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Evidence that rodent control strategies ought to be improved to enhance food security and reduce the risk of rodent-borne illnesses within subsistence farming villages in the plague-endemic West Nile region, Uganda

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Abstract

Rodents pose serious threats to human health and economics, particularly in developing countries where the animals play a dual role as pests: they are reservoirs of human pathogens, and they inflict damage levels to stored products sufficient to cause food shortages. To assess the magnitude of the damage caused by rodents to crops, their level of contact with humans, and to better understand current food storage and rodent control practices, we conducted a survey of 37 households from 17 subsistence farming villages within the West Nile region of Uganda. Our survey revealed that rodents cause both pre- and post-harvest damage to crops. Evidence of rodent access to stored foods was reported in conjunction with each of the reported storage practices. Approximately half of the respondents reported that at least one family member had been bitten by a rat within the previous three months. Approximately two-thirds of respondents practiced some form of rodent control in their homes. The abundance of rodents was similar within homes that practiced or did not practice rodent control. Together, our results show that current efforts are inadequate for effectively reducing rodent abundance in homes.

Keywords

food security; food storage; rodent-borne diseases; rodent control; rodent damage; plague; subsistence agriculture

1. Introduction

Rodents pose a significant threat to public health and economics, particularly in developing countries where concerns about food security and rodent-associated zoonoses are often closely linked (Makundi et al. 1999). On a global scale, rodent damage to pre- and post-harvest crops has contributed substantially to malnourishment and reduced food security

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(Meerburg et al. 2009). The damage caused by rodents gnawing on crops can lead to spoilage of stored crops, or structural damage to plants resulting in reduced yields (Elias 1988; Brown et al. 2008). Furthermore, close contact between humans and rodents facilitates transmission of rodent-associated human pathogens. Such pathogen transmission may occur either through direct contact between humans and infected rodents (e.g. rat bite fever), or indirectly through contact with food or water contaminated by the urine of infected rodents (e.g. leptospirosis, hantaviruses, arena viruses), or exposure to rodent fleas or other ectoparasites (e.g. plague, murine typhus) (Mills et al. 1997; Gratz 2006; Meerburg et al. 2009).

Appropriate use of rodent control and improved food storage practices could increase the quantity and quality of food available to humans, and reduce the risk of rodent-associated diseases by reducing contact rates between humans and rodents. Our study focused on the West Nile region of Uganda, where traditional housing (earthen structures with grass thatch roofs) is commonly surrounded by fields devoted to crops associated with subsistence agriculture (Borchert et al. 2010). Storage of these crops in and around homes is common (Orach 2003), and this often attracts rodents that feed on stored foods, particularly cereals (Makundi et al. 1999, Borchert et al. 2010). Indeed, rats (primarily *Rattus rattus* and *Arvicanthus niloticus*) are quite common in and around homes in this region (Amatre et al. 2009; Borchert et al. 2010; Eisen et al. 2012). The close association between rodents and humans in this setting increases the risk of human exposure to plague bacteria and other rodent-associated pathogens. Within the West Nile region, an average of 266 human plague cases were reported annually from 1999 through to 2007 (Eisen et al. 2010); the prevalence of other rodent-associated zoonoses, such as leptospirosis, rat-bite fever, rodent-associated viral illnesses and murine typhus, are unknown and under-studied in this region and throughout East Africa (Mills et al. 1997; Makundi et al. 1999; Gratz 2006). Nonetheless, a common prevention message for many rodent-borne zoonoses, reduce food and harborage for rodents in the peridomestic environment also serves to reduce rodent damage to stored crops in this setting (Fielder 1988; Gage 1999; Orach 2003).

As prelude to developing interventions aimed at reducing rodent abundance in and around homes in this region (e.g. improving food storage and other rodent control methods), we sought to: (1) identify and categorize the types of foods that are commonly grown in the West Nile region; (2) assess current food storage practices in and around the home; (3) determine the extent to which rodents are observed to be in contact with crops, both pre-and post-harvest; (4) gauge the level of contact between humans and rats; (5) define current rodent control practices; (6) assess the burden of rodents inside homes where rodent control is reportedly practiced or not practiced; (7) ascertain whether there is a perceived need for improved food storage and rodent control methodologies.

2. Methods

2.1. Study locations and survey design

The study focused on a previously described elevation gradient in Arua and Zombo (formerly Nebbi) districts, located in the plague-endemic West Nile region of Uganda (Eisen et al. 2012) (Figure 1). Roughly 90% of the population within these districts resides in rural

areas, with close to 60% of those persons living in Ugandan government-defined poverty and more than two-thirds relying on subsistence farming (i.e. use of traditional seeds, breeds and tools and indigenous technical knowledge) to make a living (Lakwo et al. 2008).

The sampling transect (Figure 1) consisted of 10 sampling sites, each comprising four multi-structure households. Sites were evenly spaced with respect to elevation along the transect, which extended from approximately 725 m (site 1) to 1630 m (site 10) in elevation (average difference in elevation between neighbouring sites: 99 m, range 73–127 m). The residents along the transect encompassed two ethnic/linguistic groups; respondents from the lowest elevation sites (sites 1–4) belonged to the Madi tribe, and others belonged to the Alur tribe. Given that plague risk is higher at elevations above 1300 m (sites 7–10), the transect was established initially to assess rodent diversity and abundance along the elevation gradient, as well as to identify agricultural or food storage practices that differed between villages within areas classified as low or elevated risk (Eisen et al. 2010). Although the earlier study did not identify differences in agricultural or food storage practices that were likely to result in significant differences in plague risk along the transect, the transect population provides a representative sample of food storage, agricultural, and rodent-control practices within this region and identifies practices that could be modified to reduce rodent damage to foodstuffs and lower risks of rodent-borne diseases among residents living in this region.

2.2. Rodent trapping within huts

For each homestead enrolled in the survey, 2 Sherman (model 3310A, H.B. Sherman Trap Company, Tallahas-see, Florida, USA) and 2 Tomahawk (model TLT102, Tomahawk Live Trap Company, Tomahawk, Wisconsin, USA) traps were set within each hut within the family compound. Traps were baited with a mixture of equal parts of maize, groundnuts (peanuts) and dried fish and were operable from dusk to dawn. For each hut, traps were run for two consecutive nights spanning from 20 August through to 8 September 2011. Abundance per homestead was assessed as the number of rodents captured per 100 trap nights. All animal handling procedures were approved by the United States Centers for Diseases Control and Prevention Division of Vector-Borne Diseases Institutional Animal Care and Use Committee.

2.3. Questionnaire

A standardized questionnaire (see Appendix 1) was administered in the local languages at each household by Ugandan research team members who are fluent in these languages. Topics included demographics, crops grown and harvested by month, foods stored and method of storage, access by rodents to pre- and post-harvest crops, number of structures in household compounds, and uses of each rodent control practice and their efficacy, and contacts between humans and rodents within huts.

2.4. Study design

Specific households were selected, based on enrolment in a previous study, which described rodent and flea community structure in relation to plague risk along an elevation gradient (Eisen et al. 2012). Interviewers requested to speak with the person present with greatest responsibility for food preparation in the household. Households were visited up to three

times on separate days to enrol respondents. If no one was found at home on each of those three visits, the household was excluded from the survey. Questionnaires were administered from 22 to 26 August 2011. This time period coincided with the beginning of the “short” rains, which typically mark the start of the plague season (Monaghan et al. 2012).

3. Results

3.1. Household demographics

Thirty-seven of 40 attempted interviews were completed, with three households having no one present to answer the questions on any of three visits. Eighty-one percent of respondents were female and self-identified as the primary preparer of foods for the household (30/37) and they ranged in age from 15 to 85 years, with a median age of 45 years. Homesteads included in the survey had a median of 5 huts (range 2–13) and the number of persons within a family group residing in the homestead ranged from 4 to 34 (median 10 persons). Responses suggested that most huts were used for multiple purposes (e.g. sleeping, eating, cooking, food storage).

3.2. Small mammal abundance and diversity within huts

During 2544 trap nights, 142 rodents in total were captured inside huts within the enrolled homesteads. Roof rats (*Rattus rattus*) represented 88% of captures. Other species captured included *Arvicanthis niloticus, Crocidura* spp., *Mastomys* spp., *Praomys* spp. and *Thamnomys* spp. The numbers of roof rats captured per 100 trap nights per homestead ranged from 0–13.75 (median 4.16), with similar numbers trapped inside versus outside the plague focus (Wilcoxon’s Ranked Sums Test with χ^2 approximation: $\chi^2 = 1.89$, $df. = 1$, $P = 0.17$).

3.3. Agricultural plots

Across all households, cultivation of 23 different crop types was reported, with a median of 9 crop types reported per household (range 4–15). Beans (*Phaseolus vulgaris*), common potatoes (*Solanum tuberosum*), maize (*Zea mays*) and cassava (*Manihot esculenta*) were the most commonly reported crops, with over 90% of households reporting growth of each (Figure 2). We examined the months in which the 10 most common crops were harvested (Figure 3). Cassava and bananas (*Musa* spp.) were harvested year-round. Other crops, including coffee (*Coffea* spp.), finger millet (*Eleusine coracana*) and pumpkins (squash) (*Cucurbita* spp.) showed clear seasonality, with several months of the year when fewer than 5% of households reported harvesting. The remaining crops were reportedly harvested in each month, but there was a noticable increase in the percentage of households reporting harvest activities in July through to December (Figure 3).

All respondents reported seeing rodents as well as rodent burrows in their agricultural plots. Thirty-seven percent of respondents ($n = 14$) reported using methods to reduce rodent damage to crops. These included planting fishbean (*Tephrosia* spp.), which contains a toxin (rote-none) in its leaves ($n = 5$), weeding ($n = 4$), placing rat traps ($n = 3$) or rat poisons in the field ($n = 1$), slashing and burning fields ($n = 2$), placing foods at the garden perimeter ($n = 3$), or keeping domestic cats ($n = 1$).

3.4. Food and water storage in and around huts

Nearly all households reported storing staple crops including beans, maize and cassava (≥ 95% of households); storage of other common crops including Irish potatoes, pumpkins, etc., was more variable (Figure 4). The majority of respondents indicated that food is stored inside of a hut (e.g. in open containers, bags or on the floor, per observation), but not always hung within the hut (Figure 5). Because *Rattus rattus*, the predominant rodent collected from huts (Amatre et al. 2009), is nocturnally active, we postulated that risk of rodent and human contact would be greatest at night when residents are sleeping. We sought to assess whether it would be possible for villagers to reduce contact with rodents by sleeping in huts where food is not stored. The majority of respondents (68%) believed that it would not be possible to avoid food storage in huts where people normally sleep. Of the 25 households that cited reasons for continuing to store food in sleeping huts, responses included: concerns about theft (88%); lack of huts where people do not sleep (56%); concern that rodents might take food (32%); and/or that livestock might take food (20%).

All 37 respondents reported that they carry water to their homes on a daily basis using 20-L capacity plastic containers with narrow spouts (referred to as jerry cans); 24% and 11% reported also hauling water in cooking pots, or bottles or jars, respectively. All respondents reported storing water in huts. Water was stored in an assortment of containers including: African (earthen) pots (fired clay pots that are round with a short narrow neck and fluted opening; 86% of households), cooking pots (62%), jerry cans (51%), plastic bottles or jars (8%). Five percent of respondents reported finding a rodent in stored drinking water within the last 3 months, suggesting potential problems with water quality due to rodent-related contamination.

All 37 respondents reported storing food inside one or more huts in their household, and all reported having seen rodents in or around their stored food. The majority (92%) reported evidence of rodents gnawing on food or food containers; 95% reported seeing rodent droppings in and around stored food, and 14% had seen dead rodents in or around stored food.

The majority of respondents (97%) reported suspending food from the roof inside at least one hut in their homestead; 81% of these reported that rodents still gained access to such food. Among those who hung food, 14 (40%) reported using a device or method to prevent rodents from getting into the hanging food. Among those employing such devices, 3 respondents reported using string or a thin wire; 2 of these 3 reported that this method worked well. Six reported using a guard or barrier to the hung food which reportedly worked well for two-thirds of those using guards. Two reported using poison on string and both responded that this method worked well. Three reported use of other alternative methods; two reported hanging food within a bag, but noted the method did not work well. The other reported that fixing a round piece of plastic or a plastic bag on the top of the hanging food to force the rat to slide off worked well. Two-thirds of the 37 respondents replied that they would use a rat guard (e.g. similar to the conical metal pans used on mooring lines for ships) on their food hanging device, if it were available.

Storing food on the roof top of the hut was also quite common (70%). Among the 26 respondents who stored food on the roof, 88% observed that rodents gnawed on food, 85% observed rodent droppings near the stored food, 81% had seen rodents in or around the stored food, but only 4% had found a dead rodent in or around the food stored on roof-top. The numbers of roof rats trapped within households that stored food on roof-tops (median 4.84, range 0–13.75) trended slightly higher than those that did not (median 3.75, range 0–7.5), but the values were statistically similar ($\chi^2 = 1.7$, *df*. = 1, $P = 0.19$).

Nearly half of the 37 respondents (49%) reported hanging food in trees. Of the 18 households that hung food in trees, 78% reported that rodents gnawed on food, 67% had observed rodent droppings near food, and 78% had seen rodents near the food. None reported dead rodents in or near the food. The survey did not gauge the use of rat guards in this setting, where food is usually tied in a bundle and placed on a branch near the trunk without the use of rat guards.

To assess the quantity of food stored by respondents, we asked how large a food storage box would need to be to hold all the food that is normally stored inside of huts. Respondents were presented with a meter stick and asked to indicate the needed width, depth and height. Responses ranged from 0.5 to 32 cubic meters (median 4.7 m^3). Surprisingly, there was no statistically significant linear relationship detected between perceived storage volume and number of persons in the household. All respondents stated that they would prefer to have a lock on the food storage device and approximately 64% opted for keeping the storage device inside of a hut rather than outside.

Thirty percent ($n = 11$) of respondents reported having an outdoor granary, a traditional structure used exclusively for food storage. Among the 11 families that had granaries, most had 2 (median), but the number of granaries per household ranged from 1 to 5. At least one of the granaries was out of use in 5 of the 11 households. Notably, granary usage was significantly higher at the lowest elevation sites among the Madi tribe (66.7% of respondents reported the presence of a granary) compared with higher elevation sites among the Alur tribe (4.5%; $\chi^2 = 16.48$, *df*. = 1, $P < 0.0001$). Interviewers noted that agricultural plots tended to be further from homesteads at these sites, relative to higher elevation sites. Among the families possessing granaries that were not in use ($n = 5$), reasons for lack of use included (some respondents listed multiple reasons): not rodent-proof ($n = 2$), snakes get into granary ($n = 1$), other animals get in ($n = 1$), too small ($n = 1$), food gets wet ($n = 1$), food spoils ($n = 1$), state of disrepair ($n = 1$). None of the respondents cited fear of theft as a reason for not using existing granaries. The numbers of small mammals captured within homesteads where granaries were present or not were similar.

3.5. Rodent contact with humans and within-hut rodent control

Approximately half (49%) of respondents reported that at least one family member had been bitten by a rat in the last 3 months. The median number of bites received during the prior 3 months per household was 1.5 (range 1–8). Nearly all (94%) reported bites occurred when the affected person was sleeping; most bites were received on toes (89%), fingers (67%) and less frequently on lips (11%). Similar numbers of small mammals were captured within huts

where rat bites were or were not reported and no differences in the likelihood of rat bites was revealed based on tribal affiliation.

Most respondents, 24 (65%) acknowledged practicing some form of rat control inside of huts. Of those households that practiced rodent control in their homes, 71% acknowledged using poisons, 58% used kill traps, 4% reported keeping cats, and 17% reported using some other form of rodent control, including pouring water into burrows or using a stick to kill rats. The number of roof rats trapped per 100 trap nights was similar between homesteads that reportedly practiced rat control (median 4.5, range 0–12.5) and those that did not (median 4.2, range 0–13.8; $\chi^2 = 0.7$, $df. = 1$, $P = 0.08$). Likewise, amongst those households that reported practicing rat control, we compared the number of rats per 100 trap nights between those who used poisons (median 4.2, range 0–12.5) or not (median 4.7; range 3.8–11.3) and those who used kill traps (median 4.0; range 0–11.3) or not (median 4.9, range 0–12.5) and found no significant differences ($\chi^2 \leq 0.64$, $df. = 2$, $P \geq 0.42$).

4. Discussion

Recent quantitative estimates of pre- and post-harvest crop losses attributable to rodents are lacking for East Africa. Although the magnitudes of such losses are likely to be geographically and temporally variable, some have estimated losses in East Africa to be greater than 15% (Makundi et al. 1991, 1999). Our results confirm that rodents cause damage to crops both pre- and post-harvest within subsistence farming villages in the West Nile region of Uganda where food security is already a concern (USAID 2011). Despite approximately one-third of households practicing some form of rodent control in the field and nearly two-thirds in huts, all respondents experienced the incursion of rodents into at least some of their crops in the field, and nearly all reported that rodents consumed or spoiled stored food within huts. Furthermore, approximately half of all households reported that at least one family member had been bitten by a rodent within the past three months. This observation, coupled with contamination of stored food and water by rodents, demonstrates conditions under which risk of transmission of rodent-associated pathogens to humans is significant. While public health directives instruct householders to reduce food and harborage for rodents in and around the home in order to limit the risk of rodent-associated diseases (Makundi et al. 1991; Gage 1999; Orach 2003), there are few ways in which householders in the West Nile region or similar areas can comply with this suggestion, given the limited economic or government-funded resources available to local residents, as well as the limits of currently available structures and tools (Makundi et al. 1991, 1999).

Our findings suggest that there is a need to identify options for improved rodent control and food storage practices in order to increase food security and decrease rodent-associated diseases. These efforts can be targeted to the households where the economic losses are greatest or where human–rodent contact is highest. The development of such tools should focus on efforts that are first of all effective, as well as economically feasible and acceptable to the region’s residents. While zoonotic diseases are a serious concern, they are nonetheless relatively rare events; however, the loss of food to rodents is felt acutely by local residents. Anecdotally, questions about the loss of crops and food to rodents were raised during focus

groups covering other issues with community health workers in both Arua and Zombo districts. All groups responded to this issue with great animation, and were extremely interested to discuss the prospect of a household option for food storage (E. Zielinski-Gutierrez and M. Hayden, personal communication). Residents' concern and motivation regarding this issue may increase the likelihood of adoption, above an intervention that would focus on reduction of zoonotic disease risks alone.

This study provides several insights into the development of a device for household food storage. Given that most crops are seasonal and that the availability of commercial crops is limited, there is a real need to store foods for long duration in order to provide nourishment until the next harvest. In addition, stored seeds are an investment for future planting seasons and stored grains may serve as a source of income (Makundi et al. 1999). Consistent with a previous study (Orach 2003), our survey revealed that storage of foods inside of homes is common and this practice is influenced largely by a real concern about theft. Thus, the likelihood of any new food storage methodologies being adapted into daily routines would probably increase if the food storage device can be contained within occupied huts and secured against theft.

While the quantity of food stored varies considerably among households, it is clear that any storage options would need to be flexible to accommodate considerable quantities of stored foods and to be useable throughout the year, with the capability of accommodating seasonal changes in abundance and variety. Previous work in East Africa has shown that food storage containers must prevent spoilage and permit adequate air flow to prevent the development of harmful molds such those that produce aflatoxin (Aziz-Baumgartner et al. 2004). In our survey, the majority of households reported that in addition to storing food in containers (or otherwise) inside of huts, they commonly hang food within these structures. Some reported that the use of a plastic shield or rat guard on a string or wire supporting the hanging food was effective at preventing rodent access. Improvements to such a guard and attempts to promote wider use might be a viable food storage solution to reduce losses to rodents.

Historically, granaries were used commonly to store cereals in the West Nile region (Orach 2003, Meerburg et al. 2008). Indeed, use of granaries has been recommended as a plague management strategy because the separation of stored foods from human habitations presumably reduces contact between humans and potentially infectious rodents and their associated fleas (Orach 2003). However, in a previous study, concern over theft was cited as a reason for the decline in granary use, particularly among the Alur tribe (Orach 2003). In our survey, less than one-third of households reported the presence of granaries within their homesteads, and nearly half of those homesteads that had granaries were not using at least one of them for various reasons. Interestingly, most of the granaries were present at the lowest elevation sites where agricultural plots were more distant from homesteads compared with upper elevation sites. The Madi residents at these lower elevations are frequently absent from the homesteads where their granaries are located because of the need to attend crops in fields that might be many kilometers from the areas where they graze their livestock and where their homes are typically located, an observation that seems at odds with the concerns of Alur tribal members regarding food thefts from granaries (Orach 2003). It should be noted, however, that huts and granaries in these low elevation sites are typically

padlocked when residents are away from their homes; it is not known whether this was the case at higher elevation sites where granaries were used previously. Given that none of the respondents reported a concern of theft as a deterrent to using the granaries, but rather expressed concern about adequacy of construction (e.g. water or rodents getting into foods), structural improvements could promote the use of granaries within some homesteads. Recommendations for improvements to granaries that aim to reduce rodent contact with stored grains include: (1) raising the flooring of the structure to one meter above the ground; (2) incorporating a metal rat guard around support beams to prevent rodent access; (3) removing vegetation around the granary; (4) keeping up maintenance of the structure (Makundi et al. 1999). We note that granaries were not present at more than two-thirds of the sites and speculate that, consistent with previous reports (Orach 2003), their construction has declined in response to concerns about theft. Our survey did not assess reasons for the absence of granaries. If the re-introduction of granaries is considered as an alternative food storage method, we encourage further evaluations to determine why granary usage declined, and an assessment of factors that could increase future acceptability.

In addition to improving food storage mechanisms as a means to reduce rodent damage to stored crops and to reduce risk of exposure to rodent-associated pathogens, we noted a willingness among villagers to use various rodent control methods. However, based on evidence from this and a previous study that assessed small mammal abundance and diversity in these same villages (Eisen et al. 2012), current methods appear to be inadequate. Our survey did not address reasons for inadequacies, but it is likely that, similar to other regions of East Africa, lack of success is attributable to efforts being too limited or improperly timed (Makundi et al. 1999). Indeed, use of traps and poisons were among the most commonly practiced rodent-control measures in our study and these have been shown to be effective in other parts of East Africa (Fielder 1988; Makundi et al. 1999); however, success is dependent on widespread use, and in some cases the timing of use (Makundi et al. 1999; Belmain et al. 2002). The success of poisons is also dependent on the choice of active ingredient and bait formulation. Based on the few instances where the type of poison used was indicated in our survey, Indocid (indomethacin) – an inexpensive over-the-counter human anti-inflammatory drug – appears to be the most commonly used rodent poison. Although Indocid has been shown to be lethal to some rodent species, including *R. rattus*, the effect is dose dependent (Forson et al. 2008). Our survey did not determine the dosage or delivery method. Further studies are needed to assess the most effective, sustainable and safest rodent control methodologies. However, when considering use of rodent control measures within a plague-endemic region, it should be noted that rodent control in the absence of prior use of insecticides to rid rodents of their fleas is not recommended during plague epizootics (Gratz 1999). Nevertheless, reducing rodent abundances during inter-epizootic periods may reduce the likelihood of epizootics, which are dependent on high contact rates between infectious and susceptible rodents and their fleas (Davis et al. 2004, 2008).

Several questions are presented for future work in improving household food storage and reducing household rodent infestation. Initially, it will be ideal to provide a “proof of concept” that the introduction of food storage containers will be effective to limit rodent

abundance within household structures. Once this can be ascertained, the design of affordable, culturally appropriate and sustainable containers and storage devices will need to be addressed. Likewise, there is a need to assess the efficacy of various sustainable rodent-control practices and to address protection of larger quantities of recently harvested crops, which are often dried and stored outside the huts.

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Appendix 1. Survey instrument

Who to interview: Please ask for, and interview, the adult person in each family living group who prepares most of the meals.

Preface (please read or translate this to the person being interviewed):

> "Hello, my name is _____. I am from the Uganda Virus Research Institute's Plague Program and we are working with the U.S. Centers for Disease Control. We are doing a project to look for ways to keep rats out of crops and stored food. When rats come into your hut to look for food at night, they also bring their fleas which can transmit plague to people. If we can develop ways to keep the rats out of your food, then they will not come into your home and bring this disease. There are a lot of things we do not yet understand about crop and food storage practices and it would help us to help you if we could ask you some questions. Would it be alright for us to ask you some questions about your crops and food storage, and about how to keep rats out of your food?"
>
> "Taking part in this interview is voluntary. I will not record your name or any other information to identify you. Even if you verbally agree to be a part of this interview, you can choose not to answer any question you do not want to answer, or you can change your mind and stop taking part at any time. This interview will take about 20 minutes. Would you agree to participate?"

- No (Please thank the person for their time and move on to the next groups of huts.)
- Yes (Please continue with the questionnaire.)

Demographics:

Sex of the person being interviewed: ☐ Male ☐ Female

Age of the person being interviewed: ____years

How many people live here in your family group now? (*enter a number in each box*)

Sex	Age 0–12	Age 13–19	Age 20–49	Age 50 or over
Male				
Female				

How many other people in your family group normally prepare or cook food? _____

Please list the sex and age of each (i.e. M-14, F-49):

_____

_____

How many total huts or buildings (excluding outhouses) are present in your family's living area? _____

Check each box that is true (or yes answer). Each column in the chart represents 1 hut or building. If there are more than 6 huts in the group, continue in the charts on the next page.

	Hut 1	Hut 2	Hut 3	Hut 4	Hut 5	Hut 6
Someone normally sleeps inside this hut						
Food is normally prepared or cooked inside this hut						
Food is normally stored inside this hut						
Food is normally hung from the roof inside this hut						
Food is normally stored on top of the roof of this hut						
The roof of this hut is covered with thatch or grass						
Food is normally eaten inside this hut						
Chickens normally come inside this hut						
Water is normally stored inside this hut						

	Hut 7	Hut 8	Hut 9	Hut 10	Hut 11	Hut 12
Someone normally sleeps inside this hut						
Food is normally prepared or cooked inside this hut						
Food is normally stored inside this hut						
Food is normally hung from the roof inside this hut						
Food is normally stored on top of the roof of this hut						
The roof of this hut is covered with thatch or grass						

	Hut 7	Hut 8	Hut 9	Hut 10	Hut 11	Hut 12
Food is normally eaten inside this hut						
Chickens normally come inside this hut						
Water is normally stored inside this hut						

	Hut 13	Hut 14	Hut 15	Hut 16	Hut 17	Hut 18
Someone normally sleeps inside this hut						
Food is normally prepared or cooked inside this hut						
Food is normally stored inside this hut						
Food is normally hung from the roof inside this hut						
Food is normally stored on top of the roof of this hut						
The roof of this hut is covered with thatch or grass						
Food is normally eaten inside this hut						
Chickens normally come inside this hut						
Water is normally stored inside this hut						

What crops does your family grow? Place a check for each month in which this crop is normally harvested. If a crop is not grown, leave blank.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coffee												
Bananas												
Maize (corn)												
Beans (any kind)												
Melons												
Squash (pumpkin)												
Cassava												
Irish Potatoes												
Sweet Potatoes												
Millet												
Sugar Cane												
Tomatoes												
Onions												
Pineapples												
Tobacco												
Cotton												
Other:												
Other:												
Other:												
Other:												

Does your family normally plant fishbean around crops to help control rodents (moles or rats)? _____ yes _____ no

Does your family normally use any other methods to help control rodents around planted crops? _____ yes _____ no

If so, please describe them:

Have you seen rodents in your planted crops? _____ yes _____ no

If yes, which crops have you seen rodents in?

_____

_____

_____

Have you seen rodent burrows in your planted crops? _____ yes _____ no

If yes, which crops have you seen rodent burrows in?

_____

_____

___

How does your family normally store the following crops/food items? This includes foods that you grow and also foods that you acquire otherwise (buy, trade, receive as gift, etc). Please place a check under each method used (may answer more than one). If the crop/food item is not grown or used, leave blank.

	Hang from a tree	**Hang inside a hut**	**Store on top of a hut roof**	**Store in an outdoor granary**	**Store inside a hut**	**Other: specify**
Coffee						
Bananas						
Maize (corn)						
Beans (any kind)						
Melons						
Squash (pumpkin)						
Cassava						
Irish PotatoesSweet Potatoes						
Millet						
Sugar Cane						
Tomatoes						
Onions						
Pineapples						
Commercial Products in cans, boxes, etc						
Fish:						
Other:						

Do you think it might be possible for your family to

not store crops/food in huts where people normally sleep? _____ yes _____ no

If no, then why not?

_____ Concerns over food security (people might steal our food)

_____ Livestock (such as goats, dogs, chickens, etc) might take our food

_____ Rodents might take our food

_____ We don't have any hut available that no one sleeps in

_____ Other reasons:_____

_____ Other reasons:

_____

What kind of containers does your family use to haul drinking water in?

_____ plastic jerry cans _____ bottles or jars

_____ cooking pots or pans _____ other:

_____

_____ African clay pots

What kind of containers does your family use to store drinking water in? *In the space, write in the number of such containers that you have.*

_____ plastic jerry cans _____ bottles or jars

_____ cooking pots or pans other:

African clay pots_____

If you use plastic jerry cans, how many of them have tops? _____

Has your family found a rodent, during the last 3 months, in a drinking water container used for storing water? _____ yes _____ no How many times: _____

How many days per week does your family haul water home for drinking/cooking? _____

Typically, how many days does a container of water remain in your hut until it is empty? _____

YES	NO	Answer for food that is stored inside any hut
		Has your family seen rodents in or around your stored food?
		Has your family found dead rodents in or around your stored food?
		Has your family seen rodent droppings in or around your stored food?
		Has your family seen evidence of rodents gnawing food or food containers?

YES	NO	**Answer for food that is hung from the roof inside any hut**
		Do rodents get to your hanging food?
		Does your family use any type of device or method to prevent rats (any rodents) from getting into hanging food?
		Please describe this device or method:
		The surveyor should take a digital picture of any such device, if possible.
		Does this device work well?
		Would your family use a rat guard to attach to the hanging rope (string, wire, etc) if one were available? Such a device would need to be about 1/2 meter across and could prevent rats (any rodents) from getting to your hanging food.
		When maize or other foods are hung inside a hut, do rodents frequently chew through the rope or string causing the food to fall to the ground?
YES	NO	**Answer for food that is stored on top the roof of any hut**
		Has your family seen rodents in or around your stored food?
		Has your family found dead rodents in or around your stored food?
		Has your family seen rodent droppings in or around your stored food?
		Has your family seen evidence of rodents gnawing food or food containers?

YES	**NO**	**Answer for food that is stored hanging in trees**
		Has your family seen rodents in or around your stored food?
		Has your family found dead rodents in or around your stored food?
		Has your family seen rodent droppings in or around your stored food?
		Has your family seen evidence of rodents gnawing food or food containers?

We are considering the idea of constructing a food storage box that rodents cannot get into.

Are there any food items that you think

should not be stored together in the same box? _____ yes _____ no

Which foods should not be stored together and why?

_____

_____

_____

_____

_____

How large do you think a food storage box

needs to be to hold all the food you normally store inside huts?

Height: _____ cm Width: _____ cm

Depth: _____ cm

Do you think such a box should have a lock on it? _____ yes _____ no

Would you prefer to keep such a box inside a hut or outside? _____ inside _____ outside

Does your family normally have any commercially prepared foods? _____ yes _____ no

If so, what kinds of food and in what kind of container? (for example “crackers in a box”, “beans in a can”, etc)

_____
_____
_____

Does your family normally do anything to control rats inside huts? _____ yes _____ no

If yes, what do you do?

_____ Use poison to kill them

_____ Use a trap that kills them

_____ Use a trap that captures them (but does not kill them)

_____ Other: _____

_____ Other: _____

Has anyone in your family been bitten by a rat in the last 3 months? _____ yes _____ no

If yes, what were they doing when bitten:

_____ sleeping

_____ interacting with the rat (trying to capture/kill it/chase it out of the hut)

_____ other: _____

What part of the body was bitten: _____ fingers _____ toes

_____ other: _____

How many people in your family have been bitten by rats in the last 3 months?_____

Does your family have an outdoor granary? _____ yes _____ no

If yes, how many are in your family living area? _____

Count all granaries, even ones not being used.

How many of those are not normally used to store food in? _____

If you have a granary that is not used to store food in it, why don’t you use it?

_____ rodents get into the food in the granary

_____ other people might steal my food/disagreements with family members over food ownership

_____ snakes get into the granary

_____ other animals get into the granary, what kind: _____

_____ the top is difficult to open

_____ the granary is not large enough

_____ food gets wet in the granary

_____ food spoils in the granary

_____ other reasons: _____

Do you have any ideas that you would like to share with us on how to keep rodents away from corps and food? Do you have any ideas on what a rodent-proof food storage box should be like?

1

2

3

4

Name(s) of the UVRI staff member who conducted this interview:

_____

_____

_____

_____

_____

Date of interview:

_____

__

Name of the village:

_____

_

GPS coordinates:

_____

_____

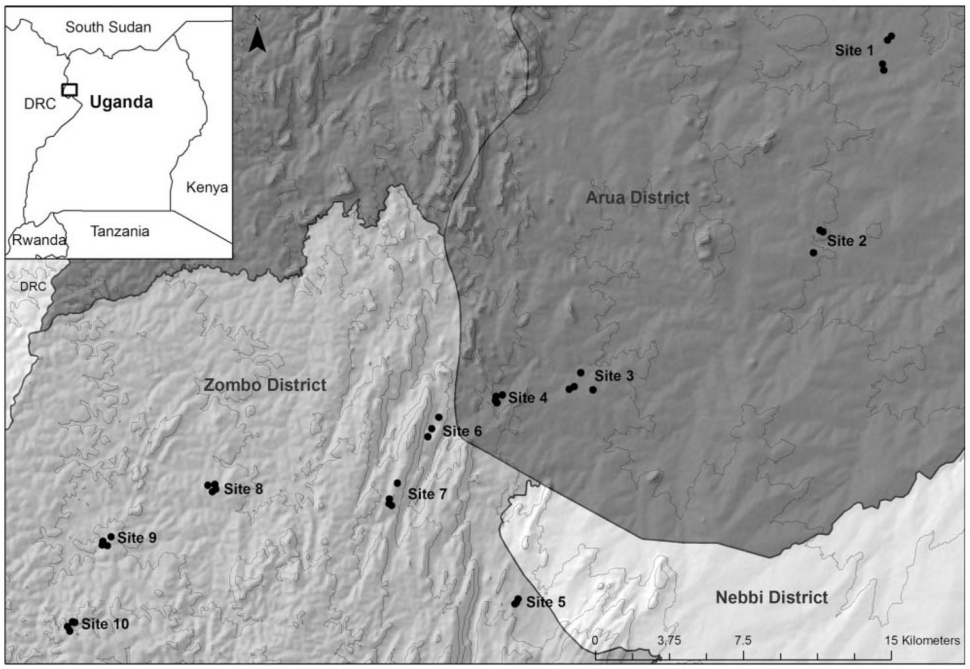

Figure 1.
Locations (points) of households included in the survey.

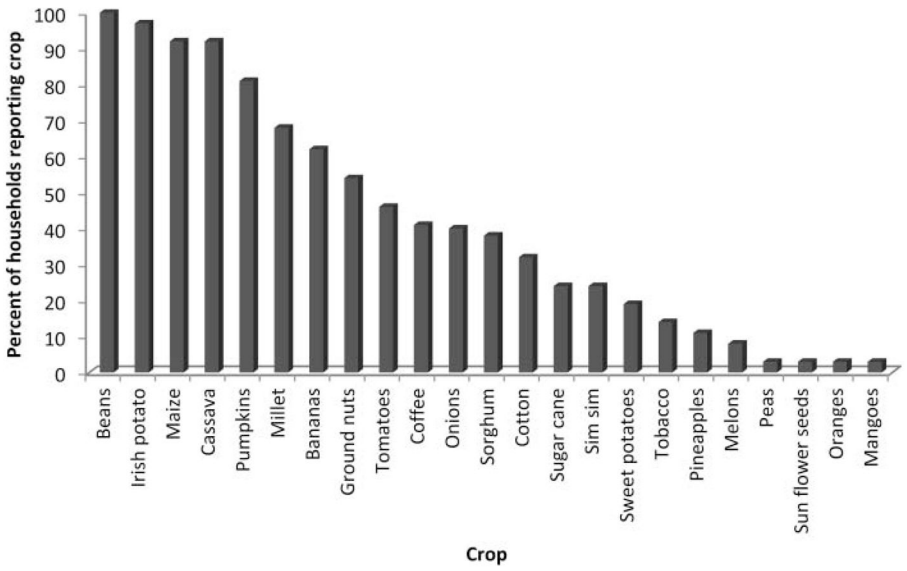

Figure 2.
Percentage of households reporting growth of various crops.

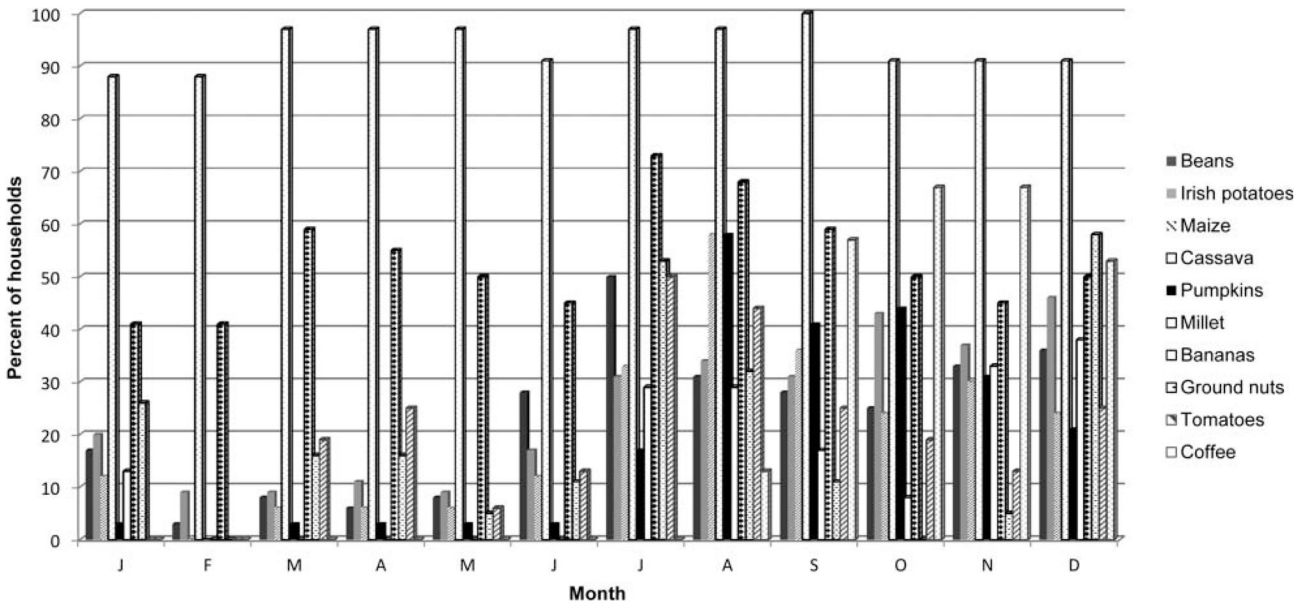

Figure 3.

Percentage of homesteads that harvest various crops by month throughout a year. Only homesteads reporting that they grow the crops listed in the Survey Instrument (Appendix 1) are included. Crops selected represent the 10 most common crops.

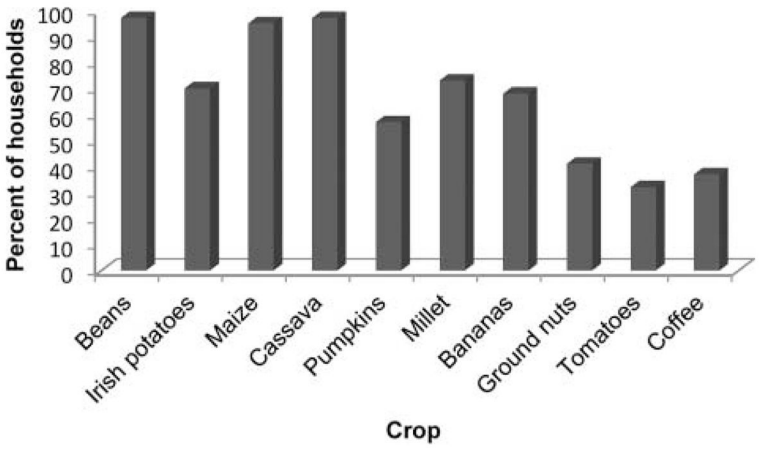

Figure 4.
Percentage of households that report storage of the top 10 crops.

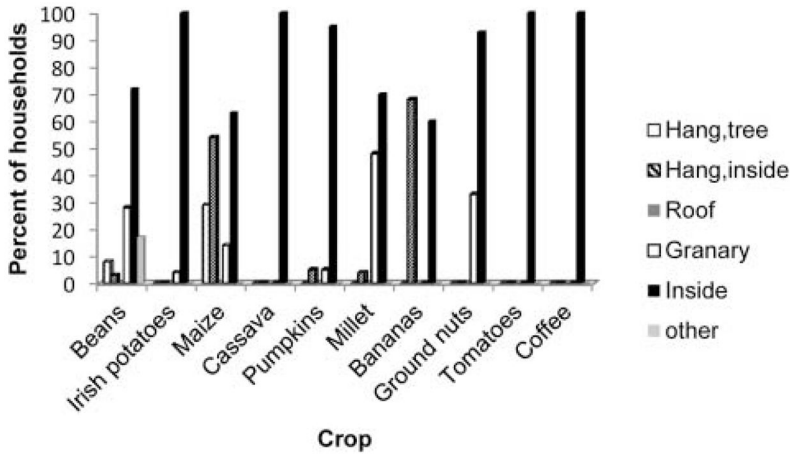

Figure 5.

Percentage of households storing crops by hanging from trees, hanging inside the hut, on the roof, in a granary, inside (but not hung), or by some other method. Location of storage is based only on responses from those reporting that they store the crop.