughly 30 per cent and 13 per cent of households respectively. The wider distribution of variety 4 was probably due to its longer existence in the parish, a pattern observed for varieties 6, 12, 14, 11 and 8, where the more recent arrivals were the least well distributed. This suggests that genes of recently adopted or incorporated varieties take some time to spread evenly across households and are therefore more vulnerable to extinction than longer established ones. In the absence of time-series data, however, these observations are not conclusive.

Finally, it is worth noting that at the field level, the small quantities of seed planted of any given variety made *all* seed vulnerable. The average amount of seed

planted of any variety by a woman farmer was a mere 230–350 g. With such a small amount of seed, most farmers stood a risk of losing one or more of the varieties they cultivated in any given season. This implies that women farmers were highly dependent on off-farm sources of seed to replenish lost seed stocks, a fact confirmed by seed turnover rates.

The seed turnover rate and use of seeds acquired off-farm (i.e. not from the woman's own seed stores) in Nyankole was calculated at 25 per cent based on the field survey. Even more dramatic is the fact that 21 per cent of women farmers had completely new seed in their plots and that another 52 per cent had kept seed for a maximum of five years, but only 5 per cent had kept seed for more than 20 years. However, although 25 per cent is a high turnover rate in global terms, it is not unusual for sub-Saharan Africa. For example, Tripp (2000) reported equivalent rates of seed turnover in Kenya, Malawi, Zambia and Zimbabwe.

Undermining it all?

Although this survey did not focus on the effect of HIV/AIDS on the farming system, the evidence gathered suggests that agricultural labour is in short supply in Nyankole parish and that this might be related to the negative effect of increased rates of death and ill health. The labour shortage, in turn, may be limiting aspects of agricultural production. Given the heavy reliance on human labour power in the region, various publications have described the major impact of HIV/AIDS on agricultural production in sub-Saharan Africa as acutely affecting production (FAO, 1995; Du Guerny, 2000; Shah *et al.*, 2002; Drinkwater, 2003). Labour losses can lead to a reduction in the area cultivated, declines in crop yields and in livestock production, increased dependence on wage labour for agriculture, loss of agricultural skills, fewer crops grown and a switch from more to less intensive cropping schemes (FAO, 1995). Research in Uganda already shows that there has been a shift from labour intensive crops such as bananas and coffee to cassava, sweet potato, maize, and to a lesser extent, yams and sorghum (Tumushabe *et al.*, 1993; Barnett, 1994; FAO, 1995).

Studies also point out that the effect of HIV/AIDS on a community can be extremely variable (FAO, 1995; Drinkwater, 2003). A series of factors that increase the impact of the epidemic has been identified including poor soil, limited rainfall, small range of crops grown, lack of cash remittances or other sources of income, high levels of out-migration, high levels of gender and age-based specialization in agricultural tasks, onerous cultural obligations to the deceased and inability to retain livestock (Gillespie, 1989; FAO, 1995). With the exception of limited rainfall, all the other variables are relevant to Tororo District.

While figures for the extent of HIV/AIDS are unavailable for Tororo District, the 10 per cent infection levels estimated for Uganda as a whole are likely to apply (Lyons, 1998). In Nyankole, farmers expressed concern about the frequency of funerals, which they claim used to happen once a month two decades ago but is now up to three times a week. Indeed, the high national dependency ratio, again linked to HIV/AIDS, is reflected in the parish demographics collected in this study. As Table 5 shows, 'old' and 'very old' women reported having more children under their care than did younger women. In other words, the burden of child rearing and/or caring for AIDS orphans is increasingly falling on older women, a trend probably linked to increased deaths among young working age adults, the worst hit by the disease. Significantly, a 14 per cent reduction in the Ugandan labour force is predicted for 1985–2020 linked to deaths from HIV/AIDS (FAO, 2001).

Table 5. Number of children cared for by women farmers by age.

Women's age (years)	Young (14–27)	Middle-aged (28–41)	Old (42–55)	Very old (56+)	F-value	P-value
Average no. children	3.296	4.500 [†]	5.048 [§]	4.956 [‡]	2.58	0.057
SD	1.463	1.863	3.025	3.612		
N	27	34	21	16		

^{†‡}Both indicate incrementally higher means; that is, the former is a higher mean than the latter. [§]Indicates significant difference between means; this result is the highest mean, statistically more significant than all others.

Note: Age categories based on women's early marriages at age 14/15 and life expectancy of 55 (51 for men) (*Macmillan Social Studies Atlas for Uganda*, 1998). Results shown for a one-way unbalanced ANOVA. Tests were run for 95 per cent confidence levels.

Not only is HIV/AIDS present in Nyankole, but it also may be having a detrimental effect on sorghum management practices and, therefore, the sustainability of sorghum seed. For example, a significant proportion of the women farmers in this study reported that they had trouble storing sorghum seed for the next season's planting. Because the priority use for sorghum grain was food, it is likely that seed stores ran out because these were being consumed in daily meals, although the most common reason given for this growing problem was more mouths to feed and fewer working-age persons to produce the food. While a labour shortage was probably exacerbated by the increase in child school attendance as well as the relatively low rates of men's full-time participation in agriculture (about 70 per cent of husbands, excluding those managing businesses off-farm), the pivotal reason is likely to be the increasing dependency ratios resulting from the HIV/AIDS epidemic.

In addition, it appears that women farmers are under-producing sorghum. Thus, despite the growing number of mouths to feed, the size of sorghum fields remained well below that needed to feed a family for one season. At 2001 levels of soil fertility and rainfall, a family with four children was said to require 0.41 ha of sorghum per season (0.82 ha per annum) while a single woman with two children required 0.1 ha per season (0.2 ha per annum). In practice, the average size of a sorghum plot came to 0.2 ha, with sizes ranging between one-eighth and one acre (0.05–0.4 ha). Taking into account that the average number of children per household was 4.4, this suggests that production fell far short of demand.

Finally, the absolute and proportionate sizes of individual sorghum plots tended to stay constant and small. While total land area accounted for some of the variation in plot size, this was only nominal (r^2 37.3). All households reflected this inelasticity regardless of the number of children present, the number of uses applied to sorghum, or the type of employment. In other words, even where there was a need for more sorghum and land was available, there was little increase in household production. The exception was households headed by women (that included a large proportion of widows), which had a significantly higher average proportion of land planted to sorghum than households headed by men.

It seems that women household heads give sorghum priority status for agricultural production. This shift in prioritization may, in turn, reflect these women's greater decision-making power over the allocation of land and labour than women in patri-lineal households. However, the widespread discrimination against separated wives and widows in Uganda means that their 'independence' comes at significant economic and social cost – upon divorce, separation or becoming a widow, women are often denied access to productive assets, including land and animals (MFPED, 2000). Recent studies

show that HIV/AIDS only increases the vulnerability of women-headed households. For example, women whose husbands have HIV/AIDS are often shunned by family and kin and denied any community assistance such as additional labour for farming; then, when they lose their sick husbands, many are then stripped of their assets and dignity and left destitute (FAO, 1995; Drinkwater, 2003; ESRE, 2004). The UN Food and Agriculture Organization (FAO, 1995) report on HIV/AIDS and agriculture in East Africa remarks that in Uganda, women who lose their partners to the disease but manage to remain on the land are forced to retrench their productive activities, having to give up commercial farming and focus only on food security crops. If women-headed households in Nyankole parish are suffering from social discrimination just as their economic options are nearly diminished, then the larger proportion of land dedicated to sorghum in these households is likely to be a sign of hardship. The consequences of all this for sorghum diversity are unknown, but current evidence suggests that seed supplies are as likely to be at risk in households headed by men.

Conclusions

This research lends strength to the argument that small-scale farming systems and crop diversity often reinforce and safeguard each other's existence. In Tororo District, eastern Uganda, multiple varieties of sorghum provide a reliable source of household food as well as income from home-brewed beer sales, thus sustaining farmers' livelihoods as well as their culinary and spiritual traditions. In particular, this study found that the decision to cultivate both food and beer varieties, when combined with traditional sowing and seed selection practices, acts as a significant impetus for plot-level diversity. At the same time, the existence of socioeconomic incentives is not enough to ensure the long-term conservation of diverse varieties. Thus, an analysis of seed flow and distribution in Tororo revealed that most women farmers are highly dependent on off-farm sources of seed and hold such small amounts of seed that they cannot be depended upon to maintain varieties for an extended period. In turn, the distribution of varieties at the parish level revealed that a large number exist in unsustainably small population sizes, effectively rendering entire varieties at risk of localized extinction.

At the regional level, funding for research and extension from international donors and governments bypasses East African sorghum as international interests in the region are heavily biased towards more commercially competitive food crops, particularly maize. Throughout the region, local brews – poor peoples' drinks – are confined to the informal beer market, while sorghum-based dishes – poor peoples' food – are increasingly limited to rural areas. At the local level, worsening social and ecological conditions have favoured sorghum over other basic food crops including finger millet, sweet potato and maize. Despite the crop's advantages and women's labour-saving practices, the surveyed households at the study site were consistently found to be cultivating insufficient amounts of sorghum to meet their families' caloric needs, or not be saving enough seed for the next season's planting.

While farmers' socioeconomic marginality is partially to blame, the critical impediment to better management of sorghum seed resources appears to be a labour supply crisis, precipitated by the high incidence of HIV/AIDS-related death and illness. The disease undermines not only those affected, but also the community as a whole, resulting in a chronic underproduction of sorghum by the majority of households. In turn, this points to a downwards spiral of reduced nutrition, energy and productivity, with negative consequences for farmers' livelihood security and for the sustainability of sorghum varieties

in the parish as a whole. These problems are likely to be true even for women-headed households that are known to allocate greater proportions of land to sorghum because their reduced productive capacity and social stigmatization – made worse for those coping with HIV/AIDS – can preclude their access to village safety nets and render them economically vulnerable. This, in turn, is likely to have a negative effect on their ability to manage sorghum varieties.

Paradoxically, regional and local sorghum populations are being undermined just as they gain greater relevance for the livelihoods of small-scale women farmers in East Africa. The crop's present-day significance resides in its ability to provide an ecologically resilient, labour-saving and nutritious food staple and source of income for those surviving at the margins of the global economy and suffering the impact of the HIV/AIDS epidemic. At the same time, these very factors render the crop vulnerable to the point where farmers may need external support from policymaking, agricultural research and extension bodies, among others, to maintain the usefulness and productivity of their varieties for future generations.

Finally, increasing dependency ratios are problems for Ugandan women because they bear the brunt of the agricultural labour burden, human caretaking responsibilities and household maintenance chores. At the same time, they are not given adequate decision-making authority over the allocation of productive resources and are more vulnerable to social stigmatization. The result is that women's capacity to manage biological resources under their care is critically impaired.

The severity of the problems faced by the women in this particular case study underscores that it is imprudent to assume that poor rural women will nurture diversity for diversity's sake as a 'natural' result of their subsistence lifestyles and/or the multiple uses they find for that diversity. Thus, the existence in Tororo of economic and cultural incentives to grow indigenous sorghum, the presence of multiple post-harvest uses for the crop and the tradition of sowing in mixtures are, in themselves, not sufficient to guarantee the future preservation of *in situ* sorghum diversity. Indeed, this paper demonstrates that a systematic look at women's management of any given resource in farming communities is essential to uncover salient details that help assess the conservation status of that resource.

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Endnotes

- 1 Landraces – variously referred to as 'farmer varieties' (Bellon & Brush, 1994), 'ecotypes' (Brandolini, 1969), 'indigenous varieties' (Evans, 1993) and 'folk varieties' (Cleveland *et al.*, 1994) – are domesticated crop varieties, the product of generations of human and natural selection (Brush, 1999). They have been typically described as 'locally adapted' populations of domesticated plants (Harlan, 1992: 147; Teshome *et al.*, 1999: 80), although this assumption of local adaptation is increasingly challenged (Hardon & de Boef, 1993; Galloway & Fenster, 2000; Scurrah-Ehrhart, 2003). *In situ* conservation refers to the maintenance of genetic resources on-farm or in natural habitats (Brush, 1999).

- 2 Rainfall is bi-modal, with an annual average precipitation of 1500 mm (*Macmillan Social Studies Atlas for Uganda*, 1998). Soils are lateritic, ranging from sands to sandy clay loams (field observations; also confirmed by Food Security and Marketing for Small Farmers Project (FOSEM) extensionist, field interview, 2001).
- 3 The term correlation is used here to denote a type of research design, not a data analyzing technique.
- 4 The household in Nyankole was (locally) defined through land allocation. Thus, family members housed within the same compound (or *shamba* comprising one or more kitchen and sleeping quarters) but responsible for and benefiting from the productivity of separate parcels of land were considered separate households.
- 5 I fully recognize here that a positive relationship between morpho/phenological diversity and genetic diversity cannot be taken for granted, because what appears to be high interspecific diversity (say, in the form of multiple grain shapes and colours distinguished by farmers) may in fact be a limited number of genes clustered in select loci (Paterson *et al.*, 1995; Koinange *et al.*, 1996; Xiong *et al.*, 1999; Poncet *et al.*, 2000; 2002). Nonetheless, even while farmers' selections may represent a limited number of genes, these are ones that count, because they satisfy the farmer and ensure the sorghum is planted. In this way, farmer-identified diversity ensures its future through the immediate value given to it by the cultivator while at the same time acting as the vehicle for passing on other diversity-carrying genes.
- 6 Women farmers admitted their growing reluctance to grow finger millet due to its relatively high soil nutrient requirements and because it requires multiple and back-breaking weeding sessions (field interviews, Nyankole parish, Tororo, 2000).
- 7 As, for example, in the studies on sorghum and maize crops in Africa and Latin America, including Teshome *et al.* (1999) and McGuire (2000) in Ethiopia, Friis-Hansen (2000) in Tanzania, and Bellon and Brush (1994) in Mexico – all reporting forms of edaphic and/or managerial differentiation of sorghum varieties by local farmers.
- 8 The habit of mixture sowing does not appear to be causing indiscriminate gene flow over time because the spread of years between varieties – as revealed by the 'history of arrival' of varieties – implies certain stability in the landrace populations. Thus, a new variety 'appears' – whether locally selected or brought in from neighbouring areas – approximately every ten years.
- 9 Variety seed lots refer to the total amount of seed planted to each variety by all the farmers sampled in a given season (based on terminology in Louette, 1999; see Figure 3). These variety seed lots represent random samples, or subsets, of their respective variety populations. Seed turnover refers to the proportion of the total seed planted acquired off-farm in a given season. When disaggregated by household, this information indicates the degree to which farmers depend on external sources for their seed.
- 10 Varieties 12 and 15 (both 'Atwal' group sorghums) were long duration varieties whose harvests could be made to coincide with annual periods of sorghum scarcity, thus serving as food security backups.

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