

Extended Abstract

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Paper/Poster Title	Quantifying farmers' preferences for antimicrobial use for livestock diseases in northern Tanzania
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Abstract prepared for presentation at the 97th Annual Conference of the Agricultural Economics Society, The University of Warwick, United Kingdom

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Abstract	200 words max
<p>Understanding the choice behaviours of farmers around the treatment of their livestock is critical to counteracting the risks of antimicrobial resistance (AMR) emergence. Using varying disease scenarios, we measure the differences in livestock species' treatment preferences and effects of context variables (such as grazing patterns, herd size, travel time to agrovets shops, previous disease experience, previous vaccination experience, education level and income) on the farmers' treatment choices for infections across three production systems - agro-pastoral, pastoral and rural smallholder - in northern Tanzania, where reliance on antimicrobial treatment to support the health and productivity of livestock is high. Applying a context-dependent stated choice experiment, we surveyed 1224 respondents. Mixed logit model results show that farmers have higher preferences for professional veterinary services when treating cattle, sheep and goats, while they prefer to self-treat poultry. Antibiotics sourced from agrovets shops are the medicine of choice, independent of the health condition to treat, whether viral, bacterial or parasitic. Nearness to agrovets shops, informal education, borrowing and home storage of medicines, and commercial poultry rearing increase chances of self-treatment. Based on our findings, we propose interventions such as awareness and education campaigns aimed at addressing current practices that pose AMR risks, as well as vaccination and good livestock husbandry practices, capacity building and provision of diagnostic tools.</p>	
Keywords	Antimicrobial use, antimicrobial resistance, antibacterial resistance, livestock production systems, Tanzania, preferences, context-dependent choice experiment, context variables
JEL Code	Q18, I12 see: www.aeaweb.org/jel/guide/jel.php?class=Q
Introduction	100 – 250 words
<p>Minimising risks of antimicrobial resistance (AMR) through reducing antimicrobial use (AMU) in livestock (Goździewska et al. 2020) is an important public health goal. In Tanzania, for</p>	

example, bacterial resistance to frequently used antibiotics has been reported in different livestock species, including cattle, and sheep and goats (Frumence et al. 2021) owing to several reasons. First, animal health professionals are poorly supported in making treatment decisions (Mangesho et al. 2021) due to a lack of veterinary infrastructure and of tailored antimicrobial stewardship programmes. Second, livestock keepers often self-administer antimicrobials to their livestock without professional advice (Caudell et al. 2017; Caudell et al. 2020). Third, there is an assumption that discouraging the misuse and overuse of antimicrobials as understood in AMR interventions in high-income countries apply directly to LMIC settings. Fourth, livestock rearing, and veterinary care practices are associated with varying cultural beliefs, sociocultural and economic factors. These should be considered in the design of antimicrobial stewardship programs (Caudell et al. 2022). Fifth, LMIC governments suffer financial constraints (Rosenkrantz et al. 2019) and prioritisation of resources is necessary while addressing the needs of communities.

Due to these challenges, Tanzania, adopted the agenda of the sixty-eighth World Health Assembly of May 2015 that encouraged member states to develop National Action Plans (NAPs) for antimicrobial resistance. The situational analysis presented in the NAP outlines several research gaps and antimicrobial policy-related weakness. Currently, very little is known about the choice behaviours around antimicrobial treatment in livestock in communities across production systems in Tanzania and East Africa more generally. We aimed to acquire critical information to inform behavioural change interventions that consider contextual differences to enable farmers to preserve the health of their livestock through improved treatment practices while minimising AMR risks. A successful intervention needs to be informed by an understanding of farmers' choice patterns, their preferences, and drivers of AMU, and how these vary across and within livestock production systems.

Methodology	100 – 250 words
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Economists often obtain choice data and quantify individual preferences using discrete choice experiments (DCEs). In the area of animal health economics, single-context DCEs are common where an individual is assumed to make rational choices which are independent of external circumstances other than those which the analyst can control for (Molin and Timmermans, 2010). In the context-dependent DCE in our study, we focus on a range of disease syndromes across different livestock species and production systems, and individual-specific characteristics to obtain farmers' choice patterns to quantify AMU preferences in livestock health. We assume farmers choose treatment options from a set of available actions depending on (i) the clinical signs they observe, (ii) the type of livestock species in which the clinical signs (here cattle, poultry, sheep and goats) are observed, and (iii) the type of production system under which they operate.

We designed 24 unlabelled choice tasks per livestock species with four alternatives: 'Option 1', 'Option 2', 'Option 3' and 'None of these' (status quo). We presented 8 choice tasks (4 for each of the two disease scenarios per livestock species) to each of the 1224 respondents comprising household heads and their spouses to ensure gender parity across three livestock production systems (smallholder, agro-pastoral and pastoral) in Mwanga, Misungwi and Ngorongoro districts respectively in northern Tanzania. The attributes included source of treatment advice, medicine source, medicine type, action after treatment and cost of medicine. The infectious diseases widespread in the study area are: contagious bovine pleuropneumonia (CBPP), foot-and-mouth disease (FMD), peste des petits ruminants (PPR), Newcastle disease and coccidiosis. We fitted multinomial logit models as a first check on the choice data before estimating a series of mixed logit models for each livestock species.

Results

100 – 250 words

The marginal utility for consulting professional veterinary services is positive and significant in cattle, sheep and goats and poultry. However, for poultry the marginal utility coefficient for self-treatment is larger. Further, the marginal utility coefficients for antibiotics in cattle and sheep and goats are positive and significant while that of herbal medicine in poultry is slightly higher. Regarding medicine source, the marginal coefficient estimates for agrovet shops is positive and significant in cattle, sheep and goats.

In cattle, farmers' mean willingness to pay (WTP) for access to a veterinary officer is TSh 680 (\$0.29). On the other hand, the WTP for antibiotics is TSh 602 (\$0.26) while that for anti-parasites is estimated at TSh (-516) (\$ -0.22). Farmers' WTP for agrovet shop as a source of these medicines is estimated at TSh 919 (\$0.40). In sheep and goats farmers' mean WTP estimate for a veterinary officer when clinical signs of FMD and PPR are observed is TSh 668 (\$0.29). The mean WTP for antibiotics is TSh 303 (\$0.13) while that of isolation of ill animals is TSh 3459 (\$1.50). In poultry, the mean WTP to consult a veterinary officer is estimated at TSh 42 (\$0.018), while that of self-treatment in poultry is TSh 74 (\$0.032). Regarding medicine type, the mean WTP for herbal medicine is TSh 415 (\$0.18) and is slightly higher than that of antibiotics at TSh 357 (\$0.15).

We find significant differences in choice behaviour based on herd size, medicine storage at home for livestock, grazing type, proximity to agrovet, previous FMD illness, and previous FMD and CPBB vaccination experiences in cattle. In sheep and goat preference heterogeneity is observed based on education level, home storage of livestock medicine, time to agrovet, previous FMD vaccination and PPR illness experiences. In poultry, farmers' preferences differ based on the type of rearing system, their education and income levels.

Discussion and Conclusion**100 – 250 words**

Our study assessed farmers' heterogeneity preferences for and contextual effects of different treatment options across three livestock production systems - agro-pastoral, pastoral and smallholder -, and livestock species - cattle, sheep and goats and poultry - in northern Tanzania. Overall, our findings show that choice behaviour for treatment advice, medicines and their sources differ across individual farmers and livestock species. An understanding that is important in demonstrating the real potential of the diversified use and demand for antimicrobials and the need to draw insights from a wide range of options for developing antimicrobial stewardship programs, since these likely vary across livestock systems and disease contexts.

More specifically, we show that farmers would prefer to seek professional veterinary services when they observe clinical signs consistent with FMD and CBPP, and FMD and PPR in cattle, and sheep and goats, respectively. However, poultry farmers prefer to self-treat their birds over consulting a veterinary professional when coccidiosis and Newcastle disease occur on their farms like findings in Nonga et al. (2008). Farmers prefer to use antibiotics when treating FMD and CBPP in cattle, FMD and PPR in sheep and goats, and coccidiosis and Newcastle diseases in poultry, consistent with other studies (FAO, 2007; Balamurugan et al. 2014; Rugumisa et al. 2016; Caudell et al. 2017). This is problematic because in many cases antibiotic treatment does not have therapeutic benefit. Our findings also show that antimicrobial use behaviour is context dependent. Although farmers across all three livestock production systems and species obtain medicines from agrovet shops as in Mangesho et al (2021), farmers with smaller herd sizes may borrow medicines from friends/relatives/neighbours. In cattle the most important context variable is time to the agrovet where shorter durations increase WTP for self-treatment. As such, living close to agrovet shops increases self-treatment owing to easy access to antimicrobials (Mangesho et al. 2021). In sheep and goats, informal education and previous FMD experience is likely to lead to lower WTP to isolate and consult a vet while previous PPR experience increase WTP for anti-parasites and antibiotics. Therefore, farmers without formal education were more likely to self-treat and sell ill animals compared to those with higher education levels. In communal grazing systems, farmers were more likely to consult a veterinary officer (see also Caudell et al. 2017) but self-treatment was the preferred option and was associated with high WTP in poultry even under commercial poultry rearing systems where potential economic losses could occur (see also Nonga et al. 2008).

Our findings show us that if the government is to minimise the mis-use of antimicrobials then interventions should target three antimicrobial stewards - farmers, veterinary officers and agrovet shop attendants. We also suggest three main interventions (a) education and community awareness campaigns, (b) infection and prevention control interventions, and (c) capacity building through better training of veterinary officers and provision of diagnostic tools.

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