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Case Study:

Improving Poultry Production for Sustainability in the Ruaha Landscape, Tanzania

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Improving Poultry Production for Sustainability in the Ruaha Landscape, Tanzania

Report prepared for WCS TransLinks Program

Danielle Knueppel, University of California, Davis
Peter Coppolillo, Wildlife Conservation Society*
Ayubu Omari Msago, Wildlife Conservation Society
Peter Msoffe, Sokoine University of Agriculture
David Mutekanga, Wildlife Conservation Society
Carol Cardona, University of California, Davis

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Author Contact Information:

*Corresponding Author: Peter Coppolillo (pcoppolillo@wcs.org)

WILDLIFE CONSERVATION SOCIETY

Improving Poultry Production for Sustainability in the Ruaha Landscape, Tanzania

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Summary

Shortages in protein availability are a well-known problem in village economies, especially in Africa, and the neurological and nutritional importance of animal-source protein is increasingly being recognized. A Newcastle disease vaccination program for chickens was undertaken to increase livestock productivity and to preemptively rule out Newcastle disease so that highly-pathogenic avian influenza would be more readily detected. This intervention offered an opportunity to examine how chicken vaccination affects household economies, and to test whether increased livestock productivity could reduce illegal hunting for bushmeat. We found that vaccinations did increase chicken production and egg and meat consumption but did not reduce the frequency of bushmeat consumption at the household level and, furthermore, that bushmeat consumption was not related to food security. Our findings suggest that bushmeat likely supplements (rather than substitutes) domestic meat, and its supply is driven by hunters' demand for cash rather than household demand for protein.

Background of the Area

Ecological and Socioeconomic Overview

The Ruaha Landscape is one of Tanzania's largest wild areas, with extraordinary biodiversity of national and international significance including over 35,000 elephants and an intact carnivore guild that includes Africa's third largest population of the critically endangered African wild dog. Much of the Ruaha Landscape lies within Ruaha National Park, Rungwa, Kisigo and Muhezi Game Reserves and the Pawaga-Idodi Wildlife Management Area. The Ruaha Landscape forms the southern limit of Tanzania's "arid corridor," where rainfall is approximately 200 mm or less per year. The Great Ruaha River collects water from Tanzania's southern highlands, where it flows through the arid corridor and provides scarce surface water for irrigation, livestock grazing, inland fisheries, terrestrial wildlife and the majority of Tanzania's hydroelectricy.

Like many protected areas, those within the Ruaha Landscape lie very close to human populations, many of which lack land use planning and suffer from extreme poverty. Unlike other large protected areas (see Bruner et al. 2001), however, those of the Ruaha Landscape are not inhabited. Populations that historically lived in or cultivated the area were relocated by the government of Tanzania to nucleated settlements south of the Ruaha River, and the communities now primarily depend on the resources within the resettled area for their livelihoods (Coppolillo and Dickman 2007).

The Pawaga and Idodi Divisions of the Iringa District are the focus of this study, because they include 21 of the 23 villages that directly border the Ruaha National Park and the Great Ruaha River. They are also characterized by a diverse population, consisting of both crop

agriculturalists and pastoralists, and are part of the major food producing areas for the Iringa Region as a whole. Currently, the human activities taking place in this area include pastoralism and crop agriculture with irrigated rice cultivation during the dry season. These rice fields are not leveled and water must flow across them continuously, causing massive water loss from the Great Ruaha River, which provides 40% of Tanzania's hydro-electric power. Land use conflicts are common; livestock incursion in cultivated areas is the most prevalent, followed by incursions into village-managed areas designated for wildlife. Most meat production is from livestock, but consumption of wild meat (or "bushmeat") is also common, though (mostly) illegal.

Numerous agricultural and agro-pastoral ethnic tribes live in the area. The numerically dominant tribes are the Hehe, Bena, Masaai and Gogo. A large majority of the people living in the Ruaha Landscape engage in small-scale agriculture, with the vast majority of these being subsistence farmers. Maize and paddy rice dominate crop agriculture and have the dual function of being both a food and cash crop. Agricultural activities coincide with the rainy season, which begins in late November and lasts until April or May. Food stores are high following harvest in June but often begin to run out from December until the maize begins to ripen in March. This period, when grain stores are most depleted and harvests have not yet taken place, is called the 'hungry' or 'lean' season, and food shortage is common in many families.

This area, like many Tanzanian rural areas, is characterized by increasing human population and poverty and lacks basic amenities like clean water and sanitary health facilities. While tourism is increasing, it still employs less than two percent of the local population (Dickman 2008), mostly for unskilled labor in tourist camps. Most of the young people are jobless, leading to their involvement in illegal activities like the poaching and sale of bushmeat.

Chicken Production

Chickens play a vital role in many poor rural households by providing an important source of high-quality nutrition and income at very little cost. Chickens are a renewable asset, important for insect pest control, for providing manure and for their role in social activities, religious ceremonies and the traditional treatment of illness. Chickens are often kept by households as a source of quick money to pay for medicine, food, transportation costs or school fees, and are small enough that they can be consumed quickly by a family, unlike larger livestock that, once slaughtered, may spoil without refrigeration.

Village chickens suffer high mortality and low productivity, because people invest little in feeding, housing and disease prevention. Typically, chickens are allowed to scavenge for food freely throughout the day and are kept confined at night to discourage theft and predation, either in the house (under beds or in the kitchen space) or in specially-built structures. If chicken housing is provided, it is often

built of local materials, such as mud, sticks, bamboo, grass, or scrap materials. Drinking water is sometimes provided in a shallow bowl, especially in the dry season. Chickens forage on insects and worms, grains and grain by-products, seeds, fodder, grass, roots, and household cooking waste. They are infrequently given supplemental feed of leftover food and maize bran. The amount of feed available fluctuates with season and household practices, and partially determines the production potential of the flock.

As in many developing countries, women play a major role in family poultry production in Tanzania. Women, assisted in some cases by children, are often the primary caretakers of chickens, feeding, watering and treating birds and cleaning their shelters. Certain tasks, such as shelter construction and selling and buying birds in village markets are often the responsibility of men or boys. Although women are generally the owners and caretakers of chickens, they do not always have decision-making authority on the use of chickens and eggs.

Village flocks usually range from 10 to 30 birds per household and annual egg production ranges from 40 to 60 eggs per hen (Boki 2000). The age at first lay for hens ranges from six to eight months, and the average hen has three laying cycles per year. By estimating that at least 5 chicks per clutch will survive to maturity, a household with a core breeding group of 5 hens will produce, on average, 25 chickens for sale or consumption per laying cycle. With 3 laying cycles per year, that is 75 chickens available for sale annually per average household. If sold at 3,000 Tanzanian Shillings each (about US $3) this translates roughly into 225,000 Tanzanian Shillings (about US $225) annually from chicken production, which is close to the average per capita GDP in rural Tanzania.

Preventative measures against disease are rarely taken, and chicken disease and resultant mortality (particularly from Newcastle disease) is a major problem facing rural chicken producers. Free-range flocks are constantly exposed to the weather and predators, as well as to germs and parasites found in the soil and in wild birds and animals. Viral infections (such as infectious bursal disease, Newcastle disease and fowl pox), bacterial infections (such as coccidiosis and salmonellosis), internal and external parasites, and malnutrition are the major causes of disease and death of village chickens in Tanzania (Sonaiya and Swan 2004). The movement of live birds through sale and exchange is often implicated as the major factor in the spread of disease (Yongolo et al. 2002).

Newcastle Disease

A major constraint to small-scale, family-based poultry production in Tanzania is viscerotropic velogenic Newcastle disease (hereafter referred to as Newcastle disease), which is caused by a virus that is capable of causing up to 80 to 100% mortality in unprotected flocks (Sonaiya and Swan 2004). The virus spreads rapidly by means of

airborne droplets produced by the coughing or sneezing of infected birds. Birds of any age can be affected, although the young are more susceptible. Chickens infected with the virus may die suddenly, with few symptoms. However, clinical signs of Newcastle disease include lethargy, coughing, sneezing and gasping. The respiratory signs usually develop first and are sometimes followed by a twisting of the neck, dragging of the wings, loss of appetite and greenish diarrhea. In Tanzania, the highest prevalence of Newcastle disease outbreaks occurs in the dry season, from June to October (Yongolo et al. 2002). Factors that may influence the spread of Newcastle disease at this time of year include the increased exchange of chickens in the market (Alders and Spradbrow 2001), winds that can carry the virus in the air, and the sharing of a small number of contaminated water sources among chickens (Sonaiya and Swan 2004).

Newcastle disease can be controlled by the use of vaccines. Several studies (Bensink and Spradbrow 1999; Foster et al. 1999; Wambura et al. 2000; Msami et al. 2004; Illango et al. 2005) have documented the beneficial effects of Newcastle disease vaccinations (e.g., significant decreases in chicken morbidity and mortality rates) on village chickens in Tanzania and other African countries. The heat-stable I-2 vaccine, administered as an eye-drop, has reported disease prevention rates ranging from 77% to 100% (Wambura et al. 2000; Msami et al. 2004; Illango et al. 2005). The vaccine is inexpensive and easily administered by trained villagers. At the time of this study, a dropper vial of the I-2 vaccine, enough to vaccinate about 400 chickens, cost 2,000 to 3,000 Tanzanian Shillings (US $1.6-2.5). The Tanzanian Ministry of Livestock recommends that chickens be vaccinated at least one month before an outbreak is likely to occur, and that vaccinations by eye drop be carried out at least 3 times per year, as immunity will diminish if chickens are not revaccinated.

Figure 1. A typical village flock. Note the multi-age birds, which are common only when Newcastle control is successful.

Bushmeat Hunting and Chicken Production

The term ‘bushmeat’ refers to meat from any non-domesticated animal, ranging from terrestrial mammals to amphibians and insects harvested for food (Nasi et al. 2008). In this study, bushmeat is regarded as a source of both protein and income to the families living in the study area. In Nasi et al.’s (2008) discussion of the bushmeat crisis, the substitution of domestic animal protein for that of bushmeat is identified as a challenge, raising multiple concerns about the cultural sustainability and economic suitability of domestic livestock as a substitute for bushmeat. Although the transition away from bushmeat may be complicated and difficult for local communities who consume and derive income from the hunting of easily accessible wildlife species, many argue that a transition to domestic meat may be the most realistic bushmeat alternative given the lower productivity of wild game and the low human densities that wild populations can sustain (e.g., Bennett and Robinson 2000). In this applied study, we examine whether an increase in poultry production affected bushmeat consumption, and we explore the potential linkages between domestic livestock production and bushmeat.

The Newcastle Disease and Avian Flu Control Project

The Wildlife Conservation Society’s Ruaha Program, together with researchers from Sokoine University of Agriculture in Morogoro and the University of California, Davis, initiated the Newcastle Disease and Avian Flu Control Project (NDAFCP), a poultry development and research project in three villages located near Ruaha National Park. This project was housed under the larger Avian Flu School program funded by USAID through the Global Livestock Collaborative Research Support Program, with collaborative links to USAID-funded work through

Feeding chickens

the Tanzania Mission and TransLinks. The NDAFCP was aimed at: (1) implementing and evaluating a sustainable chicken Newcastle disease vaccination program; (2) assessing extension and training methods for improved poultry husbandry; and (3) developing strategies for preventing Avian Influenza at the village-level.

The NDAFCP contained the following major activities:

- Training policy makers, at the district and ward levels, on village chicken health and production, with an emphasis on the importance of disease control, especially Newcastle disease and Avian Flu. Training included a focus on ensuring institutional support for planning, budgeting and creating by-laws in the implementation of village-level poultry disease prevention.
- Training village vaccinators and record keepers to ensure that, even following project completion, vaccinations and record keeping continues.
- Providing Newcastle disease vaccinations for all village chicken flocks.
- Gathering information from households on the extent of their knowledge of poultry diseases and the economic benefits of poultry production.
- Collection of samples from project village poultry, for diagnosis of poultry diseases.

Three project villages – Nyamahana, Malinzanga and Mafuluto – were chosen by the WCS office to receive the chicken vaccinations, on the basis of village government support and cooperation. In the three project villages, village vaccinators were selected, trained, and supplied with dropper vials of the I-2 Newcastle disease vaccine. They conducted vaccinations in May and September 2007, and February, June and October 2008 (Table 1). All vaccinations were free, except for the last one in October, where people were required to pay 30 Tanzanian Shillings per chicken vaccinated (less than US $0.03 per chicken).

The vaccination interventions provided an opportunity to observe changes in bushmeat consumption, which is the focus of the work reported here.

Table 1. Chicken vaccination and household survey timeline.

Date	Event
May 2007	vaccinations (free)
September 2007	vaccinations (free)
February 2008	vaccinations (free)
March 2008	household surveys
June 2008	vaccinations (free)
October 2008	vaccinations (US $0.03/bird)
March 2009	household surveys

Study Questions, Design and Methods

We hypothesized that an increase in chickens kept by households would have a beneficial impact on household income, food security, and consumption of animal-source protein, which in turn can lead to a decrease in poaching of wildlife for food and income. We define "food security" as a state in which all people, at all times, have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life. The purpose of this study was to assess the socioeconomic impact of the Newcastle disease vaccinations on households in the project villages. Three control villages – Luganga, Magozi, and Ilolo Mpya – were selected based on similarities (socioeconomic, location and infrastructure) to the three project villages. The control villages were located in relatively close proximity to the project villages but did not receive chicken vaccinations through the vaccination program.

The provision of free or low-cost Newcastle vaccinations offered an opportunity to examine the relationship between poultry production and household bushmeat consumption. Specifically, we sought to examine two contrasting pathways (see Figure 2): (1) household-level demand for bushmeat is driven by a lack of protein; or (2) the supply of bushmeat is driven instead by hunters' need for cash. We hypothesized that, if bushmeat demand was driven by a lack of protein, then increasing protein availability (a result of Newcastle vaccination) should reduce the consumption of bushmeat. This hypothesis assumes that chicken would substitute, rather than supplement, existing protein sources. A contrasting, though not mutually exclusive, hypothesis posits that the supply of bushmeat is actually driven by hunters' need for cash. In this case, flooding the village with protein would not affect bushmeat supply, since individuals would still require cash and would still supply bushmeat to meet their cash demands. In fact, one local producer guessed that a glut of poultry might increase bushmeat consumption by driving its price down, so that suppliers would have to provide more meat to meet their monetary needs.

Differentiating between the validity and relative importance of these two pathways is important. If protein demand is driving bushmeat consumption, increasing the protein supply could help alleviate the demand for wild meat. However, if the demand for cash is driving the trade, conservationists would be better served by helping to provide alternate

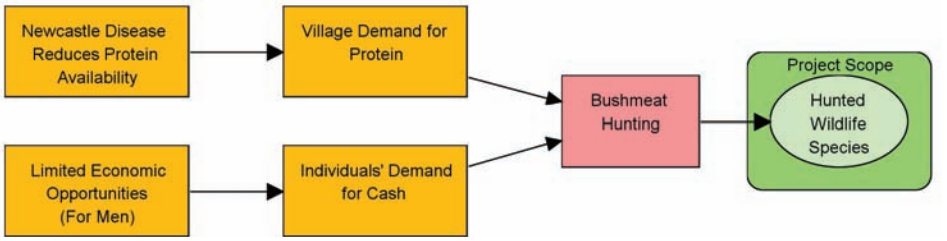

Figure 2. A conceptual model of the relationship between bushmeat and poultry.

economic activities for potential hunters. Increasing village chicken productivity may help meet demand for animal protein, but may not offer an alternative income to hunters if men, for traditional reasons, would resist investing their time in chicken production and marketing.

Data collection methods included key informant interviews, conducted in February 2008, and household surveys. The household surveys were done twice - in March 2008, after three rounds of free vaccinations in the project villages, and again in March 2009, after a further two rounds of vaccinations (one free, one not) (see Table 1). The surveys took place during the period before the harvesting of crops when households often experience food shortages. In 2008, a random sample of 237 households was chosen, and in 2009, a separate random sample of 261 households was chosen. Households were eligible for inclusion in the study if they had at least one child between 1-5 years of age and they owned chickens (either at the time of the study or one month prior to the study). Eight trained, local research assistants interviewed the mother, or primary caregiver, at her home. The interview consisted of a structured questionnaire on household socioeconomic characteristics, frequency of animal source food (ASF) consumption for the mother and child, the frequency of household food insecurity, and chicken and egg production and sale. Household food insecurity status was measured using the Household Food Insecurity Access Scale (Coates et al. 2007), an instrument developed by the Food and Nutrition Technical Assistance program of USAID.

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Major Findings

Sample Characteristics

The two groups were very similar, with no significant differences between the project and control village households in terms of demographic, education, religion, or wealth measures in 2008 (see Table 2). And in 2009, the only significant difference between the project and control groups was the mother's age. We also saw no significant differences in socioeconomic characteristics between the combined groups in 2008 and 2009. This similarity is optimal for making comparisons between the project and control groups.

Chicken Vaccinations

In 2008, about 20% of project village households vaccinated their chickens three times and about 44% of households vaccinated twice (Figure 3). The large majority of control village households did not vaccinate their chickens in 2008. In 2009, however, vaccination rates decreased in the project villages and increased in the control villages, as more control households were independently vaccinating their chickens (almost 20% vaccinated once and over 10% vaccinated twice). In 2009, therefore, the control village group was no longer a suitable control group and we decided to examine any changes taking place in the control villages as potentially due to the increase in chicken vaccinations.

Table 2. Characteristics of the sample households.

	2008			2009		
	Project village households (n=119)	Control village households (n=118)	P value	Project village households (n=134)	Control village households (n=127)	P value
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
Mother's age (yrs)	32.3 ± 10.3	30.5 ± 8.9	NS	34.1 ± 10.3	31.2 ± 7.4	0.024
Number of children under 16 years (n)	2.9 ± 1.2	3.0 ± 1.4	NS	3.1 ± 1.2	3.4 ± 1.3	NS
Household size (n)	5.2 ± 1.5	5.4 ± 1.7	NS	5.5 ± 1.5	5.7 ± 1.6	NS
Child's Age (yrs)	2.5 ± 1.4	2.5 ± 1.4	NS	2.9 ± 1.4	2.9 ± 1.4	NS
Mother's education level (yrs)	5.3 ± 3	4.7	NS	5.0 ± 3.0	4.9 ± 3.2	NS
Husband's education level (yrs)	5.8 ± 2.7	6.2	NS	5.6 ± 2.8	5.8 ± 2.8	NS
Sex of child (% male)	47.9% (57)	48.3% (56)	NS	49.3% (66)	51.1% (69)	NS
Religion						
Christian	93.3% (111)	89.2% (99)	NS	93.9% (122)	92.1.%(116)	NS
Muslim	6.7% (8)	10.8% (12)		5.4% (7)	5.6% (7)	
Tribe						
Pastoralist	13.5% (16)	19.8% (23)	NS	6.0% (8)	8.1% (10)	NS
Agriculturalist	86.5% (103)	80.2% (93)		94.0% (125)	90.9% (114)	
Household wealth score	18.2 ± 3.2	17.8	NS	18.4 ± 3.2	18.7 ± 3.3	NS

Chicken Numbers

In a multivariate model adjusted for confounding factors, we found that after the first year of free vaccinations, project households kept significantly more chickens than control households (Figure 4). However, in the second year, when fewer vaccinations occurred in the project villages and more occurred in the control villages, no significant differences were observed. The numbers of chickens owned by project households decreased slightly from 2008 to 2009 while the number of chickens owned by control households increased.

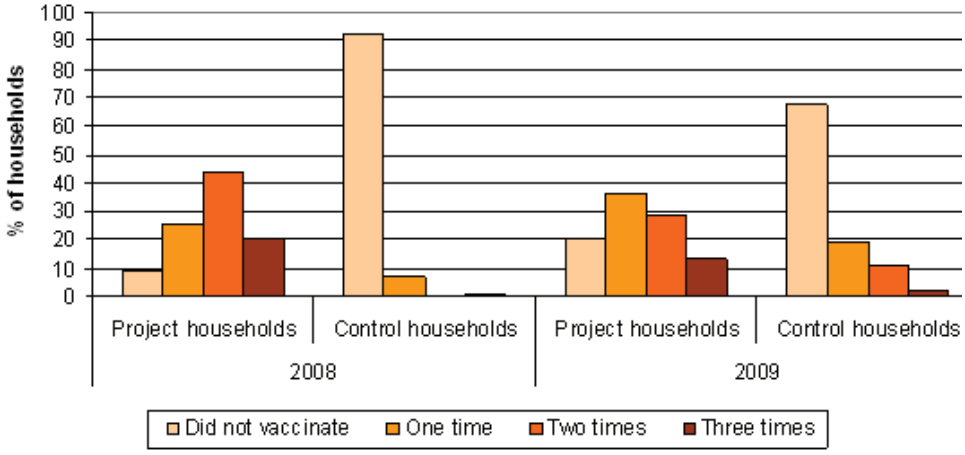

Figure 3. Number of times chickens were vaccinated in project and control households.

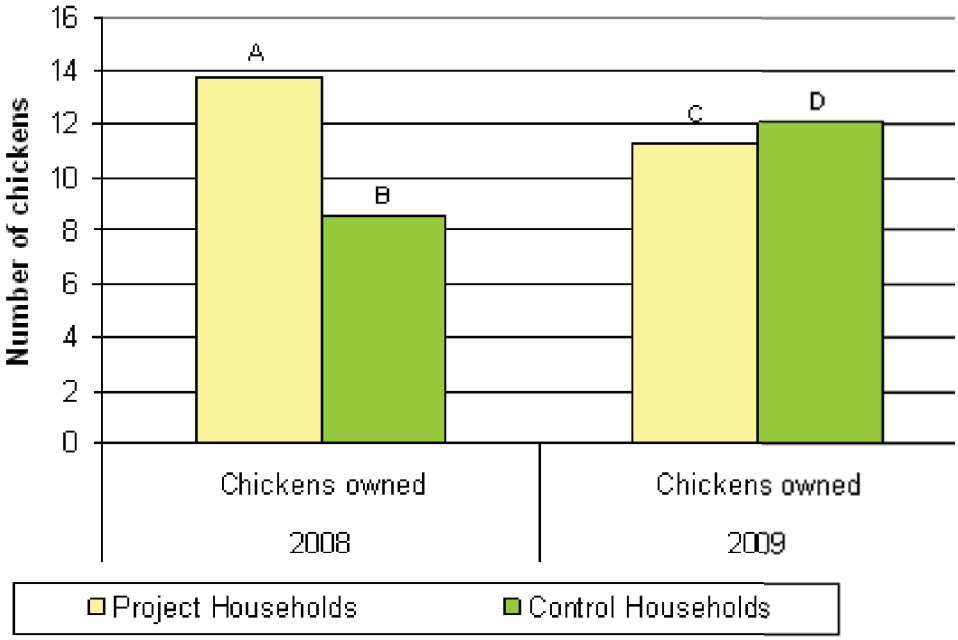

Figure 4. Adjusted* mean number of chickens owned by project and control village households (n=470).

*Adjusted for variation between project and control groups; variation between project and control groups by year; father's education level; and household wealth score. Significant differences: A&B, p = < .0001; B&C, p = 0.025; B&D, p = 0.005

Chicken and Egg Consumption

Mothers were asked how frequently they and their youngest child between the ages of 1-5 eat chicken. They received a score of '0' if they don't eat chicken, '1' if they eat it less than once per month, '2' if they eat it about once per month, '3' if they eat it about once per week, '4' if they eat it a few times per week, and '5' if they eat it almost every day. Results showed that, in general, mothers and children eat chicken once per month (Figure 5). We did not see a significant difference in chicken consumption between project and control village mothers and children in 2008 and between project and control village children in 2009. However, there was a significant difference in mothers' chicken consumption in 2009, with mothers from project village households consuming more chicken than mothers from control villages (P = 0.028).

In 2008, mothers in project households consumed significantly more eggs than mothers in control households (P = 0.0002; Figure 6). However, in 2009 this gap decreases, with mothers consuming eggs less frequently in the project villages and more frequently in the control villages. Children from project villages tended to eat more eggs than children in control villages in 2008, but the frequency of egg consumption increased among children from control households and decreased among children from project households in 2009.

Income

According to key informants, chickens are primarily used for sale, secondarily for household consumption, and at other times, are given as gifts. Eggs are primarily reserved for hatching into chickens, secondarily for household consumption, thirdly for sale, and lastly as gifts. Respondents that sold chickens or eggs reported that income earned

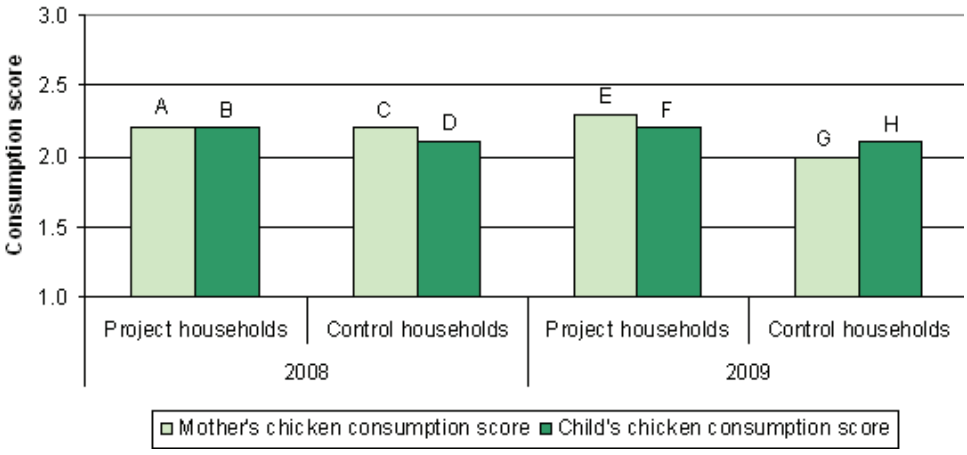

Figure 5. Adjusted* mean chicken consumption scores for mothers (n=489) and children (n=488). *Consumption scores: 0=does not eat; 1=less than 1x/mo; 2=1x/mo; 3= 1x/wk; 4=a few times/wk; 5=almost every day*

*Mothers' scores are adjusted for household wealth score and tribe (agricultural/pastoral). Children's scores are adjusted for household wealth score; tribe (agricultural/pastoral); age and sex of child. Significant difference: E&G, P = 0.028

from these sales in the past six months was used for the following purposes, ranked in order of most common to least common: household items (e.g. salt, matches, kerosene, etc.); clothes; food; school fees; medicine; farm supplies; and village development taxes.

Mean prices obtained for chickens in project and control villages in 2008 and 2009 ranged from 3,071 to 4,656 Tanzanian Shillings (TSH), while mean prices obtained for eggs ranged from 100 to 140 TSH (1USD ≈ 1,200 TSH). In general, there were no significant differences in the mean price obtained for chickens and eggs between the project and control villages except that, in 2009, control village households obtained a greater price for chickens sold in the month prior to being interviewed (4,656 ± 1,293 TSH) than project village households (3,637 ± 1,303 TSH; P=0.008), which indicates a smaller supply of chickens in control villages compared to project villages.

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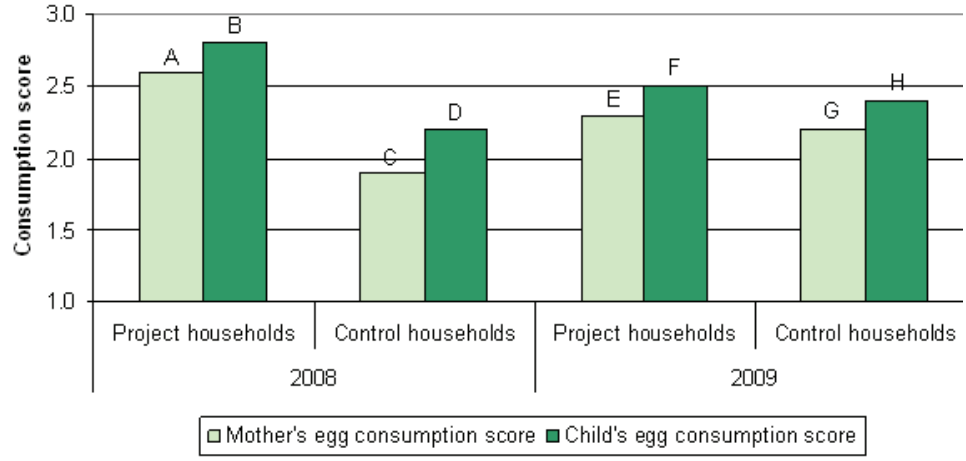

Figure 6. Adjusted* mean egg consumption scores for mothers (n=489) and children (n=488). *Consumption scores: 0=does not eat; 1=less than 1x/mo; 2=1x/mo; 3= 1x/wk; 4=a few times/wk; 5=almost every day*

*Mothers' scores are adjusted for unmeasured variation between project and control groups; mother's education level; household wealth score; and tribe (agricultural/pastoral). Children's scores are adjusted for unmeasured variation between project and control groups; unmeasured variation among villages; household wealth score; and tribe (agricultural/pastoral).

A larger number of project village households sold chickens and eggs in both years compared to control village households, but relatively few households sold chickens and eggs overall, resulting in a small sample size for income from chicken and egg sales. Given this, it is not surprising, therefore, that the data showed no significant difference between households in project and control villages in average income earned from chicken and egg sales, in either 2008 or 2009 (Figures 7 and 8).

Food Security

Households were given a food insecurity score, which ranged from 0 (secure) to 27 (least secure), based on their access to food. Project households showed greater food security than did control households in 2008. The food insecurity status of project households remained relatively constant from 2008 to 2009, while control households showed an improvement (Figure 9).

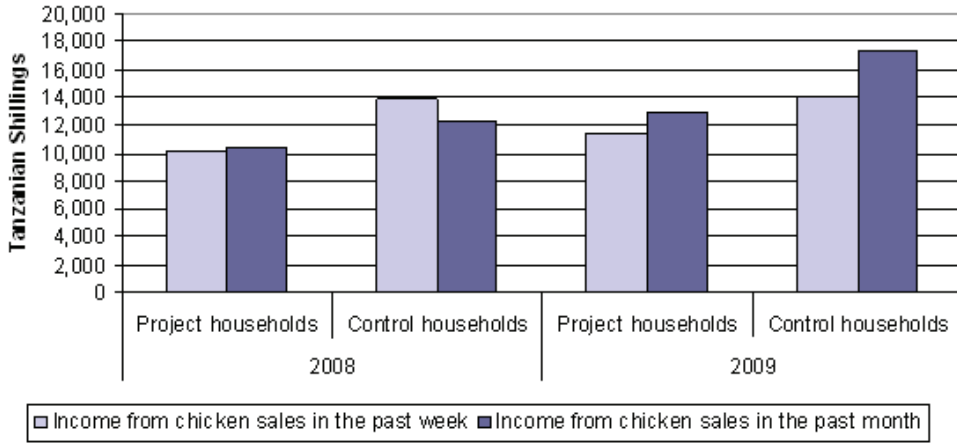

Figure 7. Adjusted* mean income from chicken sales in the past week (n=100) and adjusted mean weekly income over the past month (n=123). (1,000 Tanzanian Shillings ≈ US $0.80)

*Weekly and monthly income adjusted for household wealth. No significant differences found.

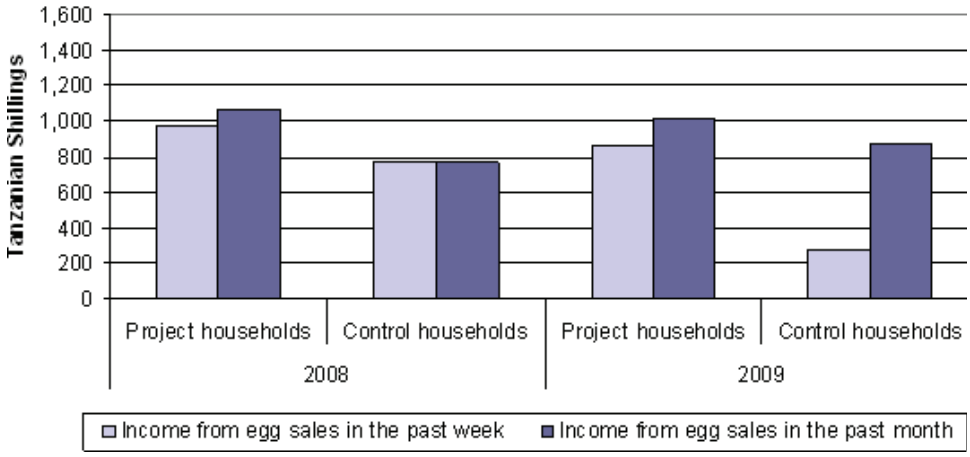

Figure 8. Adjusted* mean income from egg sales in the past week (n=24) and month (n=32). (1,000 Tanzanian Shillings ≈ US $0.80)

*Weekly and monthly income adjusted for household wealth. No significant differences found.

Bushmeat Consumption

Respondents were asked whether they or their youngest child ate bushmeat and, if so, how frequently they consumed it. The majority of respondents reported not eating bushmeat at all. In 2008, only 29% of mothers and 24% of children in the study sample reported eating bushmeat and in 2009, only 27% of mothers and 23% of children did. In both years, no significant differences in the frequency of bushmeat consumption were found between project and control villages (Figure 10). Our results showed that, as the frequency of bushmeat consumption by mothers and children increased, the frequency of chicken, egg, and animal-source foods in general also increased. When exploring

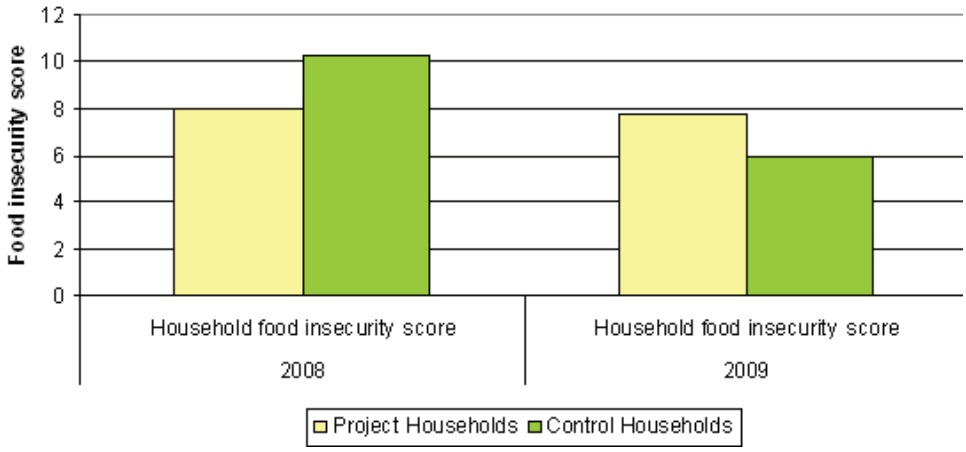

Figure 9. Adjusted* mean household food insecurity scores (n=464). (Food insecurity scores range from 0-27, with high a score being most insecure.)

*Adjusted for variation between years; variation between project and control by year; variation among villages; household size; mother's education level; husband's education level; and household wealth score. No significant differences found.

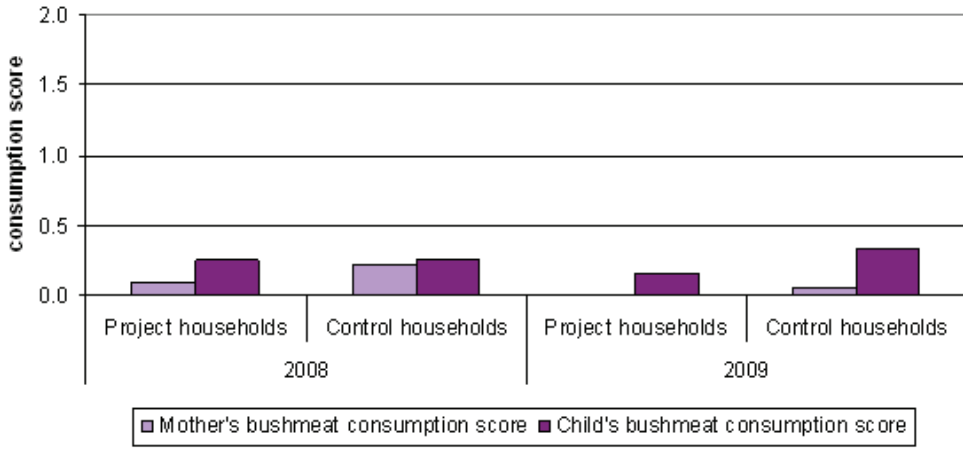

Figure 10. Adjusted* mean bushmeat consumption scores for mothers (n=487) and children (n=491). *Consumption scores: 0=does not eat; 1=less than 1x/mo; 2=1x/mo; 3=1x/wk; 4=a few times/wk; 5=almost every day*

*Mothers' scores are adjusted for mother's age; religion (Christian/Muslim); and tribe (agricultural/pastoral). Children's scores are adjusted for household size; and tribe (agricultural/pastoral). No significant differences found.

household characteristics related to bushmeat consumption, we found that an increase in bushmeat consumption was significantly related to a decrease in the household wealth score, a decrease in the number of livestock (excluding chickens) kept by the household, a decrease in the mother's age, a decrease in household size, and an increase in consumption of chickens, eggs and other animal-source foods. Barring the consumption measure, all are associated with poverty in general. Interestingly, we also found increasing bushmeat consumption to be significantly correlated to an increase in the mother's education level. The frequency of bushmeat consumption was not found to be significantly related to the husband's education level, the number of chickens owned or vaccinated, the household food insecurity score, nor the amount of income earned from chicken and egg sales in the past month or week. Mothers and children from agricultural tribes consumed significantly more bushmeat than mothers and children from pastoral tribes, and mothers that were Christian consumed more bushmeat than mothers that were Muslim. In a multivariate analysis, the significant predictors of the mother's bushmeat consumption were the mother's age, religion, and tribe (agricultural or pastoral). The significant predictors of the child's bushmeat consumption were the household size and tribe.

Summary, Discussion and Lessons Learned

From this two-year study, we conclude that Newcastle vaccination has the potential to increase households' chicken holdings, and potential protein availability, but sustained intervention (in the form of repeated vaccinations) may be necessary because villages did not continue the vaccination schedule on their own as was hoped. Chicken consumption within the households studied did not change until the second year of the study, and even then this change was only apparent among mothers. This may suggest that initial increases in chicken productivity were used to provide cash for women (rather than protein). Because women are often the last to eat in the household, it is possible that greater poultry productivity may have led to larger meals, so that chicken remained after men's and children's portions were given out and was therefore available to many mothers for the first time.

Households that vaccinated their poultry sold more eggs and chicken than control households, but the effect on mean income at the village level was not large enough to create a statistically significant difference between treatment and control villages. Furthermore, vaccination did not change the chicken or egg prices between treatment and control villages. Combined, these results suggest that vaccination programs can positively affect household income, nutrition and food security, but may not have large effects on village economies until all, or almost all, households participate repeatedly in vaccinating their poultry.

We also found no evidence that the increased protein and income provided by chicken vaccination programs reduced bushmeat consumption. In other words, even when protein availability and income

increased, bushmeat consumption remained constant. This finding suggests that village-level demand for protein is probably not driving the amount or frequency of bushmeat consumption in villages. Instead, we suggest that the availability of bushmeat in the market (and its subsequent consumption) is driven by mens' demand for cash. Hunters kill and sell bushmeat when they need a quick source of money, rather than when demand is high in the villages. Key informant accounts corroborate this finding, as many villagers explain that bushmeat hunters don't have another income strategy (like farming, beekeeping, or charcoal). Because the inputs are modest and income from hunting is available without waiting for growing seasons or honey production, it remains a fallback option for quick income. It is also informative to note that the households consuming bushmeat were larger, had lower wealth scores, kept fewer livestock and were headed by mothers that were both younger and better educated. With the exception of mothers' education, all of these factors are related to poverty. If it is indeed the economic needs of hunters that drive bushmeat supply, then supporting alternative income-generating activities or access to micro-credit could be a more effective way to reduce unsustainable bushmeat hunting.

A number of other results are worth mentioning. There was an overall decrease in chicken vaccinations over time in the project villages, and a concurrent increase in vaccinations over time in the control villages, as there was no prohibition on households vaccinating their own chickens in control villages. Discussions with local stakeholders led us to believe that the decline in project villages' vaccination rate was due to: (1) project households being unwilling to pay to vaccinate their chickens after having received the vaccination for free; (2) uncertainty by project staff about the number of households and chickens needing vaccination, and resultant vaccine shortages, in some places; and/or (3) some households may not have known about the vaccinations or (4) may have questioned the necessity of second and third vaccinations. It is not clear whether the incomplete coverage affected the results presented here, but the decline in coverage could affect the success of other animal vaccination and/or public health interventions, so it is noteworthy whether or not it affected the outcome. As the number of vaccinations decreased in the project villages and increased in the control villages, the gap in the number of chickens owned by households, food insecurity status, and egg consumption consistently narrowed between the project and control groups. This suggests that the observed effect was genuine; as the treatment declined, so did the contrast with the control group. This shrinking gap also suggests that if chicken vaccinations are not maintained over time, the dietary and income benefits of vaccination also diminish.

Other factors may have also influenced our findings. While the rate of Newcastle vaccination was not as widespread as intended, the vaccine can spread from vaccinated to unvaccinated chickens if they are housed in close proximity (Alders et al. 2001). Therefore, it is possible that the vaccination may actually have had greater coverage

than it appears from self-reported vaccination records. Also, since no measures were taken to prevent the control group from vaccinating their chickens, some control households actually received treatments. Program leaders did not want to prevent villagers from taking steps to potentially improve their livelihoods, so even though this further reduced the contrast between control and treatment samples, it was deemed acceptable. Third, this study may have been conducted too early to detect changes in income from chicken and egg sales and consumption of chicken and bushmeat. Finally, since the hunting and consumption of bushmeat is mainly illegal, respondents may not have responded truthfully regarding their consumption of bushmeat.

To promote the use of Newcastle disease vaccinations in chickens, as well as numerous other beneficial interventions, it may be necessary to demonstrate the benefits first. Since the reason for the observed low rates of vaccination may be due to households not knowing about the vaccinations or questioning the necessity of second and third vaccinations, it would be wise to implement an education component that stresses the benefits of such interventions. Many sensitization programs are initiated with the goal that participants who see the benefits of an intervention will continue to carry out the intervention after the project has finished. It is important, however, that programs, particularly those where free services are provided and capacity is limited, include a plan for management and sustainability to avoid a cessation of activities once outside support has ended. In these cases, new local partnerships may be necessary to sustain the program into the future (Castillo et al. 2006).

Finally, future research efforts should examine household decision-making processes regarding the vaccination of chickens and how nutritional tradeoffs are managed. Examination of income-generating interventions for bushmeat hunters could also provide insights on whether, or under what circumstances, their economic needs drive the supply of bushmeat.

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TransLinks is a 5-year Leader with Associates cooperative agreement that has been funded by the United States Agency for International Development (USAID) to further the objective of increasing social, economic and environmental benefits through sustainable natural resource management. This new partnership of the Wildlife Conservation Society (lead organization), the Earth Institute of Columbia University, Enterprise Works/VITA, Forest Trends, the Land Tenure Center of the University of Wisconsin, and USAID is designed to support income growth of the rural poor through conservation and sustainable use of the natural resource base upon which their livelihoods depend.

The program is organized around four core activities that will be implemented in overlapping phases over the life of the program. These are:

1. Knowledge building including an initial review, synthesis and dissemination of current knowledge, and applied comparative research in a number of different field locations to help fill gaps in our knowledge;
2. Identification and development of diagnostic and decision support tools that will help us better understand the positive, negative or neutral relationships among natural resource conservation, natural resource governance and alleviation of rural poverty;
3. Cross-partner skill exchange to better enable planning, implementing and adaptively managing projects and programs in ways that maximize synergies among good governance, conservation and wealth creation; and
4. Global dissemination of knowledge, tools and best practices for promoting wealth creation of the rural poor, environmental governance and resource conservation.

Over the 5-year life of the program, TransLinks aims to develop a coherent, compelling and, most importantly, useful corpus of information about the value of, and approaches to, integrating Nature, Wealth and Power. To do this, TransLinks is structuring the work around two core issues – 1) payments for ecosystem services and 2) property rights and resource tenure.

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