INTERNATIONAL CONFERENCE OF AGRICULTURAL ECONOMISTS

ICAE

29th | Milan Italy 2015

UNIVERSITÀ DEGLI STUDI DI MILANO AUGUST 8 - 14

AGRICULTURE IN AN INTERCONNECTED WORLD

Do Veterinary Paraprofessionals Provide Quality Clinical Veterinary Services for Cattle? Results from a Role Play Experiment in Rural Uganda

John Ilukor[1,2] and Regina Birner[1]

[1]*University of Hohenheim, Institute of Agricultural Economics and Social Sciences in the Tropics and Subtropics*

[2]*CGIAR Independent Science and Partnership Council (ISPC) Secretariat- FAO Rome*

Abstract: The study uses a role play experiment to analyze how the interaction of farmers and service providers influences the quality and the demand for clinical services. The game was played in four rounds, and the quality of clinical services was measured by scoring the accuracy of a service provider prescribing the appropriate drug for selected animal diseases. The results show that the accuracy of prescriptions by veterinarians is not significantly different from that of paraprofessionals trained in veterinary science. However, the ability of service providers who are not trained in veterinary medicine is significantly lower than that of service providers trained in veterinary science. The continued interaction between paraprofessionals and veterinarians gradually leads to an improvement in the ability of paraprofessionals not trained in veterinary sciences to perform correct diagnosis and drug prescription. However, farmers' inability to punish poor quality service providers limits interaction between paraprofessionals and veterinarians.

Keywords: Belief updating, lemon market, role play game

1. Introduction

This paper is concerned with measuring and assessing the quality of clinical veterinary services in developing countries, using Uganda as an example. The existence of veterinarians and paraprofessionals of varying skills and training can be a major problem in animal health markets (Leonard et al., 1999). Qualified veterinarians have to compete with less qualified and unqualified practitioners. Moreover, professionals trained in general agriculture have both crop and livestock training may be involved in providing the same service, but of heterogeneous quality (Boden, 2010). Livestock farmers who have no skills or training in veterinary science are not able to perfectly measure or determine the quality of services being offered by these service providers. The inability of a farmer to assess and measure the quality of the service creates motivation problems such that a farmer is not willing to pay a premium fee for the service because he cannot judge the quality of the service he or she receives. As a result, service providers that deliver high quality services are forced to accept low payment since they cannot convince the farmer that their services are of high quality (Ly, 2003). Since service providers interact repeatedly with farmers, farmers' failure to differentiate the quality of the service leads to high quality service providers being displaced or nudged off the market. Akerlof (1970) describes this interface between quality heterogeneity and asymmetric information resulting in the disappearance of a market with quality goods and services as a "lemon market".

As argued by Ly (2003), a "lemon market" has occurred in animal health markets in most developing countries. In Kenya, even in productive areas, veterinary paraprofessionals have dominated the animal health markets (Oruko and Ndung'u, 2009). In Uganda, Koma (2000) found that it is very difficult for private veterinarians to break-even because farmers are not willing to pay a veterinarian a premium for a service that can be offered by the paraprofessionals at lower cost, thus leaving the paraprofessionals to dominate the market. The dominance of the veterinary paraprofessionals in the provision of veterinary services, although useful in reducing costs and increasing access, has been criticized on the grounds that this has resulted in a decline in the quality of veterinary services (Cooper et al., 2003; Mugunieri et al., 2004). To improve the quality of clinical veterinary services, there are increased calls for an improved relationship between veterinarians and paraprofessionals (Schneider, 2011; Woodford, 2004). Ahuja (2004) argues that because farmers are unable to measure the quality of services due to information failures, professional veterinarians and strong regulatory institutions are needed to ensure provision of quality services.

The economic literature on the provision of animal health services emphasizes that if farmers had information about the quality of service offered, they would be able to update their beliefs and more readily seek services of veterinarians who offer quality services. Belief updating (belief change) is the act of changing a previously held belief to take into account new information (Lang, 2007). By seeking quality services, paraprofessionals or low quality service providers would strive to consult with veterinarians in order to maintain and build their reputation. However, there is an "information externality" related to this interaction, which has not been recognized in the animal health literature. Although information exchange among farmers is not an economic activity, information externality is used in this paper to describe the effect of information sharing among farmers on the service provider. This effect can be an increase or decline of in demand of services of a particular service provider (Hendricks and Kovenock, 1989; Nakamura, 1993). Bolton and Ockenfels (2011) and Morgan and Sefton

(2001) contend that information externalities influence beliefs and decisions, and consequently the value of reputation building, price, quality and demand for products or services.

However, in the context of clinical veterinary services, this effect will depend on how farmers update their beliefs, and whether service providers value their own reputations (Schmidt, 1993). Cole (1989) argues that belief updating in light of new information is always difficult because of a lack of a mental model that allows a person to combine different factors. Bennett and Hauser (2013) also argue that health care decisions are complex, difficult to comprehend and have to be made within a limited amount of time. Therefore, because of limited time and cognitive abilities farmers may fail to change their beliefs about paraprofessionals upon receiving new information. In this study, a role play game was used to assess the influence of information on farmers' beliefs about service providers and the quality of clinical services. In particular the study aimed at answering the following questions: (1) Does the quality of services provided by paraprofessionals differ with that provided by veterinarians? (2) Does quality improve in the long run as paraprofessionals and veterinarians interact (consultations and referrals)? (3) Do farmers update their beliefs about service providers? And (4) what factors influence farmer belief updating?

To answer these questions, a role play game was chosen because it captures complexities without losing relevance to reality (Bolton, 2002). Role playing allows for the accurate capture of information externalities generated through social interaction and learning. Green (2002) compared game theory, role playing and unaided judgement in assessing decision making in conflict situations and found out that 37% of the assessments based on game theory, 28% of the unaided assessments and 64% of the role play games assessment were correct. Armstrong (2002) also compared role playing and unaided expert opinions and found that role playing predicted 56% of 146 predictions correctly, compared to 16% of 172 predictions of unaided expert opinions. Consequently, both concluded that role play games are the most accurate and consistent method of assessment and decision forecasting. Schelling (1961) argues that role play games are a useful tool for predicting and assessing outcomes that are complex in nature. Since veterinary service delivery is complex in nature (Bossche et al., 2004), role play games are a promising tool for assessing the influence of information externality on farmers' behaviour and the quality of veterinary services. The paper proceeds as follows: Section 2 covers materials and methods, Section 3 presents the results, and Section 4 discusses the findings and provides a conclusion

2 Materials and Methods

2.1 Design of the game

The experimental data used in this paper were collected from two different districts in Uganda (referred to here as A and B to ensure the anonymity of the participants). District A is located in a pastoral production system and District B in an intensive livestock production system. Subjects were recruited from each district. The subjects included the farmers, paraprofessionals and veterinarians. They were asked whether they agreed to participate in a role play game. Farmers were told they would be paid and their pay-off would depend on the outcome of the transaction (treatment of a sick animal in the role play) and their ability to negotiate with service providers for the fee the providers would charge. The farmers were provided with an initial endowment of 6,000 Uganda Shillings (US$2) in each round, which was approximately three times the daily wage for unskilled labour in the study regions. If the outcome was positive, a farmer would be paid a reward covering the difference between the fee of the service provider and the initial endowment. A positive outcome was one where the animal was cured, which happened if the service providers identified the right drug for the disease of the animal under consideration. If the outcome was negative, the farmer received nothing. A negative outcome means that the animal died because the service provider was not able to identify the appropriate treatment. Service providers were informed that their earning would depend on their reputation with farmers, which determined the number of farmers who demanded their service, and the professional fee they charged. Service providers were also told that they could refer a case to other service providers if they wished, but they should give the reason for referring. The cost of transport and drugs were considered as dead weight costs and hence not included in the game.

A total of 51 farmers were recruited to participate in the experiment, 26 in the pastoral livestock production system (10 female and 16 male) and 25 in the intensive livestock production system (12 female and 13 male). In each production system, it was planned to recruit two veterinarians and five paraprofessionals to participate in the game. In District A (pastoral area), however, veterinarians are usually absent from their duty stations because there are few trained veterinarians from these areas, and professionals from non-pastoral ethnic groups are often reluctant to work in pastoral areas because of the harsh climate and poor infrastructure (Hassan, 2003). Therefore, two government animal health assistants with a two year diploma training in veterinary medicine were asked to act as veterinarians in the role play. Their performance in terms of disease diagnosis and drug prescription was later compared with that of veterinarians in District B and it was found that there was no statistically significant difference in their scores. Therefore, it can be assumed that this replacement does not affect the results. The training level of the paraprofessionals differed between the districts. In the pastoral system, two of the paraprofessionals had diplomas in social science with three months of training in animal health, and the other three had either primary or no education, and they also had received three months of training in animal health. Three paraprofessionals in the intensive production system had certificates in general agriculture, and two had diplomas in general agriculture. In the intensive system, the three livestock diseases that were identified as the most common ones were East Coast Fever, Anaplasmosis, and Tryponamiasis. In the pastoral systems, these diseases and two more, namely, Heart Water and Red Water were most common.

The game proceeded as follows: Farmers were given a so-called “animal medical card” with the name of the disease written on it both in the local language (Pokot and Luganda) and in English. The animal medical cards were distributed to the farmers on a random basis. Farmers were asked to choose any service provider of his or her choice to treat the respective disease. Every farmer who participated in the game knew at least one veterinarian and one professional from earlier interactions. The service provider chosen by the farmer had to list the signs associated with the disease (corresponding to performing a clinical diagnosis in real life) and prescribe the drugs. The service provider also had to agree on the costs of treatment with a farmer. The costs were broken down into the professional fee, cost of drugs and transport fee. All this information was written down on the animal medical card. Two of the paraprofessionals in the pastoral areas who could not read or write in English were assisted by hired university students with no veterinary training. The students were instructed to write only what the paraprofessionals told them to write. The cards were later handed back to the farmers who presented the cards to the researcher. The researcher would then assign the outcomes based on drug prescription. Outcomes were categorized as positive and negative. As indicated above, a positive outcome is one where the animal is cured (appropriate drug prescribed) while a negative outcome is one where the animal died (wrong drug is prescribed). The signs of the diseases and the treatment are presented in Table 5.1 below. It was designed by consulting the practicing veterinarians, the Merck Veterinary manual[1] and the OIE technical disease cards[2].

The game was played in four rounds, and at the beginning of each round, the farmers received a new medical card. At the end of each round, both farmers and service providers received information about the outcomes, and their pay-offs were awarded. After the game, the participants were invited to share their reflections, and finally, a meal was served.

2.2 Analysis of data

To analyse the effect of information externalities on the demand and quality of clinical veterinary services, the degree of accuracy in identifying the signs of the disease listed on the animal medical card and prescribing the appropriate treatment were used as indicators of quality of service provision. After every round, the participants were able to consult and share their outcomes with others. The scores for every round were computed and analysed. They are also presented in Table 5.1. For identifying the cardinal signs for each disease, service providers were given a score of one point for each sign listed in the table and the total score was transformed into percentages. In the case of drug prescription, scores were awarded based on the drugs prescribed by the service providers. As shown in Table 5.1 below, if a service provider prescribed one of the main drugs, he was given a score of 8 or 9. He also received 1 or 2 points for all supplementary drugs, depending on the disease. These scores were transformed into

[1] The Merck Veterinary manual for veterinary professionals http://www.merckmanuals.com/vet/index.html
[2] OIE technical disease cards http://www.oie.int/animal-health-in-the-world/technical-disease-cards/

percentages and since eight points was the lowest score for prescribing the main drug, the pass mark could be set at 80%

The data from the role play were entered into a data base and analysed as follows: Scatter diagrams were used to analyse the quality of clinical diagnosis and drug prescription for each disease. Learning curves were constructed to examine whether quality improved with experience or after paraprofessionals interacted with veterinarians. Learning curves are used in clinical medicine to measure quality of service, and they are derived by graphically plotting performance against experience gained from acquisition of new information or knowledge from prior experience (Waldman, 2003). Hopper et al. (2007) argue that a steep learning curve implies that skills are acquired rapidly because the procedure is simple. In this particular case, a steep slope would mean service providers are consulting or learning from each other to build and maintain their reputation. Farmers' belief updating curves were also constructed to examine whether farmers update their beliefs or change their beliefs about types of service providers. The slope of the curve measures the level of belief change or updating (Danes et al., 1978; Hogarth and Einhorn, 1992). Service providers were categorized into veterinarians and paraprofessionals. The latter were further differentiated by field and level of training. The mean scores in drug prescription for each category in each round were computed and plotted on a Cartesian axis in order to construct the learning curves. In addition, the total number of farmers seeking services from the different categories of service providers in each round was computed, and the results were used to construct farmers' belief updating curves.

Insert Table 1 Clinical signs and drugs for specific animal diseases

Non-parametric statistics were used to perform statistical tests because the Shapiro-Wilk test for normality and the Doornik-Hansen test for multivariate normality showed that the data violated the normality assumption. Since the normality assumption was violated, parametric tests were considered to be less powerful than the non-parametric tests because they do not assume normality (Sawilowsky, 1990). A panel probit model with random-coefficient that allows for unobserved heterogeneity in farmers' belief updating in each round was estimated to determine factors that influence farmers belief updating. In the model, belief updating is measured as a farmer's decision to change to a different service provider from the previous service provider. A random effects model was chosen because (1) the observations are many but the number of rounds are few (R=4), thus a fixed effect model would give inconsistent estimates, and (2) a random effects model allows one to make inferences about the whole population, something that cannot be done with a fixed effects model (Maddala, 1987). Maddala (1987) further notes that the probit model is well suited for estimating random effects because it produces correlation among errors yet logistic distribution is very restrictive for this purpose. Gibbons and Hedeker (1994) used it to predict the likelihood of some doctors experiencing malpractice claims and in this paper it is used to determine factors that influence livestock farmers' decision to change service provider.

3 Results

3.1 Analysis of service quality by disease

In the materials and methods section, it was noted that animal health assistants with a diploma in veterinary science were asked to act as veterinarians in pastoral areas. Therefore, it was imperative to test whether there is a significant difference in the quality of their services (clinical diagnosis and drug prescription). A Kruskal-Wallis and Kolmogorov-Smirnov non-parametric test for equality was performed and results showed that there is no statistical evidence that the scores of government health assistants in the pastoral areas in clinical diagnosis and prescription were different from the scores of the veterinarians ($p<0.05$). The mean score achieved by government animal health assistants for identifying all signs of the disease (clinical diagnosis) were 58% and the mean score for drug prescription was 98%. The respective scores achieved by veterinarians for clinical diagnosis and drug prescription for were 53% and 99%, respectively. Consequently, the term "veterinarian" as used in this paper includes both the veterinarians and the government animal health assistants trained in veterinary science, who acted as veterinarians in the role play in the pastoral area. Paraprofessionals included service providers with a diploma and or a certificate in agriculture or social science. Community animal health workers (CAHWs) are those service providers who have received some training in animal health services, but do not hold a diploma or certificate.

Figure 1 is composed of 6 figures. Figure 1a is a scatter diagram of the overall scores in clinical diagnosis and drug prescription. Results show that the veterinarians' average score in drug prescription was always close to 100%, but in identifying the signs of the respective diseases, sometimes the veterinarians scored below 50% and this was mainly because veterinarians were not keen on listing all the clinical signs. For paraprofessionals, the results show high heterogeneity both in clinical diagnosis and drug prescription. This could be a result of variation in the training of the different types of paraprofessionals (see above). The Kolmogorov-Smirnov two-sample test was performed to find out whether there is a statistically significant difference between veterinarians and paraprofessionals in both clinical diagnosis and drug prescription. Results showed that there was a statistically significant difference between paraprofessionals and veterinarians in drug prescription, but not clinical diagnosis. Consequently, the following discussion of the results will mainly focus on drug prescription as a measure of the quality of service.

Figures 1b to 1f are scatter diagrams for clinical diagnosis and prescription for each disease. The results show that there is a major problem in drug prescription by paraprofessionals, especially in the treatment of ECF and Anaplasmosis (see Figures 1b and 1c below). Six of the cases in ECF had a score of below 80% in drug prescription, four of which are from the intensive production system and two from the pastoral system. Three cases of wrong prescription were from the same service provider, who had a diploma in crop science. This service provider was not interested in consulting with other service providers even after receiving the information that his prescription was inaccurate. He kept on prescribing Oxy-tetracycline, multivitamins and Imisol for ECF. The remaining case in the intensive system was handled by a service provider with a certificate in general agriculture. In the pastoral area, the two cases of inaccurate prescription were from a service provider who did not have any formal education, and the cases were recorded in rounds one and two. He also did not consult with veterinarians or other service providers. The prescription in both cases was only Oxy-tetracycline.

Insert Figure 1a-f: The scatter diagrams for veterinarian and paraprofessional scores in diseases diagnosis and drug prescription

For Anaplasmosis, there were thirteen cases with a score of below 80% in drug prescription; six cases were from the intensive system and seven from the pastoral system. Unlike in the case of ECF, in which cases of inaccurate prescription were from specific paraprofessionals, cases of inaccurate prescription in Anaplasmosis were distributed over different paraprofessionals in both production systems. In the intensive system, these service providers prescribed mainly multivitamins, Oxy-tetracycline, Butarex, Suriname, and Diminazene. In the pastoral areas, the prescriptions were mainly Oxy-tetracycline, multivitamins, and the following treatment: mixing either one litre or one-half litre of the cooking oil with one sachet OMO washing detergent. This sounds strange but both service providers and farmers argued that using cooking oil and washing detergent yields positive outcomes for Anaplasmosis. In the case of Tryponamiasis, there were five cases where the score was below 80% in drug prescription, and all of these cases were from pastoral system. Two of the cases were from one service provider trained in social science, and three from service providers with no formal education. The drugs prescribed were Berenil and Oxy-tetracycline. Red Water and Heart Water had three cases each that recorded a score below 80% in drug prescription. All the cases were attributed to paraprofessionals without formal education, and the prescription for all the diseases in six cases was pen-strep. The Kruskal-Wallis test was also used to test whether drug prescription varies according to disease and according to type of service provider. The results showed that there is evidence that drug prescription varies according to disease ($p<0.05$).

3.2 Learning curves and quality of veterinary Services

To test whether there is a statistically significant difference between the scores of veterinarians and paraprofessionals in drug prescription and in clinical diagnosis, the Kolmogorov-Smirnov test was performed. The results show that there is a statistically significant difference between the scores of paraprofessional and veterinarians regarding drug prescription, but not regarding clinical diagnosis ($p<0.05$). The mean scores attained by paraprofessionals in clinical diagnosis and drug prescription were 50% and 72%, respectively. Veterinarians had a mean score of 99% in drug prescription and 56% in clinical diagnosis. The scores of clinical diagnosis were low because veterinarians were not keen to list all the clinical signs probably because there was no physical animal involved in the game and they could not remember all the signs. Since scores of clinical diagnosis were not statistically significant between paraprofessionals and veterinarians, accuracy in drug prescription was considered as measure of quality to be analysed further.

To test whether there is a significant difference in drug prescription regarding field of training, production system, and rounds, the Kruskal-Wallis test was performed. The results show that the mean scores of drug diagnosis differed significantly by field of training and production system ($p<0.01$). However, only scores of drug prescription in rounds one and four were significantly different ($p<0.05$). This could be attributed to the fact that farmers take a long time (in the role play, this means more than one round) to change their beliefs about the paraprofessionals. Thus, paraprofessionals have limited incentives to consult with more knowledgeable service providers and improve their knowledge. As the feedback meeting held after the game revealed, there are trade-off in consulting with other veterinarians. On one hand, consulting with veterinarians may increase the likelihood of losing a client to a veterinarian because farmers would lose confidence in them and veterinarians would use that as an opportunity to discredit them in front of their clients. On the other hand, consulting with veterinarians helps paraprofessionals to save face in front of their clients by avoiding negative outcomes.

The learning curves of the service providers were constructed by plotting the average scores in each round (see Figures 2 below). Figure 2 is composed of three figures (Fig a-c). Figure 2a shows the learning curves of paraprofessionals and veterinarians. The veterinarians' curve shows that veterinarians are operating at maximum with an average score of 99% in drug diagnosis. Paraprofessionals had a score below the 80% pass mark. In round one, the average score of paraprofessionals in drug prescription was 60%, and in round two it was 75%. The 15% increase can be associated with the desire to build a reputation and to save face in front of the farmers. As a result paraprofessionals consulted with veterinarians after receiving the outcomes in round one. In round three, the average scores were 74% which is not significantly different from 75% (the score in round two). As noted above, the paraprofessionals did not want to show famers that they do not have skills and competence because consulting veterinarians would increase the risk of losing clients to veterinarians. However, the poor performance (outcomes) in round three forced them to consult with the veterinarians to save face in front of the clients, resulting in an increase in the average score to 88% in round four.

Figure 2b shows learning curves of service providers by field of training. The learning curves for service providers trained in veterinary science shows that they operate at maximum as expected. The scores of service providers with a social science background were 71, 91, 90 and 88 in rounds one to four, respectively. The scores represent an asymptotic curve as shown in Figure 2b, while paraprofessionals with agricultural training had a slow but gradually increasing learning curve with scores of 74, 79, 82, and 94 in rounds one to four, respectively. These curves suggest that paraprofessionals with training in social science are more ready to learn than paraprofessionals with agricultural training. In other words, paraprofessionals trained in social science easily consult veterinarians but still do not reach the level of performance in drug prescription that the veterinarians obtain. The paraprofessionals with agricultural backgrounds have potential but this depends on how farmers update their beliefs about paraprofessionals. The scores of paraprofessionals trained in agriculture and social science were not significantly different at $p<0.05$.

Insert Figure 2a-c: The learning curves and quality of veterinary services

The learning curves of paraprofessionals with no formal education took the shape of a sigmoid curve. In round one the score was 24%, in round two it was 45%, in round and 33% and in round four 77%. The poor performance in round one to three can be explained by the unwillingness to consult with veterinarians, and the improved performance in round four can be explained by the loss of farmers to other providers and the need for reputation building. The learning curves in Figure 2c show that the quality of clinical veterinary services in the pastoral system is lower than that in the intensive system. The learning curve of intensive system is gradually increasing, while that of the pastoral system takes a sigmoidal shape.

5.3.3 Demand for clinical services

To measure the effect of information on demand, the demand for services of the veterinary and paraprofessionals was measured in each round. Moreover, farmers' belief updating curves were constructed to assess whether farmers update their beliefs about different types of service providers. The farmers' belief updating curves are shown in Figure 3 which composed of four figures (a-d). Figure 3a and 3b present the farmers' belief updating curves with regard to the services of veterinarians and paraprofessionals in the intensive and pastoral system, respectively. The curves show that in the intensive system, farmers do not easily update their beliefs about paraprofessionals. The belief updating curves were perfectly inelastic even with experience of interaction up to round three. This means that even when farmers get negative outcomes, they still go back to the same paraprofessional or seek services of another paraprofessional but not services of veterinarians. As revealed by farmers during the feedback meeting, they would go back to the same paraprofessionals even when the previous outcome was negative because of the following reasons: (1) they knew them and would always want to give them the benefit of the doubt. (2) The paraprofessionals were available compared to the veterinarians. In round four, the demand for veterinary paraprofessional services declined while that of veterinarians increased. In the pastoral systems, the demand for the services of veterinarians gradually increased while that of paraprofessionals gradually decreased. This suggests that livestock farmers in pastoral areas update their beliefs about their paraprofessionals much faster than farmers in the intensive system ($p<0.001$). This could be attributed to the fact that the scores of veterinarians and paraprofessionals are significantly different in the pastoral system ($p<0.05$) but not in the intensive system ($p<0.05$).

Figure 3c shows the results for the farmers' belief updating curves with regard to service providers by field of training. Service providers with agricultural training were found only in the intensive livestock system while those with no formal training and with social science training were found only in the pastoral livestock production system. The farmers' belief updating curves for service providers trained in social sciences and agriculture were inelastic between rounds one and three and a decline was recorded in round four. The farmers' belief updating curve for veterinary-trained service providers gradually increased while that of service providers without formal education gradually declined. The gradual increase in demand of service from providers trained in veterinary science can be associated with the gradual decline in demand from service providers without formal education since the demand for paraprofessionals trained in agriculture and social science remained constant up to round three. However, in round four the decline in the demand for service providers trained in social sciences and agriculture can be associated with the increase in the demand for services of veterinary-trained service providers since the demand for service providers without formal education remain constant.

Insert Figure 3a-d: The farmers' belief updating curves

A random-effects probit model for panel data was estimated to determine the factors that influence the likelihood of a farmer changing to another service provider. Three models were estimated because of collinearity in the variables. In model one, sex of farmer, pay-offs of farmers, fees charged by service provider and livestock production system were included in the model. Farmers' education level and previous outcome were excluded because they were correlated with production system and pay-offs, respectively. In model two, variable or production system was dropped and farmers' education was included. In model three, the pay-off variable was dropped and the outcome variable was included and standardized beta values of the independent variables were reported because they reveal which of the independent variables have a greater effect on the likelihood to change service providers. Results from model one show that the gender of the farmer, the pay-off farmers received in the previous round and the production system significantly influence farmers' decision to change the service provider (see results in Table 2). Being female and having a high pay-off reduces the likelihood of changing service providers. Farmers in the intensive production system are more likely to change service providers. As the descriptive statistics show, most of the changes were made from one paraprofessional to another and not to a veterinarian at least up to round four, see Figure 5.3a below. In model one; the livestock production system had a high significant effect on the decision to change, followed by pay-off and gender.

Insert Table 2 Random-effects panel probit model results for farmer's decision to change a service provider

In Model 2, results show that an educated farmer is more likely to change service providers than an uneducated farmer and education had a higher significant effect than pay-off. In Model 3, results revealed that the outcome of the previous transaction influences a farmer's decision to change service providers, but the livestock production system had a higher significant effect, followed by outcome and sex. In all models a fee charged by service providers in the previous transaction does not influence the decision to change providers. The likelihood that farmers change service providers was predicted using Stata post-estimation commands and the results showed that farmers are more likely to change to veterinarians than to paraprofessionals, as shown in Figure 5.3d.

4 Discussion and implications for clinical veterinary service delivery

The objective of this study was to examine whether and how acquisition of new information about performance of the service provider influences farmers' beliefs about service providers and the quality of clinical services. The results show that the quality of services, as measured in the role play game, that are offered by veterinarians is not significantly different from that of services offered by paraprofessionals trained in veterinary science. However, the quality of services provided by paraprofessionals who are not trained in veterinary science is significantly lower than those provided by service providers trained in veterinary science. This indicates that on-the-job training does not substitute formal education in veterinary science. Within the classification of non-veterinary science training, paraprofessionals with no formal education or training provide a significantly poorer quality of service than paraprofessionals with agricultural or social science training. Even with continued interaction between paraprofessionals and veterinarians, the quality of veterinary services offered by non-educated paraprofessionals failed to reach 80% accuracy for drug prescription. Disease diagnosis and drug prescription were particularly problematic for paraprofessionals who were not trained in veterinary science when handling cases of Anaplasmosis.

Learning curves reveal that continued interaction between the veterinary trained service providers and service providers with no formal veterinary training leads to improved quality of veterinary services. The learning curve for crop trained service providers was slowly increasing while those of the social science trained service providers assumed an asymptotic curve. The learning curve for service providers with no formal education took a sigmoid shape. Hopper et al. (2007) suggest that the slow rise learning is an indication of a difficult task, while the asymptotic curve can be associated with quick learning. However, in this particular case, the slow rise in the learning curve can be attributed to low propensity to consult, while asymptotic curve can be attributed to high propensity to consult. The temporal deterioration in performance, as shown by sigmoidal curves of paraprofessionals, especially those with no formal education, could be a result of lapses and over-confidence (Loftus, 1985; Stepanov et al., 2010). This could also be because of high demand for services of the service provider and attainment of a plateau-like (optimal position) position (Waldman, 2003). This is true in a sense that when a service provider has many clients and is confident of his skills then he has no interest in consulting with other providers. Therefore, to ensure quality farmers should be able to "punish" poor service providers and as Cohen et al. (2007) argue that mentorship arrangements between paraprofessionals and professionals should be developed to ensure quality.

The results contradict the findings by Peeling and Holden (2003), Oakeley et al. (2001) and Admassu et al. (2005) which showed that informal trained paraprofessionals as capable to perform diagnosis and drug prescription. For example, Oakeley et al. (Oakeley et al., 2001) conducted a random survey of veterinary service providers, including Community Animal Health Workers (CAHWs), who were only trained on the job, to examine the level of accuracy in drug diagnoses among different types of service providers. Their results showed that 85% of the diagnoses made by CAHWs were accurate. However, Curran and MacLehose (2002) dismissed this finding on grounds that they do not have proper research design to assess the level of drug prescription, and in any case no scores were presented. In addition, the three studies cited above do not consider the role of information, behaviour of farmers and service providers in making animal health management decisions in real life. Chilonda and Van Huylenbroeck (2001) argue that the study of the behaviour and decision-making processes of farmers, service providers and their interactions in different livestock production systems is a key to development of sustainable policy options for successful delivery of quality veterinary services to small-scale farmers.

The role play game has been identified and tested in the literature as a tool that can serve as an accurate and consistent method of assessment and decision forecasting (Armstrong, 2001; Dionnet et al., 2007) In this study, it was applied to analyze decisions and behaviors of both farmers and service providers. The results show that while paraprofessionals with no veterinary training were found to be of low quality compared with service providers with veterinary training, farmers changed their beliefs about non veterinary trained paraprofessionals rather slowly, thus providing few incentives for these paraprofessionals to provide quality services. The slow pace by which farmers were updating their beliefs about non veterinary trained service providers was because these paraprofessionals were available when veterinarians were not. Even when farmers change their decisions about a service provider they have to change from non-veterinary trained paraprofessional to another non veterinary trained paraprofessional. They have no choice but to go to service providers who are available since trained veterinary science service providers are few or not available to attend to their needs. Interaction between paraprofessionals and veterinarians therefore is a key to improving quality of veterinary services but this depends on farmers' ability to "punish" service providers who provide poor quality services by shifting to quality service providers. Model results show this depends on their education level, outcomes of the service, and gender. The fee charged for the previous transaction was found not to have significant impact on farmers' decision to change their service provider.

These findings are consistent with findings by Ahuja et al. (2003) who found out that price is not an important determinant of farmers' decision to use services of an alternative service provider. In fact, Leonard (2000) argues that the issue is not that farmers are poor and unable to afford veterinary services, but rather that farmers have failed to distinguish qualifications of different services providers and the quality of services they offer. The use of animal health cards or animal medical cards has a strong potential as a tool to enable farmers to distinguish and measure quality of clinical veterinary services. Most farmers in the game expressed their excitement with the use of the animal health cards as a tool to make service providers accountable. The tool can be useful in providing proper record keeping and monitoring of antimicrobial agents used in animals. Farmers can use exercise books and service providers could be asked to write their diagnosis and prescription in these books.

The role play experiment used in this study assumes that farmers do not self-treat, yet in reality farmers do treat the animal themselves. Self-treatment as an option was excluded because to include it the game would mean promoting unethical behavior. Secondly, the game assumed that the risk of an animal dying even when treated correctly is zero and yet an animal can actually die even with the right treatment because of delayed reporting and drug administration (Casadevall and Scharff, 1994). This may have been a reason why farmer's belief updating was slow. Thirdly, the limited number of participants could limit validity of the results, but since "real" participants (farmers and service providers) were involved in the game, the results are still meaningful and valid.

In summary, this paper presents a systematic study on how the interactions of farmers, veterinarians and paraprofessionals influence the quality of clinical veterinary services in rural Uganda. Results reveal the quality of veterinary services provided by paraprofessionals with veterinary training are not significantly different from those of veterinarians. However, the quality of services offered by paraprofessionals without veterinary training is significantly lower than that of veterinary trained service providers, but would improve as they interact with trained service providers. Even though services offered by paraprofessionals without veterinary training would increase in quality from continued interaction with veterinarians, there are challenges of sustaining paraprofessional interaction with veterinarians. As the results show, increased risks of losing clients, limited number (availability) of veterinarians and the slow pace by which farmers update their beliefs impede paraprofessional and veterinary interaction. From a policy perspective, investment in two years of training for veterinary paraprofessionals is a promising strategy for improving the quality of veterinary services since farmers are willing to pay for the private clinical veterinary services.

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Tables

Table 1 Clinical signs and drugs for specific animal diseases

Disease	Clinical signs	Main drug(s)	Scores	Supplementary drugs	Scores
East Coast Fever	High temperature of about 40^0C, swollen lymph nodes, increased breathing loss of appetite, nasal discharge, cough, white discharge in the eyes	Butarex, Parvexion, Clexion and Aflexion	8	multivitamins and oxy-tetracycline	2
Anaplasmosis	High temperature (41^0C), severe constipation, loss of appetite, loss of body weight, increased breathing and dry mouth	Imisol	8	salts, multivitamins and oxy-tetracycline	2
Trypanosomiasis	High temperature, stunning hair, loss of body weight, lacrimation (crying), blood discharge from the ears or skin, mucus discharge and brown urine.	Suriname, Diminazene and Ethidium	9	oxy-tetracycline	1
Heart Water	Turning in circles, grinding of the teeth, sensitivity to touch, nasal discharge and high temperature	Oxy tetracycline	9	Multivitamins	1
Red Water	Reddish urine, high temperature, loss of appetite, laboured breathing and weight loss	Imisol, Diminazene and Berenil	9	Multivitamins	1

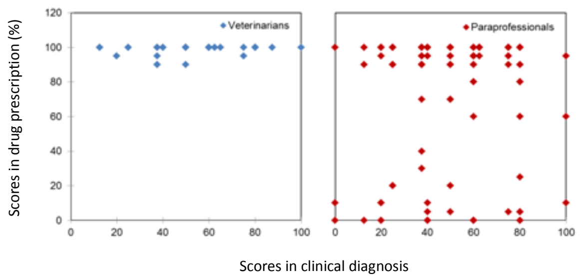
Source: Authors

Table 2 Random-effects panel probit model results for farmer's decision to change a service provider

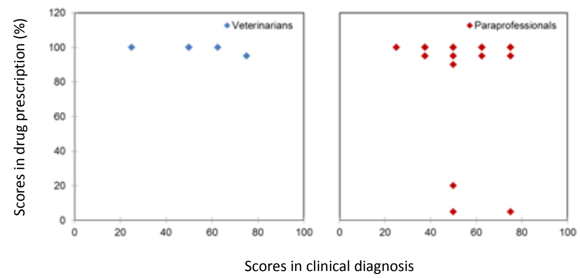
Independent Variables	**Probit Model**					
	Model 1		**Model 2**		**Model 3**	
Female farmers	-0.530*	(-2.10)	-0.25	(-1.08)	-0.494*	(-1.97)
Farmers' pay-off from previous transaction	-0.908***	(-3.42)	-0.465*	(-2.02)		
Fees charged in previous transaction	-0.117	(-0.47)	-0.01	(-0.04)	0.176	(-0.71)
Intensive livestock production systems	1.372***	(-4.75)			0.966***	(-3.73)
Farmers with education			0.581*	(-2.53)		
Previous outcomes					0.676**	(-2.76)
N	142		142		139	
Wald chi2(4)	25.68		11.31		20.8	

Standardized beta coefficients; t statistics in parentheses * p<0.05, ** p<0.01, *** p<0.001

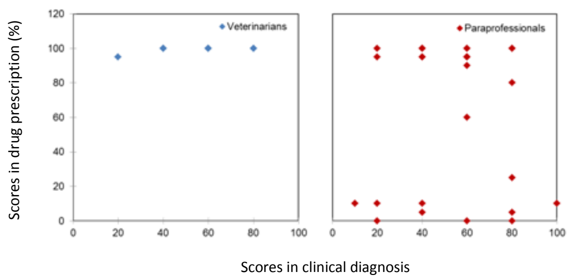
Figures



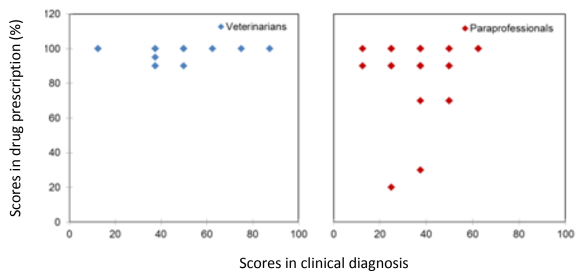
a) The scatter diagram for veterinarians and paraprofessionals overall scores in diagnosis scores in the treatment



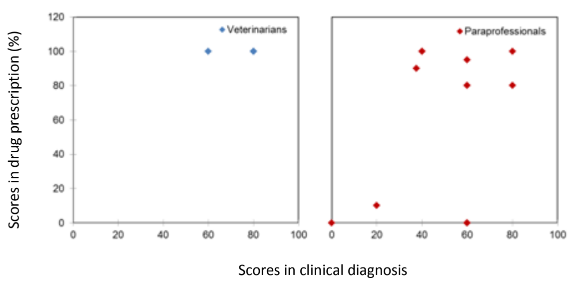
b) Veterinarians and paraprofessionals scores in the treatment of East Coast Fever



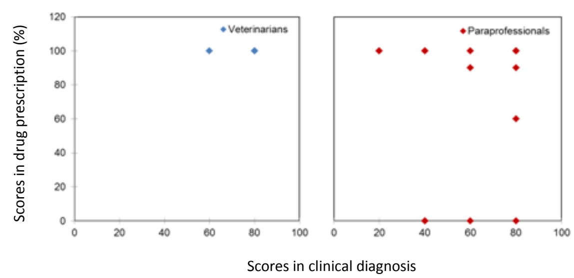
c) Veterinarian and paraprofessionals scores in the treatment of Anaplasmosis



d) Veterinarian and paraprofessionals scores in the treatment of Trypanosomiasis

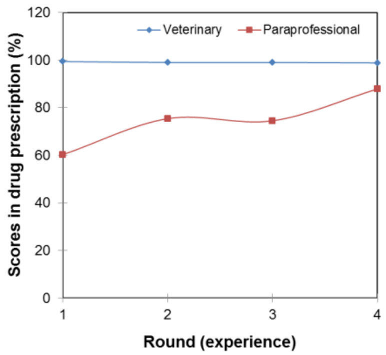


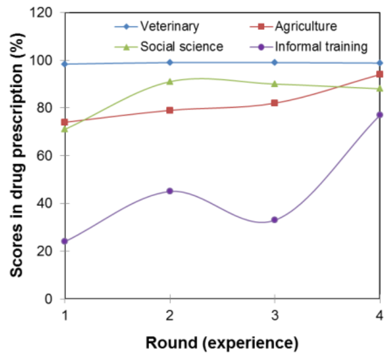
e) Veterinarian and paraprofessionals scores in the treatment of Heart Water

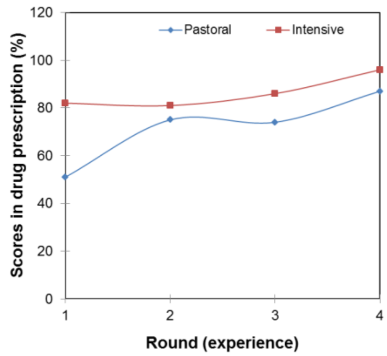


f) Veterinarain and paraprofessionals scores in the treatment of Red Water

Figure 1 The scatter diagrams for veterinarian and paraprofessional scores in diseases diagnosis and drug prescription





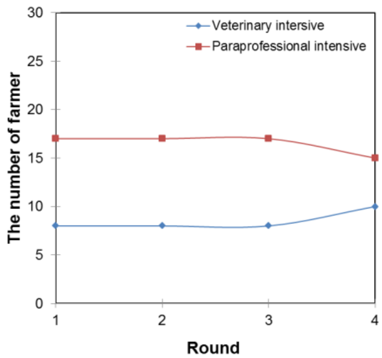


a) Learning curves by type of the service provider

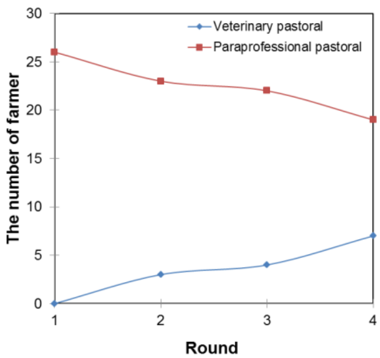
b) Learning curves by field of training of service providers

c) Learning curves by livestock production system

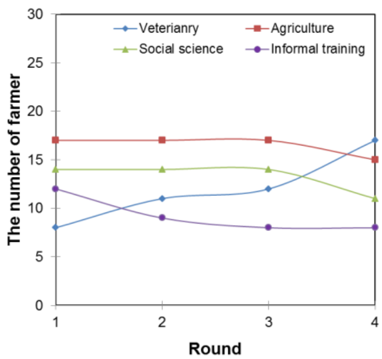
Figure 2 The learning curves and quality of veterinary services



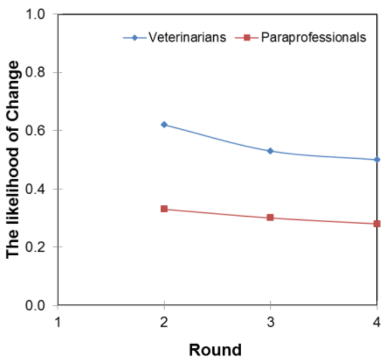
a) Farmers' belief updating curves about Service providers in the intensive production system



b) Farmers' belief updating curves about service providers in the pastoral system



c) Farmers' belief updating curves about service providers of different fields of training



d) The likelihood of changing to veterinarian or paraprofessional

Figure 3 The farmers' belief updating curves