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AN ANALYSIS OF INSTITUTIONAL ARRANGEMENTS FOR PROVIDING ANIMAL HEALTH SERVICES: A THEORETICAL FRAMEWORK AND EMPIRICAL EVIDENCE FROM KENYA AND UGANDA

Dissertation

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DEDICATION

I dedicate this work to my family, especially my late grandmother Akwi Ilukor, mother Imalingat Jane, late father Patrick Kwanga, uncle Anselm Ariko, wife Pheona Namuyaba, and my two daughters Chloe Akwi and Imalingat Regina.

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EXECUTIVE SUMMARY

Providing adequate animal health services to smallholder farmers in developing countries has remained a challenge, in spite of various reform efforts during the past decades, mainly because of governance challenges. Although good governance has been recognized as an important element in addressing emerging and re-emerging animal disease threats, animal health research has paid limited attention to the governance challenges inherent in the provision of animal health services. The existing frameworks for analyzing animal health services have mainly focused on market failures to decide what the public sector, private sector, and "third sector" (the community-based sector) should do with regard to providing animal health services. This thesis uses transaction cost economics to analyze institutional arrangements for providing animal health services since it captures both market failures and governance attributes. The objective of this thesis is threefold: (1) to develop a conceptual framework for analyzing animal health services using transaction cost theory of economic organization and to provide empirical evidence on its application using data collected on clinical veterinary services in Uganda and Kenya; (2) to identify governance challenges in the provision of animal health services and possible remedies to address them using a case study of Uganda; (3) to examine the quality of services provided by different service providers (paraprofessionals and veterinarians) and to gain insights into paraprofessional-veterinarian relations.

This thesis is comprised of six chapters. The introductory chapter provides background information regarding the study areas in Uganda and Kenya, highlights the importance of strengthening and supporting the provision of veterinary services in developing countries, and presents the main research objectives and outline of the thesis. Chapter 2 presents a conceptual framework for analyzing institutional arrangements for providing veterinary services using Williamson's discriminating alignment hypothesis and generates testable hypotheses regarding the cost effectiveness of various institutional arrangements. Using household survey data collected in Uganda and Kenya on clinical services, empirical tests of these hypotheses are presented. Chapter 3 examines the process of animal service delivery as well as identifies the main influential actors, important social relations, and main governance challenges encountered in the provision of clinical and preventive veterinary services in pastoral and intensive livestock productions systems in Uganda. Chapter 4 examines the determinants of referrals from veterinary

paraprofessionals to professional veterinarians. The Chapter 5 examines whether veterinary paraprofessionals perform correct disease diagnosis and prescribe correct drugs for selected endemic diseases. The chapter also examines whether interaction between veterinary paraprofessionals and professional veterinarians would result in correct drug prescription and disease diagnosis. Chapter 6 concludes and offers policy recommendations and areas for further research.

After presenting the importance of animal health services in developing countries, a framework for analyzing animal health services is developed in Chapter 2 based on Williamson's discriminating alignment hypothesis. This framework combines both market failure and governance attributes to assess the cost-effectiveness of different institutional arrangements for animal health services. Some of these attributes include externality, transaction intensity, care intensity, measurability, and state and community capacity. Using this attributes, testable hypotheses regarding the appropriateness of institutional arrangements for providing animal health services are developed. Using data from Uganda and Kenya on clinical veterinary services, empirical tests of these hypotheses are performed to demonstrate the application of Williamson's transaction cost theory to veterinary service delivery. The empirical results show that paraprofessionals are desirable because they offer needed care and attention to clients since they are located closer to livestock producers and thus have lower transaction costs and may be trusted more by farmers. Professional veterinarians, on the other hand, are preferred by farmers when cases require technical expertise (high measurability). The use of paraprofessional services is found to be positively associated with the availability of veterinarians, implying the existence of synergistic relationship between veterinarians and paraprofessionals. In other words, a referral system may be the most costs effective approach for building state and community capacity to provide veterinary services.

After developing the framework for analyzing the provision of animal health services, Chapter 3 examines the process of providing animal health services using Uganda as a case study. A participatory mapping tool called Process Net-Map is used to identify relevant actors and assess their influence in the delivery of clinical and preventive veterinary services in both pastoral and intensive livestock production systems. The tool also helps elicit governance challenges in veterinary service delivery. The results reveal that important social relations in ensuring the provision of quality veterinary services and the timely reporting of animal disease in veterinary service delivery include: (1) cooperation between private veterinarians and paraprofessionals, as well as private

veterinarians and government veterinarians in intensive production systems; and (2) cooperation between NGOs, government veterinarians, and community based animal health workers (CAHWs) in pastoral areas. The limited number of trained paraprofessionals and professional veterinarians, absenteeism by government veterinarians, insufficient and unpredictable budgets, weak legislation, exclusion of technical staff from the decision making process, and policy illogicality are identified as major governance problems in veterinary service delivery. Respondents also noted that the quality of veterinary services is very low because paraprofessionals without animal health training have dominated animal health markets in Uganda and the key to improve veterinary services is to build referral arrangements between paraprofessional and veterinarians.

Although the literature on animal health service delivery recognizes that referrals between paraprofessionals and veterinarians are important in ensuring correct drug prescriptions and in improving disease surveillance, detection, and reporting, little is known about determinants of referrals between paraprofessionals and professional veterinarians. Chapter 4 analyzes data collected from paraprofessionals in Kenya and Uganda to identify factors influencing referrals from paraprofessionals to veterinarians using a probit regression model. The results show that the determinants of paraprofessional referrals to veterinarians include: paraprofessional's mobile phone ownership, gender, attendance of short term trainings, annual assessments, and membership in paraprofessional associations. This chapter argues that policy makers should invest in legislation for paraprofessionals, supervision of paraprofessionals, the expansion of mobile phone ownership by paraprofessionals, the formation of paraprofessional associations, and short term training for paraprofessionals to build and strengthen referrals from paraprofessionals to veterinarians.

The question of the quality of veterinary services provided by paraprofessionals has been contested in the animal health service delivery literature. Chapter 5 examines this question by using a role play experiment to analyze how the interaction of farmers and service providers influences the quality and demand for clinical services. The quality of clinical services is measured by scoring the accuracy of a service provider prescribing the appropriate drug for selected endemic animal diseases in each of the game's four rounds. Statistical tests establish whether the quality of services provided by different types of paraprofessionals and veterinarians differ. Learning curves for service providers are constructed to examine whether the quality of services provided by paraprofessionals improves as they continue to interact with veterinarians. Belief updating curves are

constructed for farmers to examine whether they change their beliefs about paraprofessionals after receiving information about the quality of they (farmers) receive from service providers. A probit regression model for binary panel data is estimated to determine the factors that influence farmers' decisions to change service providers. The results show that the ability to identify the signs of different diseases and 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 to perform these tasks 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 trained in general agriculture and social sciences to perform these tasks. This is not the case for paraprofessionals with no formal training or education. Farmers do not easily change their beliefs about paraprofessionals, even if they receive information on their lack of ability to diagnose diseases and prescribe drugs correctly. Belief updating depends not only on the outcome of the previous round, but also on the gender of the farmer and on the livestock production system. This paper argues that the slow pace in which farmers update their beliefs about paraprofessionals limits paraprofessionals' willingness to learn and to consult with veterinarians. However, the use of "animal health cards" (records of diagnoses and treatments) could induce paraprofessionals to provide better quality services as well as enable farmers to measure the quality of services, thus improving the quality of veterinary services in the long run.

The main policy recommendation generated from this thesis are the following: (1) There is a need for developing countries to invest and create an enabling environment that supports paraprofessionals and professional veterinarians' relations to ensure timely reporting, treatment, and control of animal disease. This would help reduce wastes and efficiencies in animal production as well as human health risks. (2) The provision of veterinary extension services should focus not only on household heads, but on other household members as well, such as spouses/wives and herdsmen. This could contribute to improved reporting, treatment, and disease control, thus reducing the risks of animal loss and the spreading of diseases to other animals, livestock farms, and humans. (3) Stronger government engagement in the provision of veterinary services in pastoral or extensive livestock is required because the market has failed to attract private and trained paraprofessionals. Our findings indicate that the effort to close this gap by promoting community animal health workers with rather limited informal training has proven to be a

rather problematic answer to this problem. This is especially true when these service providers are expected to fulfill a major role in providing curative services since this may lead to the inefficient use or potentially dangerous misuse of veterinary drugs. (4) Farmers need to be empowered to hold service providers accountable by developing and experimenting with tools, such as animal medical cards, that would enable them to measure the quality of services they receive and distinguish qualifications of different services providers. (5) Investment in veterinary education is needed to ensure that enough qualified veterinary staff (both diploma and degree holders) are available to offer veterinary services. This could be achieved by supporting and encouraging recognized universities or tertiary institutions to establish training centers in livestock producing areas and by offering scholarships targeting training community-based animal health workers or students from marginalized/pastoral livestock areas.

ZUSAMMENFASSUNG

Die Bereitstellung angemessener Veterinärdienstleistungen stellt für Kleinbauern in Entwicklungsländern trotz verschiedener Reformbemühungen, die in den letzten Jahrzehnten stattgefunden haben, weiterhin eine große Herausforderung dar. Governance-Probleme, wie etwa die Abwesenheit von Veterinärbeamten sowie Markversagen (geringe Anreize für private Tierärzte) stehen dabei im Vordergrund. Obwohl eine gute Governance mittlerweile als wichtiges Ziel bei der Vorbeugung und Behandlung von Tierkrankheiten angesehen wird, hat die Forschung im Bereich Tiergesundheit den politischen und administrativen Herausforderungen, die mit der Bereitstellung von Veterinärdienstleistungen verbunden sind, bisher nur wenig Beachtung geschenkt. Bisherige Analysen im Tiergesundheitswesen haben sich vor allem nur auf Marktversagen konzentriert, um Entscheidungshilfen dafür abzuleiten, was der öffentliche Sektor, die Privatwirtschaft und der "dritte Sektor" (Gemeinschaften, Verbände, Nicht-Regierungsorganisationen) in Bezug auf die veterinärmedizinische Betreuung unternehmen sollten. Die vorliegende Studie hat auf der Basis der Transaktionskostenökonomik die institutionellen Arrangements für Veterinärdienstleistungen analysiert, da diese sowohl Marktversagen als auch Governance-Probleme erfasst. Die vorliegende Arbeit verfolgt drei Ziele: (1) Die Entwicklung eines konzeptionellen Rahmens für die Analyse der veterinärmedizinischen Versorgung mit Hilfe der Transaktionskostentheorie, und die Anwendung dieses Analyserahmens mit empirischen Daten in Uganda und Kenia zur veterinärmedizinischen Versorgung in pastoralen und intensiven Tierhaltungssystemen; (2) die Identifizierung der politischen und administrativen Herausforderungen bei der Bereitstellung von Veterinärdienstleistungen und die Identifizierung von Verbesserungsmöglichkeiten dieser Dienstleistungen anhand einer Fallstudie in Uganda; (3) die Prüfung der Dienstleistungsqualität verschiedener Dienstleister (Aushilfstierärzte (*paraprofessionals*) und Tierärzte) sowie die Analyse der Beziehungen von Aushilfstierarzten und Tierärzten.

Die Dissertation setzt sich aus sechs Kapiteln zusammen: Im einführenden Kapitel wird der Forschungsgegenstand skizziert, und es werden Hintergrundinformationen zu den Studienregionen in Uganda und Kenia gegeben. Auch wird die Bedeutung der Förderung der Erbringung von Tiergesundheitsdienstleistungen in Entwicklungsländern aufgezeigt. Vor diesem Hintergrund werden die Ziele der vorliegenden Arbeit vorgestellt und das

Vorgehen skizziert. Das zweite Kapitel stellt den konzeptionellen Rahmen für die Analyse der institutionellen Regelungen bezüglich tierärztlicher Dienstleistungen anhand von Williamson's sogenannter „Disciminating Alignment“ Hypothese dar und leitet daraus überprüfbare Hypothesen zur Kosteneffizienz verschiedener institutionellen Arrangements für Tiergesundheitsdienstleistungen ab. Die empirische Prüfung der Hypothesen erfolgt durch eine Daten aus einer Haushaltsbefragung, die in Uganda und Kenia durchgeführt wurde. .Kapitel drei beleuchtet den Prozess der Dienstleistungserbringung im Tiergesundheitswesen, und identifiziert die einflussreichsten Akteure sowie wichtige soziale Beziehungen und politische Herausforderungen bei der Erbringung der klinischen und präventiven Dienstleistungen des Veterinärwesens. Dabei wird zwischen extensiven und intensiven Produktionssystemen in Uganda unterscheiden. Kapitel 4 untersucht die Beweggründe für Überweisungen von Krankheitsfällen durch Aushilfstierärzte an akademisch ausgebildete Tierärzte. Im fünften Kapitel wird untersucht, inwieweit Aushilfstierärzte mit verschiedenem Ausbildungsstand eine korrekte Diagnose erstellen und die richtigen Medikamente für ausgewählte endemischen Krankheiten verschreiben können. Zusätzlich wird überprüft, ob eine Interaktion zwischen den Aushilfstierärzten und professionellen Tierärzten zu einer besseren Diagnose von Krankheiten und einer korrekteren Verschreibung von Medikamenten führen würde. Kapitel sechs fasst die Ergebnisse zusammen und gibt Empfehlungen für Politikmaßnamen. Außerdem wird weiterer Forschungsbedarf identifiziert.

Nachdem die Bedeutung des Tiergesundheitswesens in Entwicklungsländern dargestellt wurde, wird in Kapitel zwei, wie oben erwähnt, eine Analyse der veternärmedizinischen Dienstleistungen, basierend auf Williamson’s „Discriminating Alignment“ Hypothese vorgestellt. Diese Hypothese verbindet Marktversagen und Governance-Aspekte, um die Kosteneffizienz der einzelnen institutionellen Arrangements für veterinärmedizinische Versorgung abzuleiten. Folgende Attribute werden als relevant identifziert: externe Effekte, Transaktionsintensität, Pflegeintensität, Messbarkeit der Qualität von Leistungen, sowie die Kapazität von Staat und gemeinschaftsbasierten Dienstleistern. Mit Hilfe dieser Attribute wurden überprüfbare Hypothesen bezüglich der Angemessenheit/Eignung verschiedener institutionellen Regelungen für die veterinärmedizinische Betreuung entwickelt. Unter Verwendung von Haushaltsdaten aus Uganda und Kenia wurden empirische Tests der Hypothesen durchgeführt. Die empirischen Ergebnisse zeigen, dass der Einsatz von gut ausgebildeten paraprofessionellen Aushilfstierärzten wünschenswert sind, da sie die erforderlichen Kenntnisse haben und die

notwendige Sorgfalt aufbringen, aber ihre Transaktionskosten durch die Nähe zu den Tierhalter nniedriger sind als die der professionellen Tierärzte sowie die Landwirte zum Teil den Helfern ein größeres Vertrauen entgegen bringen. Professionelle Tierärzte wurden von Bauern bei Fällen, in denen technischer Expertise (hohe Messbarkeit) notwendig wurden, bevorzugt. Die in Anspruchnahme von tierärztlichen Helferleistungen wirken sich positiv auf die Verfügbarkeit der Tierärzte aus. Dadurch existiert eine synergetische Beziehung zwischen Tierarzt und Tierarzthelfer. Mit anderen Worten, das vorherrschende Überweisungssystem ist möglicherweise der am kostenwirksamsten Ansatz zum Aufbau der staatlichen und gemeinschaftlichen Kapazitäten bezüglich tierärztlichen Leistungen.

Nach der Entwicklung der Rahmenbedingungen für die Analyse der Bereitstellung von tierärztlichen Leistungen, untersucht Kapitel 3 den Prozess dieser Bereitstellung anhand eines Falls aus Uganda. Ein partizipatives Mapping Tool namens "Process Net-Map wurde verwendet, um die relevanten Akteure und deren Einfluss auf klinische und präventive Dienstleistungen des Veterinärwesens in extensiven und intensiven Tierproduktionssystemen zu ermitteln. Das Tool soll dazu beitragen, die staatlichen Herausforderungen bezüglich des Tiergesundheitswesens aufzudecken. Die Ergebnisse zeigen, dass soziale Beziehungen für die Bereitstellung von qualitativ hochwertigen Dienstleistungen des Veterinärwesens und die zeitnahe Meldung von Tierkrankheiten in tierärztliche Dienstleistungen notwendig sind.

Dazu gehören die folgenden Aspekte: (1) Die Zusammenarbeit zwischen privaten Tierärzten und Tierarzthelfern, wie auch die Zusammenarbeit zwischen privaten Tierärzten und von der Regierung angestellten Tierärzten in intensiven Produktionssystemen; und (2) die Zusammenarbeit zwischen den NROs und von der Regierung angestellten Tierärzte und den sogenannten *Community Animal Health Workers* (CAHWs) (Gemeinde-basierten Tiergesundheitsdienstleistern) in pastoralen Produktionssystemen. Folgende Probleme wurden identifiziert: die begrenzte Zahl von ausgebildeten Tierarzthelfern und professionellen Tierärzten, Fehlzeiten von Veterinärbeamten, unzureichende und unvorhersehbaren Budgets, eine unzureichende Gesetzgebung, Ausschluss des technischen Personals aus dem Entscheidungsprozess und politische Inkohärenz. Dies sind die bedeutendsten Governance Probleme in Bezug auf tierärztlichen Dienstleistungen. Die Befragten gaben auch eine niedrige Qualität der Dienstleistungen im Veterinärwesenn als Problem an, da Tierarzthelfer ohne veterinärmedizinische Ausbildung den Tiergesundheitsmarkt in Uganda dominieren und der Schlüssel zur Verbesserung dieser

Dienstleistungen liegen in einem verbesserten Überweisungssystem zwischen Tierarzthelfern und ausgebildeten Tierärzten.

Obwohl bereits in der Literatur beschrieben ist, dass für das Tiergesundheitswesen die Zusammenarbeit zwischen den Tierarzthelfern und den Tierärzten wichtig für eine bessere Überwachung von Krankheiten, Erkennung und Berichterstattung sowie die Sicherstellung einer korrekten Medikamenten Verschreibung ist, ist bisher nur wenig über die bestimmten Faktoren der Überweisungen von den Tierarzthelfern an die Tierärzte bekannt. Kapitel vier verwendet Daten zu identifizieren Faktoren, die Einfluss auf die Empfehlungen an die Tierärzte durch Tierarzthelfer mit Hilfe eines Probit Regressionsmodells in Kenia und Uganda aufzeigen. Die Ergebnisse zeigen, dass die Determinanten der Empfehlungen an die Tierärzte sich wie folgt zusammensetzen: Besitz von Mobiltelefonen des Helfers, Geschlecht und Ausbildung sowie Teilnahme an kurze Weiterbildungen, jährliche Begutachtungen und der Mitgliedschaft in Vereinigungen. Die Studie zeigt auf, dass die politischen Entscheidungsträger Investitionen die Aufsicht der Tierarzthelfer tätigen sollten, sowie die Möglichkeit der mobilen Erreichbarkeit der Helfer ausbauen sollten, sowie die Bildung von Verbände unterstützen und Kurzzeittrainings fördern sollten, um die Vernetzung von Helfern und Tierärzten zu stärken.

In der Tiergesundheitsliteratur wurde die Qualität der tierärztlichen Leistungen der Helfer angefochten. Kapitel 5 untersucht anhand eines Rollenspiel- Experiments, die Frage, inwieweit das Zusammenspiel der Landwirte und Dienstleister die Qualität und die Nachfrage nach klinischen Dienstleistungen beeinflusst. Das Experiment wurde in vier Runden durchgeführt. Die Qualität der klinischen Dienstleistungen wurde anhand der Genauigkeit in der Medikamentenverordnung ausgewählter endemischer Tierkrankheiten durch die Dienstleister bewertet. Statistische Tests wurden durchgeführt, ob die Qualität der Leistungen sich von verschiedenen Gruppen von Helfern und Tierärzten unterscheiden. Es wurden Lernkurven erstellt, anhand deren festgestellt wurde, ob die Qualität der Dienstleistung sich durch Zusammenarbeit mit Tierärzten verbessert. Weiter wurden Meinungskurven der Bauern erstellt, hinsichtlich ihrer Meinung der Qualität der erhaltenen Dienstleistung durch Tierarzthelfer. Ein Probit Regressionsmodell für binäre Daten wurde zur Bestimmung der Faktoren geschätzt, die einen Einfluss auf einen möglichen Dienstleisterwechsel der Landwirte haben. Die Ergebnisse zeigen, dass die Fähigkeit zum Erkennen der Anzeichen von verschiedenen Krankheiten und die Genauigkeit der Verschreibungen durch Tierärzte sich nicht wesentlich von den in der Veterinärmedizin ausgebildeten Helfern unterscheiden. Jedoch ist die Fähigkeit zur Durchführung dieser

Aufgaben von Dienstleistern, die nicht veterinärmedizinisch geschult sind, deutlich geringer als die der veterinärmedizinisch geschulten. Die häufige Interaktion zwischen Helfer und Tierärzte führt allmählich zu einer Verbesserung der Fähigkeit der Tierarzthelfer, die bereits in der allgemeinen Landwirtschaft und in Sozialwissenschaften ausgebildet sind. Dies trifft nicht auf Helfer zu, die keine formale Ausbildung oder Bildung besitzen. Die Bauern ändern nur schwer ihre Meinung über die Helfer, auch wenn sie die Information erhalten, dass die Diagnose und Medikamentierung der Krankheiten nicht immer vollständig zutreffend waren. Die Meinungskurven sind nicht nur von den Ergebnissen der vorherigen Runde abhängig, sondern auch vom Geschlecht des Landwirts und vom Tierproduktionssystem. Diese Studie vertritt den Standpunkt, dass durch nur eine langsam voran gehende Meinungsänderung der Landwirte bezüglich der Helfer, die Bereitschaft der Weiterbildung dieser, sowie die Konsultierung von Tierärzten stark limitiert ist. Die Verwendung von „Tiergesundheitskarten“ (Aufzeichnungen von Diagnosen und Behandlungen) könnten Helfer zur Erbringung von Leistungen besserer Qualität veranlassen, wobei die Landwirte diese Dienstleistungen besser bewerten und dadurch auf lange Sicht zur Verbesserung der Qualität der tierärztlichen Dienste beitragen können.

Die wichtigsten politischen Empfehlungen resultierend aus dieser Studie sind die folgenden: 1.) Es beteht einie Notwendigkeit zu Investitionen und zur Schaffung eines positiven Umfelds für bessere Tiergesundheitsdienstleistungen, vor allem in pastoralen Systemen. Maßnahmen sollten Beziehungen zwischen Tierarzthelfern und professionellen Tierärzten stärken und eine zeitnahe Berichterstattung verbessern, welche bei der Behandlung und Bekämpfung von Tierseuchen unerlässlich ist. Dies wäre ein Beitrag zur Verringerung von Produktivitäsverlust und zur Steigerung in der Effizienz in der Produktion, als auch eine Verringerung der Risiken für humane Gesundheit. (2) Die tierärztliche Beratung sollte sich nicht nur auf Haushaltsvorstände, sondern auch auf andere Haushaltsmitglieder wie Partner/innen und Ehefrauen und Hirten beziehen. Auch dies könnte zur aktuellen Berichterstattung, Behandlung und Bekämpfung von Krankheiten beitragen, wodurch die Gefahr des Verlusts eines Tieres und die Ausbreitung von Krankheiten auf andere Tiere in der Tierhaltung und beim Menschen verringert werden könnte. (3) Eine stärkeres staatliches Engagement bei der Bereitstellung von Dienstleistungen des Veterinärwesens in der intensiven oder extensiven Tierhaltung ist erforderlich, da der Markt dort nicht attraktiv für private und geschulte Helfer ist. Unsere Ergebnisse zeigen, dass die Bemühungen, um diese Lücke zu schließen, durch die

Förderung der Tiergesundheit in der Gemeinschaft durch Helfer ohne anerkannte Ausbildung eine eher problematische Lösung für dieses Problem darstellt. Dies ist vor allem der Fall, wenn von diesen Dienstleistern erwartet wird, dass sie eine große Rolle bei der Bereitstellung von kurativen Dienstleistungen spielen. Insbesondere kann dies dazu führen, dass potenziell gefährliche Medikamente unsachgemäß angewandt werden können. (4) Die Betriebsinhaber sollten die Möglichkeit haben, die Dienstleiter durch spezielle Methoden zu bewerten und die Qualität der Dienstleistung zu beurteilen. Weiter sollten die unterschiedlichen Qualifikationen der Dienstleiter durch zum Beispiel Verwendung der Tiergesundheitskarten ersichtlich gemacht werden. (5) Investitionen in tierärztlichen Ausbildung ist erforderlich, um sicherzustellen, dass genügend qualifizierte Mitarbeiter im Veterinärdienst (sowohl Diplom- als auch Hochschulabsolventen) zur Verfügung stehen. Erreicht werden könnte dies durch Unterstützung und Förderung anerkannter Universitäten und die Schaffung von Schulungszentren in der tierischen Erzeugung. Das das Angebot spezifischer Stipendien für Studenten aus pastoralen Regionen zur Ausbildung von Tiergesundheitsdienstleistern kann dabei eine wichtige Rolle spielen.

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1 INTRODUCTION

Livestock plays a critical role in feeding the world's different human populations, particularly urban dwellers and small scale mixed farmers, pastoralists, as well as ranchers. Livestock provides high quality proteins and micronutrients to consumers. In addition, it is an income source for livestock producers. The current and unprecedented increase in emerging and re-emerging animal diseases and zoonosis negatively impact animal productivity and production, trade in meat, live animals, and livestock products, human health, and poverty eradication efforts. Weak animal health care systems, mostly in developing countries, exacerbate these impacts. Strengthening the governance of animal health systems in both the public and private sector is seen as the most effective way to minimize these impacts. This study contributes to these efforts by examining the institutional environment, behavior of actors, and policy options for improving the provision of animal health services. This chapter provides background information regarding the study areas, main research objectives, and outline of the thesis.

1.1 General background

The importance of animal health services

Livestock production is a very important activity in the livelihoods of many rural households in developing countries. It often contributes to multiple livelihood objectives and is the main source of nutritious food, income, and draft power (Bender et al., 2006; FAO, 2011; Randolph et al., 2007). Livestock is also a social asset. For example, livestock is used to pay dowry for marriage, to compensate bruised parties in tribal or clan feuds, and to indicate social status (Kaimba et al., 2011; Randolph et al., 2007). Livestock production also offers employment opportunities, especially for people involved in value addition of livestock products (Perry and Grace, 2009). However, animal diseases continue to be a threat to livestock production and to the realization of livestock benefits in most developing countries, particularly in Sub-Saharan Africa (FAO, 2011; Forman et al., 2012; Sansoucy, 1995). An outbreak of disease can mean the difference between: being food sufficient and food insecure, having a secure income and losing key household assets, and eating healthy and contaminated food (FAO, 2011; Forman et al., 2012). Throughout the world, epidemic diseases, such as *pes-te des petits ruminant* (PPR), Contagious Bovine

Pleurapneumonia (CBPP) and Contagious Caprine Pleurapneumonia (CCPP), have led to the death of many animals, while others, such as Foot and Mouth and Brucellosis, have affected the growth of animals and milk production (Mcdermott et al., 2013; Plumb et al., 2013; Rich and Perry, 2011; Rushton et al., 2012). Zoonotic diseases (passed from animal to humans) and food borne diseases (resulting from the consumption of food of animal origin), such as gastrointestinal diseases, have led to deaths and have increased the costs of treatment for consumers of livestock products (Grace et al., 2012; Senior, 2009).

A report by the International Federation of Animal Health (IFAH) estimates that about one million cattle die of rabies in Central and South America each year. In addition, 55,000 people die of rabies annually throughout the world, with 99% of these deaths occurring in developing countries. In the United Kingdom, the 2001 Foot and Mouth disease (FMD) outbreak is estimated to have resulted in the slaughter of six million animals and a loss of US $11.5 billion in tourism revenue (IFAH, 2012). The report also reveals that Salmonella costs the United States $3 billion annually. In developing countries, Knight-Jones and Rushton (2013) estimate that losses from FMD in the endemic regions of Africa and Asia are US $5 to $21 billion annually from production losses and vaccines. In Cambodia, Shankar et al. (2012) estimate that FMD outbreaks reduce household income and animal value by 4.4-11.7% and 54-92%, respectively. In India, Ganesh et al. (2012) estimate that FMD infections result in losses of 450 million to 2 billion pounds of sterling per year. In Nigeria, Fadiga et al. (2013) estimate that the economic burden of pes-te des petits ruminant (PPR), Contagious Bovine, and Caprine Pleurapneumonia (CBPP& CCPP),Trypanosomiasis, Newcastle disease (NCD), and African Swine Fever (ASF) to the economy is US $179 million (29.2 billion naira).

Zoonotic diseases, such as Brucellosis, Rabies, Rift Valley Fever, and food-borne diseases like salmonella, have led to the death of many people and have burdened health care systems in most developing countries (Jones et al., 2013). A recent study by the International Livestock Research Institute (ILRI) reveals that the major geographical hotspots for zoonotic diseases are in East Africa, with Ethiopia, Kenya, Uganda, and Tanzania appearing among the top 20 most burdened countries in the world from zoonotic diseases (Grace et al., 2012). The report reveals that about 13 zoonotic diseases are responsible for 2.4 billion human illnesses and 2.2 million deaths every year in developing countries (see Table 1.1 below). The risk of zoonotic disease emergence is expected to increase with increased intensification of livestock production to meet the increasing

demand for food of animal origin, especially in developing countries (Grace et al., 2012; Jones et al., 2013).

Table 1.1 Important zoonoses and their impact on human health

Disease	Pathogens/agent	Transmission	Common illness in humans	Annual human deaths	Annual affected humans
Gastrointestinal	Bacteria (Salmonella, E. coli, Cryptosporidium)	Contact with infected farm animals, wild animals, and pets. Eating contaminated food and drinking water contaminated with excretions from infected animals. Imprudent use of antimicrobials in animals.	Diarrhoea, nausea, vomiting, and loss of appetite, abdominal cramps, weight loss.	1,500,000	2,333,000,000
Leptospirosis	Leptospira bacteria	Contact with infected animals and contaminated water.	Fever, chills, intense headache, meningitis, liver damage, and renal failure.	123,000	1,700,000
Cystlcercosis	Parasite *(Taenia solium*, a tape worm in pigs)	Eating pork or fruits and vegetables infected with *Taenia solium.*	Decreased vision, seizures, heart failures, and spine and nerve damage.	50,000	50,000,000
Tuberculosis	*Bacteria (Mycobacterium tuberculos*)	Inhalation of aerosols or the ingestion of unpasteurized milk.	Cough, fever, fatigue, sweating, weight loss, chills, and abdominal swelling.	100,000	554,500
Rabies	Neurotropic virus	Bites from infected animals including dogs, cats and bats.	Fever, headache, fatigue, confusion, hallucinations, and paralysis	70,000	70,000
Leishmaniasis	Parasites (e.g., sandfly)	A parasitic disease spread by the bite of infected sand flies.	Affects internal organs (spleen, liver, and bone marrow).	47,000	2,000,000
Brucellosis	Bacteria (Brucella)	Contact with infected animals or meat. Drinking raw milk from infected cattle, goats, camels.	Back pain, chills, abdominal pain, excessive sweating, headache, fever, joint pain, weight loss, and muscle pain.	25,000	500,000
Echinococcosis	Parasite (Echinococcus)	Humans become infected when they swallow eggs in contaminated food from cattle, dear, pigs, sheep and contact with dogs.	A closed pocket tissue forms in the liver, brain, bones, kidney, lungs, skeletal muscles, and spleen.	18,000	30,0000
Toxoplasmosis	*Parasite (Toxoplasma gondii)*	Contact with cat faeces that contain the parasite, Eat contaminated food (lamb and pork) or drink contaminated water.	Body aches, swollen lymph nodes, headaches, miscarriages, stillborn children,, blurred vision, and liver problems.	10,000	2,000,000
Q fever	Bacteria (*Coxiella burnetii)*	Drinking raw or unpasteurized milk, as well as inhaling dust or air contaminated with infected animal feces, blood, or birth products.	Dry cough, fever, headache, chest pain, rash, and muscle pains.	3,000	3,500,000
Trypanosomosis	Parasite (*Trypanosoma brucei)*	Tsetse fly bite.	Fever, swollen lymph glands, headaches, irritability, confusion, slurred speech, seizures, and difficulty walking and talking.	2,500	15,000
Anthrax	Bacillus anthracis	Contact with infected animals, wool, meat, or hides.	Cutaneous (skin), lungs and gastrointestinal infections.	1,250	11,000
Hepatitis E*	Hepatitis E virus	Ingestion of fecal matter (especially through drinking contaminated water), food from infected animals, and blood transfusion.	Abdominal pain and tenderness, nausea, vomiting, and acute liver failure.	300,000	14,000,000

Information and data from this table are based on Grace et al. (2012) and the U.S. National Library of Medicine.

The Food and Agriculture Organization (FAO) projects an increase of meat consumption from 158.3 to 330.4 million tons between 2010 and 2050 in developing countries (FAO, 2011), which is attributed to growing per capita income, population, and

urbanization (Pica-Ciamarra and Otte, 2008). The availability and quality of animal health services is therefore important for increasing the productivity of the livestock sector and for reducing human health risks related to animal diseases.

The provision of animal health services: from markets failure to process-based analysis

The rapid expansion of livestock production needs significant investment in animal health systems to acquire human and logistical resources to address the risks associated with animal diseases. However, the optimal ratio of staff to non-staff expenditure is difficult to determine and will vary by country. Moreover, such investments may require substantial increases in developing countries' budgets, which is unlikely to occur given their pervasive fiscal problems. As a result, cost effective institutional arrangements are needed to lessen animal disease risks arising from the production of livestock related products. Previous efforts aimed at developing cost effective institutional arrangements led by the World Bank resulted in the privatization of most veterinary services and retrenchment of most paraprofessionals. However, markets failed to work and did solve service delivery problems. Subsequently, Umali et al. (1994) developed a framework that categorized veterinary[1] services into private and public services. Veterinary services for which no market failure was assumed to exist are categorized as private services and veterinary services where market failures existed are categorized as public goods (Leonard, 2002; Riviere-Cinnamond, 2004). As a result, a number of institutional arrangements emerged, including decentralization, cost recovery, sub-contracting, provision of subsidies to animal health service providers, and – particularly in pastoral areas – the Community Animal Health Worker (CAHW) system. Nonetheless, expectations in most cases have not been met (Pica-Ciamarra and Otte, 2008) and this is largely attributed to institutional and governance challenges (Pastoret and Chaisemartin, 2011; Schneider, 2011; Vallat and Mallet, 2006).

To address the institutional and governance challenges, Riviere-Cinnamond (2004) recommends that economic analyses of animal health service delivery should move towards a process-based approach that provides a broader perspective and understanding of transaction costs. Process-based analysis provides insights to transaction costs that arise from political interference, behavioural attributes, and other economic attributes including

[1] The word veterinary and animal health are used interchangeably

market failure (Riviere-Cinnamond, 2004). Process-based analysis facilitates the development of cost effective institutional arrangements or policy options for addressing these problems. However, studies that apply process-based approaches to analyze the provision of veterinary services have been limited, partly because animal health economists did not have economic theory and the tools to support this type of analysis.

1.2 Specific objectives and research questions

Although institutional and governance challenges have been cited and recognized in the animal health literature as key bottlenecks to the efficient and sustainable provision of animal health services, little is known about the real nature of governance challenges and the extent to which these challenges manifest themselves and affect animal service delivery. In addition, existing analytical frameworks for analyzing animal health services provide little attention to governance problems. The objectives of this thesis are: (1) to develop a conceptual framework for analyzing animal health services using transaction cost theory (TCE) and to demonstrate its application in assessing the cost effectiveness of institutional arrangements for providing veterinary services; (2) to identify the actors, their roles, possible challenges, and remedies to address challenges faced in the provision of animal health services using Uganda as a case study; (3) to determine factors that influence paraprofessional-veterinarian relationships; and (4) to examine the quality of services provided by different service providers (paraprofessionals and veterinarians) and to measure the impact of paraprofessional-veterinarian relations on the quality of veterinary services.

In this thesis, a conceptual framework for analyzing animal health services is developed based on transaction cost theory by reviewing the literature on the provision of veterinary services in developing countries. Applying Williamson's discriminating alignment hypothesis as an analytical basis, hypotheses regarding cost effective institutional arrangements to provide animal health services are developed and tested using empirical data on clinical services collected from Uganda and Kenya. The process Net-Map tool is also used to examine the process of animal health service delivery and to identify the actors and their roles, interests and challenges. A role play experiment measures the quality of services provided by paraprofessionals and the impact of paraprofessional-professional relations on the quality of veterinary services using Uganda as a case study.

1.3 Overview of the study area

Both Uganda and Kenya are low income countries with livestock contributing over 5% and 12%, respectively, to Gross Domestic Product (GDP) (FAO, 2005). Both countries adopted structural adjustment policies (SAPs) that were instituted in the late 1980s by the World Bank. However, unlike Uganda which adopted and successfully implemented the SAPs in 1987, Kenya began implementing SAPs in 1993 and did not completely liberalize the provision of private veterinary services (FAO, 2005; Silkin, 2005). In addition, Kenya did not lay-off or retrench para-veterinarians, but instead stopped the policy of automatic recruitment of veterinarians into the government's formal veterinary system (Silkin, 2005). Uganda, on the other hand, retrenched all para-veterinarians and ceased the policy of automatic recruitment of veterinarians into the formal government veterinary system. Variations in the implementation of the SAPs resulted in variations in level of investment and provision of animal health services (Woodford, 2004). Therefore, it is important to study the impact of these policy variations on the provision of animal health services in these two countries.

Field research was conducted in Kiambu and North Pokot districts of Kenya and in Mukono and Amudat districts of Uganda in 2012. Mukono and Kiambu districts are located in intensive livestock production systems, while Amudat and North Pokot districts are located in pastoral systems. The two production systems differ in terms of infrastructure as well as in the supply of and demand for animal health services. These are the most important factors influencing the development of sustainable animal health service delivery systems in developing countries (cf. Woodford, 2004). Kiambu and Mukono districts were selected because they are located close to the capital cities of Kenya and Uganda, respectively. In addition, the main types of animals kept in both districts are dairy cattle, pigs, and chicken, mainly for commercial purposes. Kiambu district has two farmer cooperatives, the Githunguri and Ndumberi Dairy Farmers Co-operative Societies which collect 170,000 and 20,000 litres of milk, respectively. However, about 40% of livestock farmers are members of the cooperatives and about 7% of livestock farmers are actively engaged in supplying milk to cooperatives. According to Mburu et al.(2007), livestock farmers in Kiambu district who solely depend on farm income, own larger land sizes, have more cows, and produce more milk are less likely to actively participate in cooperatives because cooperative prices are lower than the market price.

Amudat and North Pokot districts were selected because they boarder one another and are inhabited by one ethnic group, the *Pokots*. The *Pokots* keep large herd size of mainly indigenous breeds of cattle and shots (Ettyang, 1999). In both Uganda and Kenya, the *Pokot* communities lack access to basic developmental services and physical infrastructure. Their access to schools and hospitals is limited and most roads in the area are not passable (Kristensen, 2009; Yiga et al., 2008). The number of trained animal health service providers in these areas is also low (Hassan, 2003). Very few trained veterinary professionals are willing to stay in these areas because of the limited access to basic services and the prevalence of rampant cattle rustling (Greiner, 2013; Hassan, 2003).[2] To the *Pokots*, livestock is the main source of food (namely, milk, blood, and meat), provides income, and is an integral component of social relations since livestock is used for dowry payments and is a store of wealth, symbol of prosperity, and means for compensating aggrieved parties in tribal, clan, and family conflicts (Kaimba et al., 2011).

1.4 Research topics and questions

Research topic 1: A review of the literature and an empirical application of Transaction Cost Theory for analyzing institutional arrangements for providing animal health services

This topic is dealt with in Chapter 2. In this chapter, Oliver Williamson's discriminating alignment hypothesis is applied to assess the cost effectiveness of various institutional arrangements and to generate testable hypothesises. The rationale behind the application of the TCE framework is that it allows us to address market failure, governance, and contextual problems specific to the provision of animal health services. This chapter contains the hypothesis that the inclusion of governance and context specific factors in to the analysis animal health service delivery may lead to the conclusion that private animal health services should become a public service. For example, clinical services (often considered as a private service that can be provided by a market-based system may require public sector intervention.

[2] Cattle rustling also called cattle raiding are the act of stealing cattle. It is common practice among the pastoral communities in East Africa such as the Karamajong in Uganda, the Pokot, and Turkana in Kenya

Research topic 2: Influential actors and governance challenges in the provision of veterinary services – A case study of Uganda

A full discussion of this topic is dealt with in Chapter 3. The main research questions addressed within this research topic are: Who are the actors and what role do they play in the provision of animal health services? What are the governance challenges and what is their effect on the provision of animal health services? And what are the possible remedies to these governance challenges? Understanding the roles of different actors, as well as their interests and resource capacity is useful in creating suitable institutional arrangements for proving animal health services and for improving coordination among actors (Burgos and Otte, 2009). Improved coordination among the actors ensures good governance of veterinary services and systems, as well as improved service delivery (Vallat and Mallet, 2006). This chapter applies the Process Net-Map tool to identify networks of actors, problem areas, and possible strategies to solve these problems using a case study of Uganda.

Research topic 3: Determinants of referrals from paraprofessionals to veterinarians in Uganda and Kenya

The topic is dealt with in Chapter 4. The main research question is: What factors influence referrals from paraprofessionals to veterinarians in animal health care? Because of the limited literature on referrals in animal health care, the study uses referral literature in human health care to generate hypotheses. The chapter contains the hypothesis that paraprofessional's mobile phone ownership, gender, attendance of short term trainings, annual assessments, and membership in paraprofessional associations, as well as the prevalence of epidemic animal diseases and the number of paraprofessionals not trained in animal health in a given area influence their referrals to veterinarians.

Research topic 4: The quality of veterinary services provided by veterinary services providers in rural Uganda

This topic is dealt with in Chapter 5. The research questions covered in this chapter are: Does the quality of services of paraprofessionals differ from that of veterinarians? Does information about the quality of services by paraprofessionals influence farmer's choice of service providers? Do interactions between paraprofessionals and veterinarians influence the quality of animal health services? Finally, what influences farmer's decision to change animal health service providers? A contentious issue in animal health service delivery is

the quality of services provided by veterinary paraprofessionals. To date, there is no clarity as to whether veterinary paraprofessionals provide quality services. For example, studies by Oakeley et al. (2001) and Peeling and Holden (2004) show that paraprofessionals, especially community animal health workers (CAHWS) with three weeks of training provide quality services in Kenya, Tanzania, and the Philippines. However, Curran and MacLehose (2002) dismiss these studies for their poor research design in assessing the level of drug prescription and disease diagnosis. Chapter 3 analyzes results from a role play experiment, which is an innovative yet tested approach to answer the above questions.

1.5 Thesis Outline

The thesis is organized as follows: Chapter 2 presents a conceptual framework for analyzing the provision of veterinary services based on transaction cost theory. Chapter 3 examines the interaction of different actors in the provision of veterinary services and also identifies governance challenges, policy options, and entry points for addressing these challenges. Chapter 4 examines determinants of referrals from paraprofessionals to veterinarians. Chapter 5 measures the quality of services provided by different types of service provides and examines how farmers' decisions influence the quality of veterinary services. Chapter 5 also assesses whether information influences farmers' decision to change service providers and whether interactions between veterinarians and paraprofessionals result in improved service quality. Chapter 6 provides a discussion of the results, data limitations, and offers policy recommendations.

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2 ADDRESSING GOVERANCE CHALLENGES IN THE PROVISION OF ANIMAL HEALTH SERVICES: A REVIEW OF THE LITERATURE AND EMPIRICAL APPLICATION OF TRANSACTION COST THEORY

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Abstract

Providing adequate animal health services to smallholder farmers in developing countries has remained a challenge, in spite of various reform efforts during the past decades. The focuses of the past reforms were on market failures to decide what the public sector, the private sector, and the "third sector" (the community-based sector) should do with regard to providing animal health services. However, such frameworks have paid limited attention to the governance challenges inherent in the provision of animal health services. This paper presents a framework for analyzing institutional arrangements for providing animal health services that focus not only on market failures, but also on governance challenges, such as elite capture, and absenteeism of staff. As an analytical basis, Williamson's discriminating alignment hypothesis is applied to assess the cost-effectiveness of different institutional arrangements for animal health services in view of both market failures and governance challenges. This framework is used to generate testable hypotheses on the appropriateness of different institutional arrangements for providing animal health services, depending on context-specific circumstances. Data from Uganda and Kenya on clinical veterinary services is used to provide an empirical test of these hypotheses and to demonstrate application of Williamson's transaction cost theory to veterinary service delivery. The paper concludes that strong public sector involvement, especially in building and strengthening a synergistic relation-based referral arrangement between paraprofessionals and veterinarians is imperative in improving animal health service delivery in developing countries.

Key words: *Institutional arrangements, Animal health services, Market failures, Governance Challenges, Paravets, Community Animal Health Workers, Transaction Cost Economics*

2.1 Introduction

Providing effective animal health services to livestock keepers in developing countries has remained a challenge. Provision of these services by the government prevailed in the first decades after developing countries reached their independence. In the structural adjustment period that began in the 1980s, government provision of livestock services came under increasing criticism for high costs and limited effectiveness. A solution was seen in the privatization of those veterinary services for which no market failure was assumed to exist (Leonard, 2002; Pica-Ciamarra and Otte, 2008; Riviere-Cinnamond, 2004). An important analytical framework to justify this approach was developed by Umali et al. (1994), who applied concepts of public economics to determine the services for which a market for animal health services was expected to emerge -a market in which private veterinarians and other private service providers could flourish. The experience showed that this approach had its merits. High-potential areas and market-oriented livestock systems, such as the intensive dairy systems of Kenya, are indeed served by this market (Oruko and Ndung'u, 2009). However, marginal areas and poorer livestock keepers continued to lack adequate access to animal health services (Okwiri et al., 2001; Otieno et al., 2000).

Following the failures of both the public and the private sector in these areas, a new wave of reform focused on a "third sector" consisting of community-based animal health workers. In spite of initial concerns about their capacity, they became a major feature of recent reform efforts (McSherry and Brass, 2008). And indeed, this approach had its merits, too. For example, the eradication of the rinderpest -which is without a doubt the single biggest success in animal health provision in modern history-would not have been possible without the thousands of community-animal health workers who vaccinated animals in the most remote and conflict-affected areas of the developing world (FAO, 2012a).

However, the "third sector" approach is not a panacea and serious problems remain in spite of reform efforts and their successes (Oruko and Ndung'u, 2009). Foot and Mouth disease (FMD), Contagious Bovine Pleurapneumonia (CBPP) in cattle and Rift Valley

Fever disease in both cattle and humans have continued to inflict serious losses to livestock farmers, especially the rural poor. For example, in 2011 there were 60 outbreaks of FMD reported in Kenya, 58 in Ethiopia, 15 in Uganda, 57 in Ghana, and 161 in Burkina-Faso (FAO, 2012b). Over 15 million cattle, sheep and goats suffer from FMD annually (Knight-Jones and Rushton, 2013). The overall economic costs of FMD for each country in East Africa is estimated to be US$4.5 billion annually (ILRI, 2012). In 2002, 87 outbreaks of CBPP were reported in East Africa, 54 of which occurred in Uganda, 18 in Kenya and 15 in Tanzania (Tambi et al., 2006). Estimates by Rich and Wanyoike, (2010) indicate that the 2007 outbreak of Rift Valley Fever disease in Garrisa and Injara districts in Kenya led to economic losses of US$9.3 million in the two districts (Rich and Wanyoike, 2010) which is more than twice the budget expenditures of the two districts estimated to be US$3.5 million. These values include both direct and indirect costs such as loss in milk, and abortions as well as losses made when sick animals are sold to avoid total loss due to death and losses to traders and slaughter houses.

A study of livestock keepers in Northern Ghana by Mockshell et al (2014) showed that such losses are not only important from the perspective of national development, but are also important for household welfare especially as asource of food (milk and meat), income, draft power (transportation and animal traction) and food nutrients required for human development (Bender et al., 2006; FAO, 2011). For poor people who depend on livestock, every animal lost can be a threat to the family's livelihood and future development opportunity. Moreover, with the current European Union (EU) led *"zero tolerance"* standards on free disease regions, poor livestock keepers are missing out from the increasing global demand for food of animal origin, which is the driving force behind the "*livestock revolution*" (Otte et al., 2004; Wymann et al., 2007).

Why do these problems remain in spite of all of the previous reform efforts? As will be discussed in this paper, a major reason can be seen in the neglect of the governance challenges that are inherent in each of the three sectors—public, private, and third—which can be involved in the provision of animal health services (Birner & Gunaweera, 2002). While "good governance"[deliberate effort to create workable arrangements to ensure continuity and mutuality in exchange (Williamson, 2005)] has been on the development agenda since the late 1990s (UN, 1998), governance issues have remained relatively neglected in the debate on animal health services. As noted by Vallat and Mallet (2006), good governance is a key to addressing the emerging and re-emerging animal disease

threats. Yet, little attention has been paid to this problem. According to the World Bank (1994), good governance is characterized by predictable, open and enlightened policy making; a bureaucracy instilled with a professional character; an executive arm of government accountable for its actions; and a strong civil society participating in public affairs; and all behaving under the rule of law. This definition is of particular relevance because it emphasizes the need for transparency and accountability in policy making process and the significance of all actors performing their responsibilities effectively, in a sustainable, coordinated and coherent manner. Such actors may include political actors and institutions, interest groups, civil society, and non-governmental and transnational organizations. Sustaining coordination and coherence among actors is key to promoting suitable governance for veterinary health policies (Vallat and Mallet, 2006).

The problems inherent in public sector service provision are well known. In fact, they have been the major reason for the drive towards privatization in the 1980s. One problem is the absenteeism of extension staff: veterinarians and other staff are absent from their duty stations and fail to visit their clients since it is very difficult for the government, especially the central government, to supervise them. The problem of absenteeism of civil servants is a serious problem for service providers in primary education and health (Chaudhury and Hammer, 2006). Another problem is sub-standard performance, which arises from the information asymmetry problem-the livestock keeper has difficulties to assess whether a negative result, such as the death of a sick animal, is due to lack of effort and skills of the service provider or due to reasons beyond his or her control (Leonard and Leonard, 1998, 1999; Leonard, 2002). A third problem is the propensity of public sector service providers to demand "fees" or accept favors or bribes in return for preferential treatment from veterinarians (Heffernan and Misturelli, 2000). As a consequence, poor livestock farmers have less access to their services, resulting in a problem also referred to as "elite capture"-the better off farmers are able to capture a larger share, or all, of the public spending made for the provision of these services (Birner and Anderson, 2007). Public sector service provision is also affected by a range of problems, which are not the "fault" of individual staff. Lack or delay of the government funding necessary to vaccines and equipment, low salaries and failure to pay the salary of service providers in time, are frequent problems in developing countries.

The private sector has its own challenges just like the public sector. Some challenges were well-known and addressed in the early analytical frameworks (see Section

2). Preventive services such vaccinations have positive externalities and involve collective action problems. For example, individual livestock keepers have incentives to "free-ride" and save costs by not vaccinating their animals, assuming that others vaccinate. Such problems justify government involvement. However, other governance challenges of private service provision have been underestimated, as the experience of the privatization reform has shown. Substantial market failures arise due to the high travel costs of serving livestock keepers, especially in pastoral areas and for private veterinarians who for the most part do not live close to or in marginal are. Cash constraints faced by such farmers aggravate the problem. The challenge of information asymmetry mentioned above also applies to private animal service providers. Hence, substandard service provision may also apply in this case. Private veterinarians who sell veterinary drugs also face a conflict of interest or adverse selection and moral hazard problem, as they may be inclined to sell substandard or non-essential drugs (Leonard, 2000).

Community animal health workers- the "third-sector" providers-are subject to the same governance challenges that arise from information asymmetry, yet may be better able to overcome the problem of high transaction costs of service provision. They can demand lower fees because they live in rural areas and do not have to recover the high investment in education that a university-trained veterinarian has to make. However, the downside of this low-cost provision is that they are also less well-trained. Moreover, they are not subject to the same mechanisms of government regulation and self-regulation that characterizes the veterinary profession. In addition, if the community is expected to fund such health workers collectively, the typical free-rider problem of collective action problems may jeopardize their funding. If non-governmental organizations or donors provide funds for community animal health workers, they are subject to a similar or even greater problem regarding the unreliability of funding than their public sector counterparts. Also, people may not feel obliged to pay for their services or value their services if a donor is providing the funding

To devise institutional arrangements that can address these governance challenges, there is a need to expand existing analytical frameworks. This paper proposes a transaction costs approach to achieve this goal. Specifically, we propose a framework that is based on the so-called "discriminating alignment hypothesis" developed by Williamson (1991). The transaction costs framework, which is further explained in the next section, has been selected for four major reasons: First, acknowledging that there is no "one-size-fits-all"

solution, the framework makes it possible to identify the context-specific factors that determine the comparative advantage of different institutional arrangements for providing animal health services. Hence, the framework makes it possible to move "from best practice to best fit", which has been a major insight in the literature on governance in developing countries (Birner et al., 2009; Grindle, 2007; World Bank, 2004). Second, rather than "re-inventing the wheel", this framework is compatible with the existing frameworks (that focused on public economics) and makes it possible to build upon the rich insights that have been derived from such frameworks. Third, the Williamson's transaction costs framework has been widely used in assessing the comparative advantage of empirically observed institutional arrangements. Hence, even though the empirical research for the animal health services still needs to be carried out, the framework has considerable promise for its application to this area. The fourth reason relates to the fact that transaction costs is a broader concept than market failures (Arrow, 1969), which considers market failures as well as process based challenges in the supply and demand of animal health services

The paper is structured as follows: Section 2 develops the conceptual framework and explains how it is linked to existing frameworks. Section 3 interprets the existing literature in the context of the new framework with the goal of deriving hypotheses about the comparative advantage of different institutional arrangements for animal health service delivery. Section 4 discusses the empirical approach and presents results for the case of clinical services to test the hypotheses. Section 5 concludes.

2.2 A Transaction Cost Framework for analyzing veterinary service delivery

As indicated above, the framework developed in this section builds upon existing frameworks. Therefore, those frameworks are briefly reviewed first.

2.2.1 A review of analytical frameworks

The main analytical frameworks used to determine which animal health services should be provided by the public versus the priviate sector was published in 1994 by Umali et al. (1994). Their seminal contribution was the application of the concepts of public and private goods to animal health service delivery. A public good is defined in this literature as a good that is both non-excludable and non-rivalrous in consumption, implying that

individuals cannot be effectively excluded from its use (non-excludability) and that the consumption of the good by one individual does not reduce its availability to others (non-subtractabilty). Using these concepts, Umali et al. (1994) classified animal health services based the economic attributes of non-subtractability and non-excludability to determine whether a service is a public good or a private good. Subtractability occurs if the production or use of a service reduces the quantity of this service that is available to others, while excludability arises when only those who pay for the service benefit from it.

Table 2.1 Animal health services that should be provided by the private and public sector based market failures

Veterinary service	Public	Private	Economic Attribute of Veterinary Service
Clinical		✓	
Treatment & diagnosis of endemic diseases		✓	Private good
Diagnostic and treatment of epidemic diseases	✓		Public good with externality
Preventive			
Vaccination	✓		Public good (correcting free rider problem)
Vector control-ticks	✓	✓	Public good (correcting free rider problem)
Vector control-Tsetse fly	✓		Public good (correcting free rider problem)
Slaughter of animals (meat hygiene/inspection)	✓		Measure to correct moral hazard
Quarantine	✓		Measure to correct externality
Surveillance and regulation	✓		Public good
Public health	✓		Public good with externality
Production			
Research ,extension and training	✓	✓	Public private good
Breed improvement.	✓		Private good
Animal drug distribution		✓	Private good
Animal drug quality control	✓		Measure to correct moral hazard

Source: Ahuja (2004); Umali et al. (1994)

A veterinarian who diagnoses and treats an animal with endemic diseases has less time available to treat other animals and the benefits that arise from treating this animal only accrue to one livestock farmer. According to this reasoning, the treatment and diagnosis of a disease like Tryponamiasis is considered a private good and should therefore be provided by the private sector (see Table 2.1 below). Ahuja and Redmond (2001, 2004) expanded this framework by considering not only public goods attributes, but also externalities and moral hazard problems that are generated by a particular service. An externality is a cost or benefit that is not transmitted through prices and is incurred by a party who was not involved in the use or production of that service. Moral hazard arises

when both the livestock owner and veterinarian fail to effectively monitor the effort that the other devotes to the production of the contracted service (Leonard, 2000). Ahuja and Redmond recommend that those services that exhibit public goods attributes and produce externalities should be provided by the state and that those that exhibit private good attributes and produce no externalities should be provided by private service providers (see Table 2.1).

2.2.2 The transaction cost framework: An illustration

The framework presented in this paper is based on transaction cost theory as developed by Williamson (Williamson, 2005, 1991, 2000, 1989), and its application to agriculture, natural resource management and rural service provision by Birner and Braun (2009) and Birner and Wittmer (2004). The logic behind the application of the transaction costs paradigm is as follows: Veterinary services differ in their attributes (characteristics) and these attributes need to be identified to derive implications for the choice of governance structures. Although the literature on animal health service delivery identifies many institutional arrangements such as decentralization government structures, community animal health workers and para-veterinarians (paraprofessional) system, and cost sharing, this study considers the following three main service delivery systems: paraprofessionals, professionals and referrals for analytical purposes. Paraprofessional system is one with service providers having experience in animal health care but no formal training. They are often called Community Animal Health Workers (CAHWs) and are found mainly in marginal areas (Peeling and Holden, 2004). Animal Health Assistants (AHAs) with certificates or diplomas in animal health or general agriculture also belong to the paraprofessional system (Schneider, 2011, 2006). Professional system is one with services providers having degrees in veterinary medicine, while the referral or integrated system is one that links government veterinarians with private veterinary professionals, paraprofessionals and farmers.

These systems differ in terms the costs, accessibility, and quality of service offered. Applying Williamson's alignment hypothesis to this area suggests that veterinary services that differ in their characteristics should be aligned with a system or an institutional arrangement or governance structure, that "differ in their costs and competencies, so as to yield transaction cost economizing result" (Williamson, 1991; pp. 277). Following Williamson's concept that transaction costs are the costs of using a specific governance

structure (Williamson, 1979, pp. 243), transaction costs are defined here to include the costs incurred by a farmer accessing the service, failing to access the service (access failure costs), and an inadequate provision of the service (effort failure costs) such as costs relate antimicrobial resistance like repeat treatment costs for same case from a different service provider resulting from inadequate prescription and wrong diagnosis from the first service provider. In contrast, production costs include the costs of the drugs or vaccines and the cost of the labor of the service provider.

Access costs include transport costs, communication costs, opportunity costs of time spent by the livestock keepers, and, if applicable, bribes paid to access the service. Losses caused by delays in reporting a disease due to communication problems, such as (lack of access to mobile phones), are also access costs. Access failure costs include the loss due to the death of the animal as a result of failing to access a service, the reduction in milk yield and growth rates; and any reduction in the price of selling the animal or its products that result from failure to access animal health services. Effort failure costs arise if the livestock keeper has access to the service, but faces problems regarding the quality of the treatment, which is caused by information asymmetry (Leonard, 2000). Such costs arise due to delays, poor diagnosis, prescription of the wrong drugs, or the supply of sub-standard drugs by the service provider. Like access failure costs, these costs may include the loss of the animal or loss in weight and milk production that could have been prevented if the treatment was appropriate. Effort failure costs can also arise from diverting public resources for service delivery for private gains (embezzlement). For example, a government veterinarian may purchase vaccines that are not enough to vaccinate the target number of animals, but records the target number and uses the saved funds for his own purposes. It is important to note that "effort failure costs", as defined here, only refer to costs arising due to substandard performance or wrong-doing of the service providers. An animal may die even in the case of correct treatment. Such cases would not be considered to be an "Effort failure". Based on transaction cost economics, the magnitude of these costs vary depending on service attributes and animal health delivery system.

The hypotheses regarding the appropriateness or cost effectiveness of different animal health service delivery systems (governance structures) is illustrated in Figures 2.1 and 2.2 below. These diagrams illustrate a cost-effectiveness analysis (comparing the costs arising under different governance structures to produce a defined output). The rationale of Williamson's discriminating hypothesis is that governance structure (institutional

arrangement) A is considered to be more cost-effective than governance structure B or C if a defined output-in this case a service of defined quality that reaches a specified number of users-can be provided by governance structure A with lower costs than B or C. Hypothetical cost curves are used to analyze the comparative advantage of different governance structures by representing the total costs of producing the specified output under the different governance structures. Since the goal of selecting a governance structure is to minimize total costs, production and transaction costs have to be considered simultaneously. The attributes of the transactions, which influence the comparative advantage of different governance structures, are displayed on the horizontal axis, as in Figure 2.1 below (Williamson, 1991; pp. 284). A set of these attributes determines the appropriateness of these arrangements and will be discussed in Section 3, based on a review of the existing literature. In a cost-effectiveness analysis, the output is held constant. However, differences in service quality or in the number of livestock keepers with access to the service can be included in the analysis. Such changes are reflected as increased costs: reducing the number of livestock keepers served with a given level of resources is equivalent to increasing the resources needed (i.e., increasing the costs) to reach a given number of livestock keepers. The same consideration applies to the quality of service: reducing the quality of service provided with a given level of resources is equivalent to increasing the effort failure costs (the costs of providing substandard service).

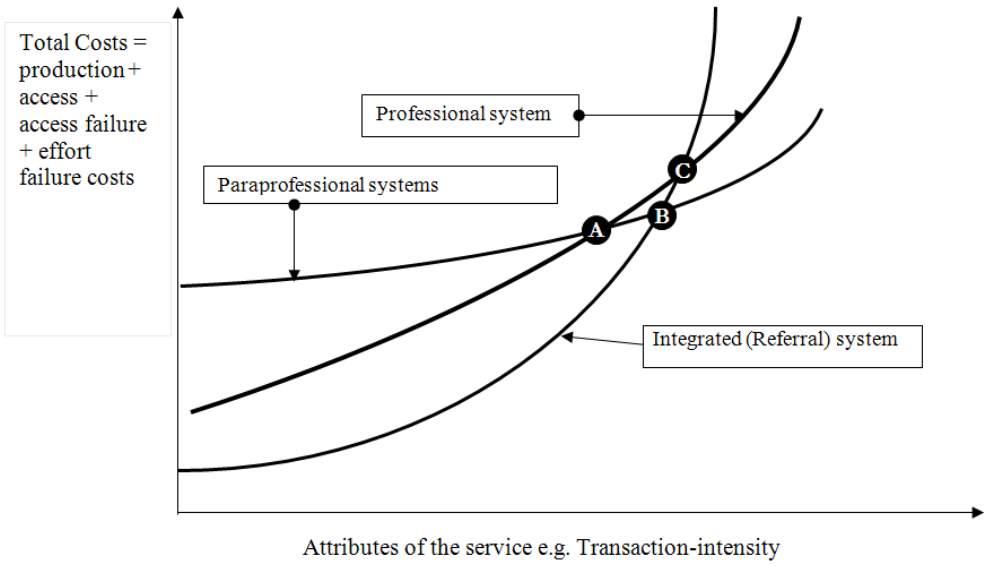

Figure 2.1 High transaction intensity and systems cost effectiveness.

Source: Adapted from Birner and Braun (2009, pp.292)

In Figure 2.1, the vertical axis indicates the total costs arising from the delivery of a specified animal health service, according to the above considerations. The horizontal axis displays those attributes that influence the cost-effectiveness of different institutional arrangements for service delivery. In a two-dimensional diagram, one can only consider the change in one attribute on the horizontal axis, while keeping all other attributes constant. However, the same considerations apply to all attributes that cause the same direction of change in the cost curves. As further discussed in Section 3, the attributes that matter for veterinary services include transaction and care intensity, measurability of the service, and state and community capacity. In Figure 2.1, we consider the attribute of transaction-intensity for illustration purpose.

Transaction-intensity refers to the extent to which a service requires a large number of activities (transactions) both with regard to time and space (Pritchett and Woolcock, 2004). For example, tick control is transaction-intensive with regard to both space and time because it has to be carried out for all animals in a region at regular time intervals. An annual vaccination campaign is also transaction-intensive in terms of space (all animals have to be covered), but not with regard to time (as it is only carried out once a year). If transaction-intensity is an important attribute for the provision of a particular veterinary service activity, one can hypothesize that the paraprofessional system has a comparative advantage over a professional or veterinarian system and a referral system. This is indicated in the slope of the hypothetical cost curve for paraprofessionals in Figure 1 above, which increases less than the slope of the cost curves for alternative governance structures as the level of the attribute transaction-intensity increases (moving from left to right on the horizontal axis). Points A, B and C are the equilibrium positions while the area above point A is a relative advantage of the paraprofessional system to professional system. Similarly, the area above point B is a relative advantage of the paraprofessionals to the referral or integrated system and the area above point C is relative advantage of the professional to integrated or referral system. If transaction intensity is low, the paraprofessionals system has a low comparative advantage over the other systems. The area below point C will be the point of relative advantage of an integrated system to the professional system; the area below point B will be a relative advantage point of integrated system to paraprofessionals and the area below point A will be the relative advantage point of the professional system over the paraprofessionals as shown by slopes of the costs curves.

Figure 2.2 represents the effect of contextual factors. For example, if paraprofessionals had veterinary training their performance and service quality would improve, and transaction costs would be reduced (Mugunieri and Irungu, 2002); thus shifting downward the paraprofessional curve (shift "A"). This shift causes the relative advantage point for the paraprofessional system over the integrated system to shift from point F to H. Similarly, the governance system can be made more effective if personnel management and regulation is improved, more staffs are recruited, and infrastructure is improved. Thus most diseases are reported, diagnosed, and effective control measures are taken up immediately (Ahuja et al., 2008). Subsequently, the integrated system's curve shifts outwards and downwards (shift "B") in Figure 2.2 and the relative advantage point of the government system to paraprofessional shifts from point F to G. If paraprofessionals are trained and legislation is strong, the equilibrium will be attained at point I. Point I is the relative advantage point of the integrated system to professional or improved paraprofessional system.

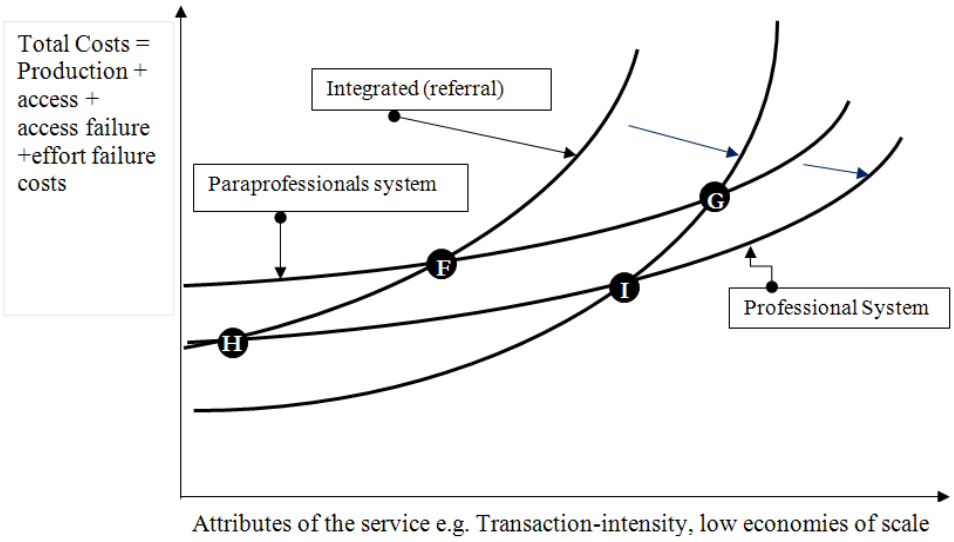

Figure 2.2 Contextual factors and systems cost effectiveness under transaction intensity.

Source: Adapted from Birner and Braun (2009, p.292)

2.3 A transaction cost framework: insights from the literature of animal health delivery in developing countries

The previous section illustrated the use of the transaction cost framework for analyzing veterinary services delivery based on the attributes of the transactions involved. In this

section, we discuss these attributes and contextual factors in more detail based on the existing literature. In this section, market failure attributes (such as externality and free rider problem) and governance attributes of animal health services (such as transaction intensity, discretion or care intensity, and service measurability) as well as contextual factors (such as community and state capacity) are discussed. Their ramifications on governance of animal health service delivery systems are examined and hypotheses regarding the appropriateness of these systems are generated. In Section 4, household survey data of clinical veterinary services in Uganda and Kenya is used to test the validity of the above hypotheses generated.

2.3.1 Externalities

Externalities are costs or benefits arising from a transaction that affect a different individual(s) or organization(s) other than those engaged in the transaction and are not reflected fully in prices. In other words, an externality occurs if the consumption/production of a veterinary service by one farmer or service provider affects another farmer's utility or service provider's ability to produce, without being fully and directly reflected by market prices (Merlo and Briales, 2000). For example, the benefits of a farmer vaccinating or spraying his or her animals accrue to another farmer who did not pay for that service because of reduced risk of exposure to his or her animal from neighbouring farmer vaccinating his or her animals. This is an example of positive externality (Ahuja, 2004; Umali et al., 1994). A negative externality occurs when a quarantine declared by the government inflict significant losses to actors other than farmers in the value chain, such as traders, slaughterhouses, casual labourer's, and butchers (Rich and Wanyoike, 2010). If a livestock health service generates an externality, an integrated system that involves key actors like farmers, paraprofessionals, veterinarians, NGOs, local leaders and government will have a higher comparative advantage than any other system. Coase (1960) argues that the optimal solution to an externality is a negotiated solution. The role of government would be to organize and enforce the solution. Empirical evidence from most developing countries including Ethiopia, Kenya, and Uganda reveals that during vaccination exercises, paraprofessionals, veterinarians (especially those from government), farmers, local leaders and non-governmental organizations are involved (Ilukor, 2012; Wolmer and Scoones, 2005).

Hypothesis 1*: *If a veterinary service is characterized by an externality, the integrated system has a comparative advantage over the paraprofessionals or veterinary professionals system.

2.3.2 Free rider problem

A free rider problem occurs if a member of the community or group who obtains benefits from the community or group does not contribute or bear a share of costs of the providing benefits (Albanese and Fleet, 1985). Unlike in the case of an externality, a free rider problem is generated directly by the affected agents or farmers. It is usually an acute problem in the collective provision of public goods or services (Stroup, 2000) because of low excludability and subtractability in consumption of public goods (Umali et al., 1994). Using an example by Umali (1994), farmers asked to contribute for aerial spraying to control the tsetse-flies, will shirk or avoid making such a contributions (Ahuja, 2004). Other examples of veterinary services for which the free rider problem can occur are quarantines and vaccination, if provided collectively. Due to the free rider problem, public goods and services are considered to be provided collectively, either through taxes and/or subsidies (Ahuja, 2004; Umali et al., 1994). Thus we can hypothesize that:

***Hypothesis 2*: *If a veterinary service is characterized by the free rider problem, the integrated system which has strong government backing has a comparative advantage over a paraprofessional, and a professional system*.**

2.3.3 Transaction intensity

Pritchet and Woolock define transaction intensity as the extent to which a service requires a large number of transactions and face-to-face interactions (Pritchett and Woolcock, 2004). This concept relates directly to Oliver Williamson concept of frequency of transaction (Williamson, 2005). As argued by Pritchet Woolock (2004) and Birner and Linacre (2008), transaction intensity is closely linked to economies of scale. Economies of scale refer to reduction or increase in the unit cost of providing a service as a number of livestock farmers served increases. If the unit cost of providing a service increases as the number served increases, the service is said to have low economies of scale. If unit costs

decreases as the number served increases, a service is said to exhibit high economies of scale. In animal health service delivery, low economies of scale arise from the indivisibility of transportation (fixed) costs incurred by service providers irrespective of the number of animals he or she will treat (Ahuja, 2004). They also arise from spatial spreading or the distribution of clients (livestock keepers) and from the frequency with which a service is demanded (Birner and Braun, 2009; Birner and Linacre, 2008; Pritchett and Woolcock, 2004). For services such as clinical services, breeding, extension, surveillance, and diagnostic services, the paraprofessional system will have a comparative advantage over professional and referral system because it is closer to farmers other factors kept constant.

Peeling and Holden (2004) observed in poor rural areas in Kenya, Tanzania, and Philippines that most farmers were of the view that although veterinarians provide better services due to better training, they were located too far from livestock-keepers to be accessible at reasonable costs (Peeling and Holden, 2004). Empirical evidence from productive areas of Kenya show that Animal Health Assistants are the predominant service provider at the farm level because they live closer to farmers and are therefore more accessible to farmers (Ndung'u, 2002; Oruko and Ndung'u, 2009). In state of Andhra Pradesh in India, Sastry and Raju (2005) found that paraprofessionals have a comparative advantage in the provision of clinical services and artificial insemination because they live in villages with farmers. These results are also supported by Kathiravan et al. (2011) who found that the average cost for travel and waiting time for using veterinarians were higher than those of using paraprofessionals for clinical and breeding services.

Hypothesis 3: *When a service exhibits high transaction intensity and low economies of scale, the paraprofessionals system has a comparative advantage over the referral and professional system.*

2.3.4 Care intensity

Care-intensive transactions or services require a service provider to be watchful, cautious and diligent (Birner and Wittmer, 2004; Fenoaltea, 1984; Pritchett and Woolcock, 2004) and relates to Williamsons concept of asset specificity (Birner and Braun, 2009). Care intensity can be measured in terms of the time spent waiting for the service provider after the first contact, the time the service provider spends with a farmer, and the number of

visits (Wennberg et al., 2009). As Leonard (2000) explains, livestock keepers are more concerned with effort, accessibility and timeliness of service providers over formal qualifications. Empirical evidence from the state of Tamil Nadu in India reveals that the waiting time for private veterinarians was highest, followed by government veterinarians and paraprofessionals (Kathiravan et al., 2011). Similarly, service time for paraprofessionals was higher than government and private veterinarians, indicating that paraprofessionals tend to provide more attention to farmers' needs and interests. In addition, because paraprofessionals are located closer to farmers, they can more frequently visits and monitor an animal's response to treatment, the probability of death, the in milk produced and animal weight loss is reduced thus reducing transaction costs. Accordingly, transaction costs curves for paraprofessionals will have a flatter slope the veterinarians.

Hypothesis 4*: *If a service is characterised with care-intensity, the paraprofessional system has a comparative advantage over the referral and veterinary system

2.3.5 Service measurability

Measurability refers to how difficult it is for people who contract a service to measure and predict the actions of the service provider because of uncertainty arising from limited knowledge of the person paying for the service (Brown and Potoski, 2003). The concept of measurability directly relates to the principal agent-problem that arises from asymmetric information and limited knowledge. Measurability attribute is related to Williamson's concept of asset specificity and uncertainty in that the animal health service providers (agents) are consulted because they have specialized knowledge or skills, but the principals (livestock keepers) cannot be sure that the service providers' skills and efforts are appropriate to solve their problem (Ly, 2003). Therefore, in repeated interaction, the principals may lose confidence and trust in the quality of the services offered by the practitioners especially if the outcomes of the transactions are bad. Consequently, principals may reduce their consumption of the services and they may only be prepared to pay an amount that is less than the value of the lowest-quality services available in the market (Leonard, 2000). As a result, a so-called "lemon market" arises. This theory was developed by Akerlof (1970) who used the term "lemon" to refer to sub-standard product. Phrased differently, a lemon market refers to a situation where the providers of services

that meet or exceed professional standards are driven out of the market by substandard service providers due to the problem of information asymmetry between service providers and clients.

In the provision of clinical services, for example, a livestock farmer has a limited capacity to determine with certainty the quality of care and effort that a service provider has employed (Leonard, 2000). If a farmer does not believe that the service provider is exerting sufficient effort based on previous experience or experience of someone in his or her network, he may be unwilling to pay for the service and may decide to change to another service provider. If he has limited options, he may either resort to self-treatment or selling the animal at a lower price (Mockshell, 2011) or obtaining poor quality service at a lower price. This may result in drug abuse and resistance, in animals thus increasing costs and losses to farmers as well as hospitalization costs for humans who develop antimicrobial resistance from consuming animal products from those animals (Wang et al., 2012). Clinical services and other services, such as quality control of drugs, and vaccine development, which require expert knowledge, will need to be provided veterinary professionals. However, if a service requires less expert knowledge to assess its outcome, such as tick control, and breeding, paraprofessionals can be more cost-effective.

Hypothesis 5**:** *With high measurability, professionals will have a comparative advantage over paraprofessionals.*

However, most services such as disease surveillance and reporting and treating of epidemic diseases, require both local and expert knowledge. For such transactions, an integrated or referral system will have a comparative advantage. For example, farmers and paraprofessionals can observe the signs of an outbreak of Riderpest, but expert knowledge is required for an accurate evaluation. Equally, clinical services which have low economies of scale, high transaction intensity, and high measurability will require an integrated or a referral system.

Hypothesis 6**:** *If a service exhibits a mix of high measurability, externality, care and transaction intensity, an integrated or referral system has a comparative advantage over the professional and paraprofessionals.*

2.3.6 Scope of corruption (state capacity)

Scope of corruption refers to the extent to which an officer is likely to use public resources and power entrusted to him or her for personal gains. This problem is manifested in four ways: (1) demanding bribes, (2) stealing or misuse of public resources, (3) elite capture and (4) influencing peddling (Shah, 2007). In the state of Karnataka in India, where veterinary clinical services and vaccination are offered freely by the government, 33% of the users paid for the services, 16% reported paying bribes of $2 (Vivekananda et al., 2010). In Uganda, a report by the Economic Policy and Research Centre (EPRC) revealed that in a Tsetse fly control project, $20,975 was recorded to have been released to Pallisa district in 2006, but information at Pallisa district indicates that only $1,044 was received and the rest was not accounted for (EPRC, 2009). The results for 2007 indicate that funds were expended on behalf of the districts by the district administration for provision of administrative goods and services rather than tsetse control (*ibid*). Moreover, no accountability was presented for the funds even for those expenditures.

The scope of elite capture is predominantly a problem in the decision-making process by local and central governments and is aggravated by the problem of "rational ignorance" where livestock keepers or voters do not always know what the government and its opposition are doing to serve their interests, because getting that information is costly (Downs, 2011, 1957). Vu (2007) presents two interesting examples: In Thailand government rejected vaccination against avian influenza and opted for alternatives like a ban on fowl transport and the insertion of microchips in fighting cocks which benefitted exporting firms owned by mainly politicians (Vu, 2007). The second example is a case of bird flu outbreak detected in July 2003 in Vietnam. The government never publicized it and adopted a policy of quiet containment until the situation became out of control (Vu, 2007). In Uganda, politicians have been observed intervene in providing preventive services based on the electoral schedule to please different interest groups. The director of animal resources at ministry of agriculture noted that local politicians support traders to defy quarantines (see Otim, 2011a; Wetaka, 2011; Monitor, 2012) and veterinarians are sent on forced leave to pave way for lifting quarantines. When the president's intervention is thought, he responds after elections. For example, they had petition the president to direct local politicians not to interfere with the implementation of quarantines early 2011

but the president intervened in January 2012, after the 2011 elections (Presidents Office, 2012).

The above example provides evidence that, when scope of corruption and elite capture is high, there no clear cut solution. Nonetheless, an integrated system where professional veterinarians, civil society, and government engage with each other may be appropriate. As Sabin and Dehaven (2012) argue, a well-educated animal health workforce will be better poised to actively advance good governance practices of accountability and transparency, thus minimizing corruption. However, professional veterinarians in most developing countries work in government. The civil society is needed to check the activities of the government officials and politicians and build the capacity of the community to demand better services (White, 1994).

Hypothesis 7*: *If the scope of corruption is high, an integrated system has high comparative advantage over veterinary professionals and paraprofessionals.

2.3.7 Community attributes or community capacity

Community attributes refer to social economic attributes of society or local governments that affect service delivery (Rose-Ackerman, 2007). These factors may include the ethnicity and education level of service providers and farmers, availability of infrastructure, community's collective action capacity, and the respective livestock production system. Ethnicity and education level of service providers is relevant in facilitating communication between a service provider and the farmer (Rushton, 2009) as well as building trust between a farmer and service provider (Oruko and Ndung'u, 2009). However, education levels in pastoral communities are low, and veterinarians who are hired by government are often from different ethnic backgrounds and cannot speak the same language as the farmers. In addition, veterinarians posted to these areas are often reluctant to work there (Hassan, 2003). Positions for the veterinarians are advertised, but no or few applications are received because pastoral areas have poor transport, communication, housing infrastructure, and the area is often insecure (Watson, 2008). As a result, there are very few veterinarians in such areas. Consequently, paraprofessionals have a comparative advantage in such areas relative to veterinarians because they can survive under above environment (Peeling and Holden, 2004). However, most paraprofessionals

are not well educated and not trained for the job, resulting in drug abuse and increased drug resistance (Mugunieri et al., 2004). An integrated system of veterinarians and paraprofessionals may have a comparative advantage since it can avoid these problems. In fact, a veterinarians in the Karamajong region in Uganda remarked during our field work that he often ask the community animal health workers, especially those he has trained to substitute for him when he is out of station.

Another important community factor is the community's collective action capacity which is often measured by membership in veterinary association and participation of community members in farmer groups, cooperatives, and service provider associations like CAHWs associations. Community groups and institutions help establishing and strengthen social networks which can serve as communication channels for gathering new knowledge and information regarding the control of diseases (Ireland and Thomalla, 2011). Groups also help in redressing or reducing the scope of corruption and elite capture (Dasgupta and Beard, 2007) and enable farmers or citizens to pool their resources together to minimize production risks (Ireland and Thomalla, 2011). For example Githunguri Dairy cooperative in Kenya has overcome perceived risks of inadequate quantities of milk, the problems related to milk collection, transportation and processing and have widened their market share. This has increased farmer income and their capacity to seek services from private veterinarians and Paravets (FAO, 1999). Empirical evidence from Uganda show that areas with high community collective action capacity have reduced poverty rates (Kwapong et al., 2012).

Hypothesis 8*: *If the community capacity is high the comparative advantage of veterinary professional's increases relative to paraprofessionals. Paraprofessionals could only benefit by working together with veterinary professionals.

The transaction cost approach described above shows that in terms of cost-effectiveness, the market failure theory is useful, but not sufficient in analysing institutional arrangements or systems for providing animal health services. The sufficient condition requires that both governance factors together with market failures should be considered in the analysis of animal service delivery. From the market failure literature, two attributes have been identified: externality and free rider problem. The ramifications of

these attributes for the delivery of animal health services are quite clear and discussed in Ahuja (2004) and Umali et al.(1994). For example, when a free rider and externality problem is high, the more appropriate system is the integrated system. In the case of the two governance attributes of care and transaction intensity in both space and time, the more relevant they are, the more appropriate system would be the paraprofessional system assuming that other factors are held constant. Measurability and high scope of corruption require veterinary professionals with technical knowledge. However, most veterinary professionals are work in the government, so they are susceptible to political interference. Moreover, they are poorly facilitated to perform their task. Therefore, an integrated system would be more appropriate than other systems. The approach also hypothesizes that veterinary professionals would gain a comparative advantage if community capacity to demand animal health services improves.

2.4 Empirical Analyses

In this section, the paper uses data from a household survey in Uganda and Kenya to test these hypotheses by considering a case of clinical services. The data was collected from pastoral livestock production districts of Amudat in Uganda and North Pokot in Kenya as well as intensive production producing districts of Mukono in Uganda and Kiambu in Kenya. The sampling design employed was two-stage clustered sampling. The respondents were clustered based on districts and randomly sampled from lists of farmers who participated in routine vaccination exercise in each district in the same year. Since the target of routine vaccination exercises is all farmers keeping livestock in the district, the sampling frame was taken as exhaustive. A total of 476 livestock farmers were interviewed. The information collected relates mainly to governance and community attributes discussed above and the summary statistics of the data variables are represented in Table 2.2 below. The results generally show that 52% of the farmers treated the last cases in their farms by themselves, 31% used services of paraprofessionals and only 17% used services veterinarians.

Table 2.2 Means and Standard Deviation of selected variables for clinical veterinary services

Variable	Description	Mean	Std. Dev.
Service System			
Veterinarian	1 if a farmer used the veterinarian service in the last case treated in his/her farm, 0 otherwise	0.172	0.378
Paraprofessional	1 if a farmer used the veterinarian service in the last case treated in his/her farm, 0 otherwise	0.309	0.462
Self-treatment	1 if a farmer treated last case in his/her farm by himself or herself, 0 otherwise	0.519	0.500
Service attributes			
Experience	A farmers experience in keeping livestock in (Years)	16.498	14.640
Education	Education level: 1=No-education, 2=Primary, 3= High school, 4=Certificate 5=Diploma ,6=Degree	1.868	0.874
Skills	1 if a farmer has knowledge on methods of treating the recently treated diseases, 0 otherwise	0.445	0.498
Records	1 if a farmer keeps farm records, 0 otherwise	0.166	0.372
Epidemic disease	1 If the recently treated animal disease in the farm is an epidemic disease, 0 otherwise	0.410	0.492
Disease frequency	Frequency with which the disease occurs in a year	6.137	12.960
TLU	Total Livestock Units in a given household	10.346	16.468
Numpp	Number of farmers present when the animal was being treated	1.679	8.076
Waiting-time	Time taken by livestock service provider to come to attend the case (Hours) including travel time	2.236	6.218
Time-spent	Time spent by livestock service provider with the farmer (Hours)	0.551	0.804
Cash objective	1 if the objective of keeping livestock is for cash, 0 otherwise	0.557	0.497
Improved livestock	1 if a farmer if a farmer keeps improved livestock , 0 otherwise	0.357	0.480
Contextual factors			
Bank account	1 if a farmer has a bank account, 0 otherwise	2.784	1.190
Credit	1 if a farmer used credit for farming purpose in the previous year, 0 otherwise	0.153	0.361
Phone	1 if the phone is the means of contact with livestock service providers, 0 otherwise	0.479	0.500
Group	1 if a farmer is a member of a livestock farmers association, 0 otherwise	0.300	0.459
Country	1 if a farmer is from Uganda, 0 for Kenya	0.431	0.496
System	1 if a farmer is from pastoral systems, 0 Intensive system	0.498	0.501
Avail_para	1 if a farmer ranked paraprofessionals as available, 0 otherwise	0.496	0.500
Avail_vet	1 if a farmer ranked veterinarians as available, 0 otherwise	0.269	0.444

2.4.1 Measurements

As noted by David and Han (2004) and Carter and Hodgson (2006), there are extensive measurement problems in the empirical analysis of transaction costs economics because of lack of unanimity on the measurement of variables. Because of this limitation, most empirical studies in transaction economics apply proxy variables to specific attributes (Battu et al., 2002; McMaster and White, 2013). For example, Battu et al. (2002) proxied labour specificity with job tenure, and membership in trade unions. In this study, the

service of interest is clinical services. This proxy variables are used to test the hypotheses generated in the previous sections and demonstrated the application of Oliver Williamson discriminating alignment approach in animal health service delivery.

In the provision of clinical services, the treatment of contagious or highly epidemic diseases in one farm produces a positive externality because it reduces the risk of the disease spreading to other farms. As a result, disease type can be a proxy variable for externality. Transaction intensity is proxied by the frequency with which disease occurs in the farm and the total livestock units. Number of community members or neighbours present during the treatment of the animal was also considered as a proxy of transaction intensity because as Leonard (2000) noted, half of the business for service providers comes from requests from farmers in the community after reaching the on call from the another farmer. This concept relates to trust and strong social ties resulting from being known to the farmers. If you are a known service provider, when you appear in village, then others farmers will come around. In human medical care, Wennberg et al. (2009) consider time spent with a patient and time spent waiting for the service provider after first contact as proxies for care intensity. In this study, care intensity was proxied by the time that the service provider spends with the farmer, takes to respond to the case and the type of livestock kept (improved or local). Harris and Newman (1994) observed that the objective of farmers who keep improved breeds is to maximize profits through increased milk production. Milk production efficiency is associated with increased incidence of metabolic disorders, impaired fertility and other health problems such as digestive disorders, skeletal disorders, and mastitis (Rauw et al., 1998). Managing these problems requires technical skills that farmers do not possess and therefore they would need to use service providers. However, as Rauw et al. (1998) argue, undesirable effects resulting from increased milk production efficiency require a lot of care, consciousness, and diligence. This means that a service provider should be located close to a farmer, be easily available and willing to spend a lot of time closely monitoring the welfare of the animal. For these reason, the type of livestock is a proxy for care intensity.

Measurability attributes is also proxied by type of disease and the farmer's experience of keeping animals, educational and record keeping. Epidemic disease treatment always requires special skills and resources that paraprofessionals may not possess. Koma (2003) observed that veterinary professionals in Uganda are mainly consulted to handle tasks that require special skills or when the animal fails to respond to

treatment. Education and experience of a farmer reduces the principle agent problem and Williamson's bounded rationality problem. Thus, farmers with experience and better education will tend to use services of veterinary professionals (Irungu et al., 2006). Hall et al. (2004) contend that recording extension effort, such as health management, helps to reduce imperfect information and enables farmers to gain a better understanding of animal health management skills.

In clinical service delivery, proxy variables regarding the scope of corruption are difficulty to capture for two main reasons: (1) Clinical services were privatized and not provided by the government and (2) because clinical services are under the private sector, the other form of corruption in clinical service delivery is the over prescription of drugs to increase sales. This information is difficult to capture using surveys and self-reporting by farmers and service providers. The empirical test of the hypothesis generated under corruption is difficult for clinical services based on surveys, but can be tested for other services such as vaccination, quarantines, and meat inspection, that are provided by government. In any case, the empirical examples cited in the literature review should provide appropriate insights for the hypothesis regarding corruption. However, in this study we use availability of veterinarians and the nation or country variable as a measure of state capacity. Jarman et al. (2011) suggest that the capacity country's veterinary system depends on the on availability of veterinarians and level of state engagement in the provision of veterinary services. A number of other contextual or community factors were also identified and include membership in a livestock farmer association, having a bank account, and phone ownership.

2.4.2 The model

The interest of this paper is to determine the service attributes and contextual factors that influence the choice of a given system in the provision of animal health services. Using the case of clinical services, the study seeks to analyze the hypotheses generated from the literature review using the Williamson discriminating alignment hypotheses. The service attributes and contextual factors are indicated in Table 2 are the independent variables, while the dependent variable is the choice of the service delivery system. Given the binary nature of such choices, qualitative choice models are appropriate for analyzing these relationships. The most commonly used models in analyzing such relationships in the new institutional econometric analysis are the probit and logit models (Sykuta, 2008). In most

applications, the choice between the two models does not make a difference (Greene and William, 2007).

As noted by Sykuta (2008), the nature of questions which transaction costs economics theory addresses, presents fundamental problems to statistical modeling. These problems include the "fallacy of dichotomous choice", endogenous decision making, and self-selection. The fallacy of dichotomous choice arises when two or more systems are used instead of one. We therefore examine three separate models representing the use of different service providers: the farmer (self-treatment), veterinary, and paraprofessional. In clinical veterinary services, this could arise in two ways: (1) a farmer can decide to consult with a paraprofessional or a veterinarian and then the farmer buys the drugs treats the animal himself, (2) a farmer uses the services of a paraprofessional and the paraprofessional consults a veterinarian before treating the animals. This poses a problem of determining outcomes of the dependent variable (choice of the system). In the case of the first problem, in this study, if a farmer treats the animal himself using modern or local medicine or if a farmer consults with a service provider and then decides to treat the animal himself, this is considered self-treatment (y=1 and 0 otherwise). In the case of the second problem, a farmer is considered to have used a service of paraprofessional or veterinarian if the paraprofessional or the veterinarian treated the animal irrespective of whether he was consulted or referred to (the dependent variable representing if the veterinarian or paraprofessional was the service used equals to one and 0 otherwise).

Endogeneity problems arise because choice or use of paraprofessional or the veterinarian services depends on the availability of veterinarians or paraprofessionals respectively and their availability. To circumvent this problem of endogeneity, a two-step procedure described in Rothe (2009 and Dong(2010) was used to correct for the endogeneity problem. In the first stage, perceptions about the availability of service providers are estimated using a reduced form probit model that includes contextual factors or production system variables, which influence both the availability and use of the services of animal health service providers and the residuals were extracted. The estimates of the regressor and the extracted residuals were used in the second stage to estimate structural equation as control variables to the estimated equation. Both the structural and reduced form equations were estimated using maximum likelihood probit with robust standard errors. The coefficients of the first step errors for veterinarian availability ***(Errorvet)*** and paraprofessional availability ***(Errorpara)*** as shown in Table 4, were

positive and significant with use of veterinarian and paraprofessional services respectively. This suggests that availability of service providers is endogenous in the structural equation and the unobserved variables that affect use of the service provider's services also increases their availability.

Formally, the two step probit model is:

$$y_{1i}^{*} = \beta y_{2i} + \alpha x_i + \mu_i; \;\; y_{1i} = 1 \;\; y_{1i}^{*} > 0, 0 \; otherwise$$

$$y_{2i} = \pi z_i + \varepsilon_i$$

where i = 1,….., N and variable y_{1i} represents aspects that influence the choice of a service provider captured as a dummy variable which takes the value of one if the farmer used the services of a particular service provider and zero otherwise. The variable y_{2i} is vector of endogenous variables, x_i is a vector of exogenous variables, and z_i is a vector of some the variables in x_i. The equation y_{2i} is expressed in reduced form and β and α are vectors of structural parameters, while π is a vector of reduced form parameters.

According to Dong(2010), the use instrumental variable which is outside the model is generally preferrable than using the one within functional form. However, in the absence of the good instrument, endogeneity can be controlled using a two-step approach (Dong, 2010; Rothe, 2009). In this particular case, we tested different instruments including production system and country of farmers but both the the Sargan-Hansen test and Hansen's J statistic revealed that the instruments are not valid. Therefore, a two-step approach was most suitable alternative. Another concern with regards to this study is that of sampling design chosen. Since, we used one stage clustered sampling where districts were clusters and farmers sampled using simple random sample, probit models with and without cluster weights were estimated. The standard errors of probit model without cluster weights were much larger than those of the model with cluster weights. So, we estimated probit model with cluster weights and robust standard errors. Finally, we also checked for collinearity of variables included in the structural model. The variance Inflation factor (VIF) for all variables including the error terms from the first step regression were below 10. This suggests that collinearity was not a problem.

2.5 Results

Results from empirical analyses are presented in Tables 2.3 and 2.4. The log-likelihoods in all models exhibit robustness of the models. Table 2.3 contains results from reduced form estimation about farmers' perceptions regarding the availability of service providers. Results show that the availability of service providers significantly varies with system of production and country. Uganda as opposed to Kenya has a negative relation with availability veterinarians and a positive relationship relation with availability of paraprofessionals. Based on Jarman et al. (2011) observation that the countries veterinary system depends on availability of veterinarians, it can be deduced that Uganda's veterinary system weaker than the Kenyan systems. This can be attributed to variations in the degree or level of privatization and state involvement in provision of veterinary and agricultural services in general. Earlier studies by Bennell (1997) and Jayne et al. (2002) reveal that Kenya did not completely adopt privatization policy as compared to Uganda. The system variable has a negative coefficient with the availability of both paraprofessionals and veterinarians suggesting that pastoral livestock production systems have inadequate animal health service providers relative to intensive livestock production systems. This finding supplements the existing literature on inadequate or limited numbers of animal health service providers in the pastoral areas (see Ahuja, 2004; Catley et al., 2004; Admassu et al., 2005)

The availability of paraprofessionals was found to have a negative relationship with availability of veterinarians and the availability of veterinarians was found to have a negative relation with the availability of the paraprofessional, suggesting a competitive relationship between veterinarians and paraprofessionals. Having a phone is positively associated with the availability of the veterinarians, but has no significant association with the availability of paraprofessionals. This suggests that veterinarians are more easily available in areas with mobile network coverage while mobile phones do not affect availability of paraprofessionals because they are nearer and could be visited in person. As expected, results indicate that in pastoral areas, paraprofessionals have a comparative advantage than veterinarians.

Table 2.3 A reduced form probit models for availability of veterinary service providers

	Availability Paraprofessional			**Availability of Veterinarians**		
Variable	**dy/dx**	**Std. Err.**	**Z**	**dy/dx**	**Std. Err.**	**z**
Account	-0. 017	0.023	-0.73	-0.001	0.017	-0.58
Credit	-0. 015	0.067	-0.22	-0.007	0.051	-0.14
Phone	0. 107	0.069	1.54	0.203***	0.052	3.93
Group	0.075	0.052	1.45	0.007	0.041	0.18
Country	0. 111***	0.041	2.69	-0.123***	0.032	-3.79
System	-0.331***	0.064	-5.86	-0.295***	0.054	-5.44
Avail_para				-0.282***	0.032	-8.74
Avail_vet	-0.416***	0.050	-8.24			
Number of obs = 476				**Number of obs = 476**		
LR chi2(8) = 136.42				**LR chi2(8) = 221.05**		
Prob > chi2 = 0.0000				**Prob > chi2 = 0.0000**		
Pseudo R2 = 0.2067				**Pseudo R2 = 0.3986**		
Log likelihood = -261.71297				**Log likelihood = -166.58779**		

Significance level: *p<0.05, **p<0.01, ***p<0.001

The empirical results from the structural equation are presented in Table 2.4. The test of significance is the Wald Likelihood ratio test, which follows a chi-square distribution with 3 degrees of freedom and z test with a 5% significance level. The models for the use of a veterinarian, a paraprofessional as well as self-treatment are statistically significant *(P<0.0001).* From Table 2.4, it is apparent that variables for measurability attribute such as disease type, experience, skill, education, and keeping records, are positive and statistically significant in influencing the use of veterinarian services. However, experience, skill, education, disease type and keeping records have a negative and statistically significant influence on the use of paraprofessional services. These results suggests that possession of skills and experience, education and recording keeping positively influence the use of veterinarian services compared to paraprofessional services. These results support hypothesis 5, which states that with high measurability, the veterinarians (professionals) will have a comparative advantage over the paraprofessionals.

Table 2.4 A probit regression models for the use of veterinarian, paraprofessional and self- treatment system of providing veterinary services

Systems	Veterinarian		Paraprofessionals		Self-treatment	
Variables	**dy/dx**	**Std. Err.**	**dy/dx**	**Std. Err.**	**dy/dx**	**Std. Err.**
Age	0.000	0.001	-0.002	0.001	0.001*	0.001
Experience	0.004***	0.000	-0.003***	0.001	0.000	0.001
Education	0.073***	0.023	-0.047	0.032	-0.029	0.015
Skills	0.033*	0.016	-0.102***	0.031	0.077***	0.017
Records	0.137***	0.029	-0.170***	0.054	0.002	0.033
Epidemic disease	0.156***	0.032	-0.122**	0.046	-0.062	0.038
Frequency	-0.003	0.003	0.001	0.001	-0.001	0.001
TLU	-0.007***	0.002	0.002**	0.001	-0.001***	0.000
Numpp	-0.001***	0.000	0.001*	0.001	0.000	0.000
Waiting-Time	0.006***	0.002	-0.001	0.002	-0.007*	0.003
Time-spent	-0.035	0.025	0.112***	0.016	-0.074**	0.026
Improved livestock	-0.100***	0.043	0.118***	0.026	-0.023	0.025
Account	0.022***	0.003	-0.038***	0.005	0.010	0.008
Credit	-0.060**	0.023	0.074*	0.033	0.009	0.017
Cash objective	0.079***	0.017	-0.102***	0.028	0.018	0.013
Phone	0.054	0.056	0.012	0.121	-0.003	0.054
Group	-0.019	0.045	-0.068**	0.026	0.018	0.016
Gender	0.014	0.018	0.014	0.014	-0.017	0.014
Nation	-0.020	0.067	0.078*	0.043	-0.014	0.018
Avail_para	0.689	0.419	0.445***	0.058	-0.414*	0.174
Avail_vet	0.370***	0.048	0.427**	0.160	-0.403**	0.050
Errorvet	0.431*	0.176	0.056	0.080	-0.175	0.104
Errorpara	-0.014	0.067	0.198**	0.068	-0.113***	0.013
N	476		476		476	
Prob>chi2	0.0000		0.0000		0.0000	
Log pseudolikelihood	-364.335		-46.568		-259.965	
Wald Chi2(3)	136.71		138.10		211.12	
Pseudo R2	0.4251		0.4276		0.6993	

Significance level: *p<0.05, **p<0.01, ***p<0.001

The proxy variables for transaction intensity, such as the number of community members (farmers) or neighbours present during the treatment of the animal and the total number of livestock units, have a significant and negative influence on the use of veterinarian services, but have a positive influence on the use of paraprofessional services. The total livestock unit decreases the probability of using veterinarian services because the probability of animal falling sick is high (Hill et al., 2009). This translates to increased

frequency of transaction and transaction costs. The number of farmers present in treatment of the animal increases probability of using a paraprofessional services because they are known to the farmers as opposed to veterinarians thus, increasing the economies of scale for paraprofessionals relative to the veterinarians. These results support hypothesis 3 which states that when a service exhibits high transaction intensity and low economies of scale, the paraprofessionals system has a comparative advantage over the referral and professional system.

Care-intensity variables, such as waiting time, were found to positively influence the use of veterinarian services and negatively influence the use of paraprofessional services, suggesting that when farmers contact veterinarians, veterinarians tend to respond more quickly than paraprofessionals. This suggests that professional veterinarians are more responsive to farmers' needs than paraprofessionals thus countering hypothesis 4. It is also possible that the waiting time is not a correct proxy for care-intensity because it could mean that veterinarians do not have many customers and can afford to reach the farmers faster. Therefore, waiting time could be a good proxy for transaction intensity. However, the service provider's time spent with the farmer and if a farmer keeps improved animals positively influence the use of paraprofessionals but negatively influence the use of veterinarian services. These results suggest that, even if veterinarians take a shorter time to respond to farmers, they cannot provide farmers with adequate attention and care. These results confirm our hypothesis 4 that when a service has the attribute of care-intensity, the paraprofessional system has high comparative advantage over the veterinarian system.

Community capacity and particular farmers' characteristics, like having bank account and keeping livestock for cash or commercial purposes, positively influence the use veterinarian services and negatively influence the use of paraprofessional services. This suggests that a veterinarian system may not survive in pastoral areas which lack banks or financial institutions and where livestock is kept mainly for food rather than cash. Group variable was found to negatively influence the use of paraprofessional services but no evidence exists to support that it influences the use of veterinarian services. Overall, these results support hypothesis 8, which states that; if the community capacity is high the comparative advantage of veterinary professional's increases relative to paraprofessionals. Paraprofessionals could only benefit by working together with veterinary professionals.

The country or nation variable was found to positively influence the use of paraprofessionals services, but no significant evidence exists to suggest that the country

variable influences the use of veterinarian services. This is probably because paraprofessionals are more available in Uganda as opposed to Kenya as shown by the results in Table 2.3. The non-significant evidence for use of veterinarian services and country could mean that veterinarians involved in provision veterinary services are few in both countries. Another very important result from these models is that, availability of paraprofessionals' increases the use of the veterinarian services and the availability of veterinarians' also increases the use of the paraprofessional services, suggesting the existence of synergistic relationship between paraprofessionals and veterinarians. This result demonstrates the need to develop a referral system and the importance of the referral system in improving state capacity to provide public veterinary services.

2.6 Conclusions

Previous analytical frameworks for animal health service delivery have mainly focused on the theory of market failures. This paper has gone an extra step to include governance factors and to demonstrate the application of Williamson's transaction costs theory or discriminating alignment approach to animal health service delivery. The approach enables us to integrate insights from market failures, governance, and livestock production system attributes and provides a lens for analyzing and addressing governance challenges in animal health service delivery. Empirical results show that paraprofessionals, such as community animal health workers are desirable because the offer the needed care and attention to clients since they are located closer to clients and thus have lower transaction costs and may be trusted more by farmers. However, for services that require technical expertise, veterinarians will be more cost effective than paraprofessionals. Moreover, a referral system may be preferable and significant in building state and community capacity to provide veterinary services.

The limitation of applying Williamson's discriminating alignment hypotheses to animal health service delivery is that veterinary services have a mix of attributes. For example, clinical veterinary services are transaction and care intensive and require high technical skills. Therefore, it becomes challenging to align a particular service to a particular system. Moreover, the contexts in which services operate vary greatly. Nevertheless, the insights we gain from this approach is that it is not enough to categorize animal health services in terms of public and private goods. Doing so ignores governance attributes that ensure continuity and sustained service delivery, as well as variation in

technical competences of the service providers and the quality of veterinary services offered to livestock farmers. Such categorization of services into public and private assumes that the private sector can attract skilled service providers and that users are able to measure the quality of the services provided by these service providers. As experience has shown, trained veterinarians in most developing countries are found in the government sector. Even in the public sector, a limited number of trained veterinarians are willing to work in pastoral livestock production systems which have high livestock populations, given their remoteness. Worse still, corruption and misuse of public funds has completely undermined government capacity to provide veterinary services.

In light of these observations, a solution lies in improving paraprofessional and veterinary relations through referral arrangements. As the results indicate, the use of veterinarian services is positively related to the availability of paraprofessional services. How referrals between veterinarian and paraprofessionals can be improved is a topic beyond the scope of this paper. Nevertheless, we recognize the importance of a synergistic relationship between veterinarians and paraprofessionals. Promotion of one system without the other reduces the use of the other system. Veterinarians are required for their technical expertise, while paraprofessionals are important because their availability to farmers. Therefore, governments of developing countries need to develop an integrated animal health care system consisting of government and private veterinarians and private paraprofessionals together. This would build state capacity and enable animal health markets to flourish.

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3 THE PROVISION OF VETERINARY SERVICES: WHO ARE THE INFLUENTIAL ACTORS AND WHAT ARE THE GOVERNANCE CHALLENGES? A CASE STUDY OF UGANDA

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Abstract: As a result of continued fiscal challenges from late 1980s to date, the government of Uganda liberalized and decentralized the provision of veterinary services. As a result, many actors are involved in providing veterinary services without adequate regulation and supervision. With the resurgence of infectious diseases, increased economic and health risks especially to the rural poor, there is need to understand relational patterns of actors to ensure good governance and address emerging and re-emerging animal diseases risks. A participatory mapping tool called Process Net-Map was used to identify the relevant actors and assess their influence in the delivery of clinical and preventive veterinary services in both pastoral and intensive livestock productions systems. The tool also serviced to elicit governance challenges in veterinary service delivery. The results reveal that important social relations in veterinary service delivery include the following: (1) cooperation between private veterinarians and paraprofessionals, as well as private veterinarians and government veterinarians in intensive production systems; and (2) cooperation between NGOs, government veterinarians, and community based animal health workers (CAHWs) in the pastoral areas. Staff absenteeism, insufficient and unpredictable budgets, weak legislation, exclusion of technical staff from the decision making process and policy illogicality were identified as major governance problems veterinary service delivery. The paper concludes that given the existing fiscal challenges, the key to improving animal service delivery in Uganda is getting priorities, policies and institutions right.

Keywords: *Curative Services and Preventive Services, Process Net-Map Tool*

3.1 Introduction

The Government of Uganda adopted structural adjustment programs in the 1980s and early 1990s. This resulted in the decentralization and privatization of clinical veterinary services and the downscaling of the civil service (Haan & Umali, 1992). Clinical services, breeding and spraying for tick control were privatized, while vaccination of animals against epidemic diseases, quarantines and tsetse control were retained under the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). The purpose of these reforms was to reduce the costs of the public administration and to cut public expenditure. Although the share of public administration costs as a proportion of public expenditure declined, this effect was offset by the following problems: First, there was an increased cost of budget financing resulting from a significant increase in interest rates caused by the increase in public budgetary support and the inflow of foreign aid (Lister et al. 2006). Second, the creation of additional districts under decentralization resulted in increased public expenditure and stressed the capacity and accountability of both local governments and the central government. Corruption and financial indiscipline have also become serious problems, undermining the partnership between government and donors (Lister, 2006). These problems also affected the financing of veterinary service delivery, thus weakening the governance of veterinary services. However, studies that examine the nature of these governance challenges and the actions and motivation of actors involved in the provision of veterinary services are limited, despite the need to identify critical intervention points in animal disease control (Rich & Perry, 2010; Schwabenbauer, 2012).

This study applies Social Network Analysis (SNA) to examine the governance problems and identify influential actors in the prevention, treatment, and control of animal diseases. Social Network Analysis has become an important approach for analyzing governance problems in health systems because many of problems with the provision of health care are relational (Luke & Harris, 2007). For example, Blanchet & James (2012) have used SNA tools to examine health care systems in Ghana. Provan et al. (2003) have also applied these tools to assess inter-organizational collaboration in disease prevention and health promotion.

Most of the social network analysis studies use mathematical processes to estimate structural measures of centrality such as “degree”, “betweenness”, and “closeness” and “centrality” to examine actors’ perceived influence or power (Borgatti, 2005; Freeman, 1979; Stephenson & Zelen, 1989). While potentially useful, these measures often turn out

to be confusing and contradictory or non-consistent (Freeman, 1979; Stephenson & Zelen, 1989). They do not account for the fact that the behavior, decisions and interests of actors are socially determined (Krackhardt, 1987; Mizruchi & Potts, 1998). For example, if peripheral actors are able to directly influence one another, the central actor becomes the least powerful node in the network (Mizruchi & Potts, 1998). As a result, relating results from mathematically computed indicators with reality in meaningful ways often becomes a challenge. As an alternative approach, one could ask respondents to directly state the perceived influence or power level the actor has (Krackhardt, 1987).

A promising new approach to social network analysis is the use of participatory social network mapping tools, which rely on the visualization of the networks by the respondents. Examples are the "Net-Map" and "Process Net-Map" tools, which use group-based interviews and mapping techniques. These tools have proved to be very useful for both collecting network data and performing a meaningful qualitative analysis of social network data because they generate the social network and identify at the same time the social-political relations underlying the social network (Gessa, Poole, & Bending, 2008; Hogan, Carrasco, & Wellman, 2007; E. Schiffer & Hauck, 2010). As further detailed below in the section on Materials and Methods, respondents first identify the relevant actors and their relations, before they are asked to rate the power that they perceive each actor to have using a visual aid. In the process, respondents are asked to verbally provide the reasons why different actors have the influence level attributed to them. The respondents my either be key informants or actors who are themselves part of the network. The visualization of the network of actors can be done using computer aids or through pen and paper. The paper-based approach of arranging ties between actors typically yields more reliable results, because they are visually appealing and can usually be understood more easily and instantly than maps generated with the use of computer aids (Hogan et al., 2007). Moreover, the participatory mapping tools are flexible and provide room for clarification of concepts during the interview. However, some of the challenges involved in these participatory or qualitative techniques include the following: defining the boundaries of the network (Heath, Fuller, & Johnston, 2009), and information distortions resulting from question-order effects as well as recall failures (Pustejovsky & Spillane, 2009).

In this paper, the participatory Social Network Analytical (SNA) tool called "Process Net-Map" was used to examine governance challenges involved in the provision of veterinary services. This tool has been developed by Birner, Cohen & Ilukor (2010) and based on the work Schiffer & Waale (2008) with the aim to identify governance challenges

encountered in the implementation of development projects (see also Raabe, Birner, Sekher & Gayathridevi, 2010 and Schiffer and Hauck, 2010). The tool was applied in this study to identify the influential actors in the provision of veterinary services, to study their interpersonal interactions, and to identify the governance challenges in different types of service provision. The "Process Net-Map" tool is used to map the consecutive steps of the process under consideration and identifies the actors involved in this process. Thus, the tool circumvents the challenge of defining boundaries of a social network, because it follows a defined process and induces the respondents to list the actors involved the start to the end of the process. Moreover, questions are sequentially ordered as respondents are being asked to describe the process step by step. This makes it easier for respondents to use a recall approach. In the original Net-Map tool, respondents were asked to identify all actors who influence a certain outcome, an approach that makes recall more challenging. In this study, the Process Net-Map tool was used to generate evidence on how social and power relations influence the design and implementation of veterinary policies and the functioning of veterinary institutions. The tool was also used to identify possible strategies for intervention. The results were validated by conducting individual interviews with experts in animal health service delivery, such as representatives of the agricultural ministry and district governments, opinion leaders, and veterinarians working with international and local government organizations. The application of the tool is further described in Section 2. The results are presented in Section 3 and synthesized and discussed in Section 4. In section 5, the paper presents the conclusions. The results are presented in eight categories, distinguishing between clinical and preventive services and between pastoral and intensive systems so as to identify the actors and governance problems in each of these systems.

3.2 Materials and Methods

The data used in this study was collected using a combination of stakeholder discussions and interviews using the Process Net-Map tool developed by Schiffer and Hauck (2010). The application of net map tool involved three phases. In Phase 1, respondents were asked in step by step procedure to describe the process delivery, and to identify the actors involved in each step. This process provided a robust way to obtain data on established patterns of interaction between actors because it enabled participants to narrate what happens in real world. The name of the actor mentioned was written on a small card and

placed on a large sheet of paper. Different colored arrows where used to represent different types of links as in Figures 3.1 and 3.2 below. In this study, the main links are information flow regarding the disease and the resource flow mainly drugs and money. More actors where added whenever the participants recalled them. The arrows were marked with numbers, and the respective implementation step corresponding to each number was noted down at the border of the paper as shown Figure 3.1 and 3.2. The description of the process was continued until the point was reached where the animal was treated or vaccinated.

In Phase 2, the respondents were asked to define or state the level of influence of each actor in ensuring that the sick animal gets treated by putting actors on so called "influence towers", which are a means of visualizing the perceived influence of the different actors. To build these "influence towers", checkers game pieces were used. One to eight pieces were stacked on top of each other to show the level of influence of an actor, as perceived by the respondent. Those actors who were considered not to have any influence on the outcome were not assigned any checkers game piece. Accordingly, actors whose influence towers have eight checkers game pieces are perceived to be the most influential actors, while those without any checkers game pieces are considered to be least influential actor. Respondents were asked to adjust the towers as they deemed necessary and to verbally provide the reasons why different actors have the influence level attributed to them. The visualization of the influence levels during the interview serves as a useful tool to elicit information. In particular, it makes it possible to easily ask the respondent to explain the influence levels of different actors' vis-à-vis each other, which would be difficult without visualization, especially if the number of actors is large. In Phase 3, the respondents were asked to identify potential problems areas which are likely to make veterinary service delivery ineffective. The focus was placed on eliciting the various governance problems that are known from the literature (see above), as well as other governance problems that may not have received much attention in the literature, so far.

Table 3.1 displays the number of interviews that were conducted in the two main case study districts, and at the regional and national level. A total of 8 Process Net-Maps were produced for the study. In addition, 18 interviews without Net-Maps were conducted. They served to gain initial insights into veterinary service delivery in order to ensure the selection of the right persons to be included in process mapping exercise. Out of 18 interviews without the Net-Maps, 12 were conducted before the Net-Maps, and 6 afterwards to cross check and validate information generated from the Net-Mapping

process. In each district, four process influence Net-Maps were conducted two in each village with farmers, local leaders, at least two paraprofessionals and a veterinarian. Two Net-Maps in each district were for clinical services (endemic diseases) and the other two were for preventive services (epidemic diseases Control). As mentioned earlier, preventive services and control epidemic disease are still under the public sector while clinical services are under the private sector. Thus service governance problems, type and number actors were expected to vary according to disease type. In addition, two districts with distinct livestock production systems were chosen to capture variations in the institutional set up, social and physical factors which influence sustainability of animal health delivery system (Woodford, 2004). District A was selected to represent a pastoral production system and district B an intensive livestock production system. The names of district are not disclosed to guarantee anonymity of participants.

A pastoral system in the context of this paper is a livestock production system were farmers keep large number of animals, mainly local breeds, for cultural, food and cash purposes (Ruhangawebare, 2010). Pastoral systems in Uganda are mainly characterized by seasonal movements in search for water and pasture and are mainly found in Karamoja and Ankole regions in Uganda (Inangolet et al., 2008; Kugonza et al., 2011). By contrast, an intensive system is one were animals are mainly of exotic breeds and cross-bred. They are kept mainly for commercial purposes (Garcia et al., 2008). Some few farmers keep local breeds as well in the intensive systems. The types of veterinary service providers in these systems vary and they include the government staff, private veterinarians and paraprofessional. In the pastoral system, there is group of paraprofessionals called community animal health workers (CAHWs) who have three month training in animal health management. In the intensive production systems, some paraprofessionals have tone to two year training in animal health while other have one to two year training in general agriculture (crop and livestock production).

Table 3.1 Number and type of interviews in the two main case study districts

	Clinical	**Disease Control**	**Total interviews**
Total interviews	9	17	26
Use of Net-Map			
with Net-Maps	4	4	8
without Net-Maps	5	13	18

Source: Authors

3.3 Results

In the first part of this section, the results for the Process Net-Map exercises for clinical services are presented for both for the pastoral and intensive livestock production systems. In the second part, the results for the preventive services are presented.

3.3.1 Actors involved in the treatment of endemic diseases

In the pastoral livestock production system, the description of the process of the clinical treatment of endemic diseases presented here is based on interviews with CAHWs, the District Veterinary Officer (DVO), fifteen farmers and one animal health assistants. They identified East Coast Fever (ECF), Anaplasmosis, Heart Water, Red Water and Tryponamiasis as the most common diseases. In the intensive systems, the description of the process of treatment of endemic disease control is based on interviews with a government veterinarian, 3 paravets, 2 private veterinarians, and 10 livestock farmers in a focus group discussion in two different villages. The main endemic livestock disease identified respondents were East Coast Fever, Anaplasmoisis and Tryponamiasis. Using the Process Net-Map tool, a total of nine actors were identified as the main actors in the treatment of endemic diseases in pastoral systems and seven in the intensive livestock production systems see Figure 3.1a and 3.1b respectively. According to the interviews, they play the following roles in the process:

a. Herdsmen

In the pastoral system, the herdsmen are mainly children of livestock keeping households, who have the task to herd the animals on the common grazing land. They are the first actors to notice that an animal is sick. They typically report first to their mother and later to their father or head of household. They were ranked as most influential with the score of 8 because they are close to animal(s) and monitor the status of the animal. If they fail to recognize or report a sick animal in time, the animal is likely to die. Just like in the case of pastoral areas, the herdsmen in the intensive system observe the sickness and reports to the livestock owners. In the intensive system, herdsmen are mainly hired individuals are were given a score of 5 because they are closer to the animal and are always able to monitor the situation of the animal and report to the livestock owner (see Figure 3.1b). Also, during the

follow ups the service provider interacts mainly with the herdsman other than the owner of the animals.´

b. Livestock Owners

In the pastoral system, when herdsmen report a case to his mother, it is a common practice for her to use local drugs first to treat the animal. If the animal does not respond to the treatment, she would usually then report to the case to her husband. It is an important practice in the pastoral system that households would sell small ruminants (typically a goat) to be able to pay for drugs and veterinary services for their cattle. Only the head of the household can either authorize the sale of a goat or sell the goat him-self in order to buy drugs. Sometimes, the wife may sell chicken in the local markets to buy drugs for cattle. From the interviews, respondents noted that the influence of the women in livestock keeping households on the outcome of the treatment process mainly stems from the use of traditional medicine and from monitoring the animal's health status. Together with the herdsmen, women are involved in the milking, and while milking, they closely observe the animals. In addition, because of polygamous family structure in the pastoral areas of Uganda, the animals are divided among the different spouses, and each spouse has her own animals to provide food for her children. Women have a strong incentive to oversee the animal's health status, because if an animal dies, it is the woman who suffers most, as she loses an important source of milk and income. Because of these reasons, women in livestock keeping households were ranked as more influential than men. They received a score of 7, as shown Figure 3.1a. Men's influence is in mobilization of resources for the treatment of the animal. Although, the management of the animal's welfare rests with women, men have the authority in deciding whether to sell or not sell and that is why men were given the a score of 6. When resources or funds are mobilized, the drugs are bout and self-administered by either men or herdsmen with help of the women or woman. Rarely are services of CAHWs used.

In the intensive livestock production system, livestock is kept mainly for commercial purposes. Therefore, any outbreak is taken serious because it threatens the livelihood of the livestock owner. When livestock owners receive the reports of sick animal from the herdsmen, they always seek the services of the Paravets, private veterinarian or government veterinarian. The respondents identified the livestock owners as

the most important actors because they are decision makers, control finances and occasionally, they treat their animals themselves.

c. Middlemen

Middle men were considered as one of the key actors in the pastoral areas and were ranked as more influential than the drug shops and CAHWs because they buy animals from farmers, thus they are the source of money used to buy drugs from drug shops, and seek services of CAHWs. In addition, middlemen help farmers to dispose-off the animal when treatment fails. They buy sick animals at a lower price; treat them and later resale at a higher price. Because of these reasons, they were given a score of 6, equal to men. The challenge, however, is that some of the animals are slaughtered and consumed before seven mandate days after treatment. Middle men were not considered as most important actors' in intensive livestock system mainly because animals are mainly kept for dairy products rather than beef and the breeds kept are exotic and require attention and care. Thus livestock owners have the incentive to use or seek services of service providers rather than selling sick animals. Consumers of meat from these animals slaughtered before the mandatory seven days are at high risks of developing antimicrobial resistance (McEwen and Fedorka-Cray, 2002; Kariuki et al., 2013).

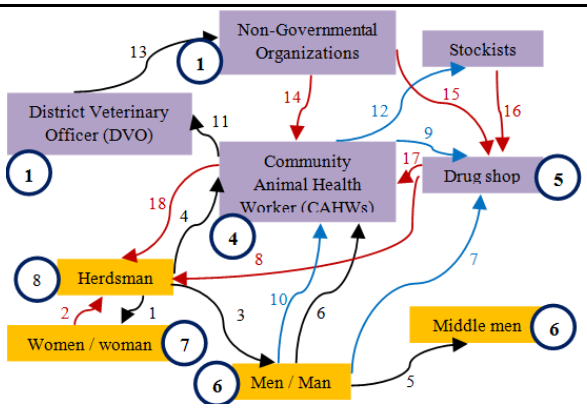
d. Service providers

In the pastoral systems, farmers mainly buy drugs from the drug shop and treat their animals themselves and seek the services of CAHWs when a case fails to respond. Consequently the drug shops were ranked as more influential than CAHWs with score of 5-4, as in Figure 3.1a. In some cases, the NGOs, give drugs to Community Animal Health workers who offer services to farmers at subsidized rates. When the cases that are handled by CAHWs fail to respond, CAHWs which have higher education and can speak English consult the veterinarians. Others give up, and a farmer is forced sell the sick animal. When a government veterinarian is consulted, he gives advice or can visit the site if it is accessible. When the animals fail to respond, farmers often sell off the animals at cheaper prices.

In the intensive systems, paraprofessionals are the most commonly approached service providers because they are available and easily accessible as compared to

veterinarians. If the animal is treated by the paraprofessionals and fails to respond to the treatment, paraprofessionals often refer the case to mainly private veterinarians and in rare cases to government veterinarians. In this system, respondent observed that it is rare for the farmers to self-treat their animals, although some farmers do self-treat especially if they feel the case is not very complicated and the drug is available. The drug shops are owned by mainly veterinarians. The paraprofessionals were regarded as the second most important actors to livestock owners with a score of 6 because they are available and easily accessible to farmers. Although there are only two active private veterinarians in district B, they were ranked as more important than the government veterinarians who are eight in total. They were given a score of 6 compared to government veterinarian score of 4 because they are able to work well with the paraprofessionals. Paraprofessionals refer cases to private veterinarians and use animal drug shops of veterinarians as contact point with farmers. They often consult veterinarians and give business to veterinarians by referring farmers to them. One veterinarian commented that "we do work with Paravets because they market us especially when they refer a farmer to us but at times it makes paraprofessionals insecure."

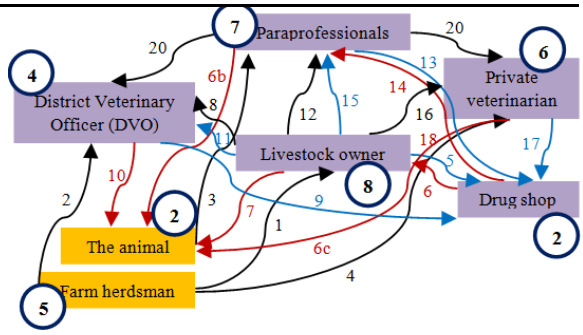
According to the respondents, government veterinarians are perceived to be treating paraprofessionals as subordinates and that is why there is always less interaction between the paraprofessionals and veterinarians. Secondly, most of the government veterinarians are working with the National Agricultural Advisory program as coordinators, a position which pays well and takes most of their time. They do not have time to handle cases referred to them and have no incentive work closely with paraprofessionals since they have assured income and do not need to cooperate with paraprofessionals. Most often, government veterinarians refer cases referred them to private veterinarians. The drug shops attendants were least influential but important actors each with the score of two. The drug shops are link between farmer and service providers. Farmers noted that if the animal is sick, they just have to go to the drug shop and they are sure to get at least one paraprofessional around the shop or a private veterinarian. In the drug shop, farmers also get advice on drug use for those who self-treat and general animal health management if they find a veterinarian in the shop.



1. Herdsman reports to woman
2. Woman treats the animal using local drugs
3. Herdsman and woman reports to man
4. Herdsman can reports the case to CAHWs
5. The man sells goat/chicken
6. The man seeks the services of CAHWs
7. The man goes to buy drug at drug shop
8. Man takes the drug tp herdsman
9. CAHWs buy the drugs from the drug shop
10. Man pays the CAHWs for the service
11. CAHWs can refer a case to veterinarian
12. CAHWs can buy drugs from stockists
13. DVOs can seek help from NGOs
14. NGOs give drugs to CAHWs
15. NGOs give drugs to drug shops
16. Drug flow stockists to drug shop
17. Drug flow to CAHWs
18. CAHWs goes to treat the animal

(X) Perceived level of influence (Scale 0-8)

a: Network of actors Involved in clinical treatment of Endemic diseases in the Pastoral system



1. Herdsman reports to livestock owner
2. Herdsman go directly to DVO
3. Herdsman can go to Paravet
4. Herdsman can go to private veterinarian
5. Pays for the drugs at drug shop
6. And gets the drugs
7. Self treats the animal
8. Livestock owner can seek services of DVO
9. DVO buys drugs from drug shop
10. DVO treats the animal
11. Livestock owner pays the DVO
12. Livestock owner can seek services of paravet
13. Paravets buys drugs from the drug shop
14. Paravet treats the animal
15. Livestock owner pays the paravet
16. Livestock owner can seek services of private veterinarian
17. Private veterinarian buys drugs from the drug shop
18. Private veterinarian treats the animal
19. Livestock owner pays the private veterinarian
20. Paravet refer the case to government or private veterinarian

(X) Perceived level of influence on the outcome

b: Process and actors influence in the treatment endemic disease in the intensive system

Figure 3.1 A network of actors involved in treatment of Endemic diseases

e. Non-governmental organizations (NGOs)

Like middle men, NGOs were only recognized as influential in the pastoral areas especially in training and supporting CAHWs as well as the provision of extension services through pastoral farmer field schools (PFS). The main skills disseminated through the PFS are disease control and deworming. One of the farmers stated "The PFS provide us with

Knowledge on spraying, animal health hygiene and diseases. In our PFS, we have experimented hand picking of ticks against spraying and we tested different accaricides; local herbs against the use of modern veterinary medicines; feeding animal using salt grass which is diluted during rainy season against the use of mineral links made from animal bones and soil". This mainly conducted under the supervision of the CAHWs. However, the challenge is that most NGOs programs are short lived and when the projects ends, the PFS also fail to perform. That is why NGOs were given a score of one as Figure below.

3.3.2 Challenges to treatment of endemic diseases

Results from process influence mapping reveal that the key problems that are encountered in treatment and control of endemic diseases in Uganda are the following:

1. Delays in reporting

Delays in reporting was found to be a main problem in Pastoral areas because of three main reasons: First, livestock keepers prefer local medicine to modern medicine, and by the time an animal is attended to, the disease is already out of hand. Second, even if the farmer wants to buy modern medicine, they have to sell another the animal to buy drugs. Worse still, the distance to the market to sell an animal and buy drugs is very long. The main means of transport used are walking and riding a bicycle. Farmers noted that sometimes it takes some farmers two to three days on the way to reach the drug shop. Third, as observed by one of respondents "the pastoralists' culture is such that, unless the animal falls down or fails to walk, a livestock farmer will not seek a service of service provider".

2. Drug misuse

In the pastoral systems, drug misuse occurs because of: (1) farmers tend to self-treat their animals yet most of them have no education. Farmers are not able to read the labels on drug and thus are not able to know how to apply and use the drug. (2) The low level education level of CAHWs and language differences limit the interaction between the veterinarian and CAHWs. As a result, CAHWs often overuse and administer wrong drugs based on wrong diagnosis. When the animal fails to respond farmers refuse to pay for the

service and lose the incentive to seek services of community animals' workers. (3) The presence of many drug shops opened by business men without animal health qualification. Their objective is to sell drugs, they do not advise farmers on the use and administration of the drugs and sometimes they sell expired drugs. The happy cow drug NGO shop under the Catholic Church which often gives advice, asks farmers why they are buying drug and disease the animal is suffering is always closed.

In the intensive system, drug abuse problem is common among paraprofessionals and farmers. The reasons for the drug abuse problem among paravets are: first, the paraprofessionals are trained from an institute which is not accredited. The institute does not have the facilities to train Paravets and thus paraprofessionals are ill equipped. Secondly, most of these paravets are trained in crop science or general agriculture but because of the existence of the market for veterinary services, crop trained paraprofessionals have joined the veterinary market. Thirdly paravets are driven with desire to make profits and tend to over and under doze the animals in order to increase sales and revenue. Over dozing occurs if paraprofessional's belief that a farmer can afford and under dozing occurs if a farmer is not able or willing to pay for right doze. Paraprofessionals then decide to give lower doze equivalent to the fee a farmer is able to pay. One of the veterinarians remarked that "paraprofessionals always make wrong diagnosis and prescription, and overdose the animal and when the animal fails to respond, they come running to us to save their image before the farmer. For example, paravets under dose goats with Albendozole and when it fails to respond, they come to us and when you shift the treatment to trodax the animal gets well. Then you know that animal became drug resistant".

3. Limited qualified staff

Veterinarians or veterinary trained staffs are very few. In district A (pastoral area) for example, there was only one veterinarian who is taken up with administrative work and not easily reached. In fact, all the farmers in who participated in net map analysis stated that they had never met or heard about veterinary officer. One of the CAHWs remarked: "Our problem is that we have only one veterinarian in the district and he is busy with administrative work, attending workshops and is always out of station. At times some of us have to consult him on phone". The district veterinary officer admitted that it is true that he does not get to villages communities because he is the only veterinarian in the district. The

veterinarian also cited poor accommodation transport and security problems. Most areas are not easily accessible and his department does not have a car. Sometimes they spend one week to reach is work station either because roads are cut-off by water during the rainy season or it is insecure. Frequently, he delegates the government duties to community animal health workers. Occasionally he conducts consultations on phone, but since he does not know the local language, only CAHWs and farmers who are comfortable with English and have phones can consult him over the phone. In the intensive system, out of 10 veterinarians available in the district only two were involved in providing veterinary services.

3.3.3 The actors involved in the treatment and control of epidemic diseases

Results from the process influencing mapping in the pastoral areas generated thirteen actors involved in the treatment and prevention of epidemic diseases among the Pokot pastoral communities. The key services in the treatment and prevention of epidemic diseases are disease surveillance, reporting and vaccination. As in the case of endemic diseases and as shown in Figure 3.2a, women and herdsmen are the first to notice the disease and report it to the men. If the disease is strange, unfamiliar to them or they are not able to handle, they report to community animal health workers. The community animal health workers then report to government veterinarian (DVO) and the NGOs staff. The government veterinarian will report to Italian cooperation laboratory (C&D) and the National Animal Disease Diagnostics and Epidemiology Centre (NADDEC) laboratory. After receiving reports from the veterinarians, C&D meets with veterinarians and community animal health workers to seek assistance in mobilizing communities to sample sick animals. Samples including blood, stool, skin scrapings, and lymph nodes among others are tested at C&D laboratory and results are presented to donor partners, and the local governments who are responsible for dissemination of the results to the communities. Sometimes, because of inefficiency in dissemination of the results, radio programs are organized by C&D and government veterinarians are invited to disseminate the confirmed results to livestock owners.

When the results from the surveillance are in, quarantines are issued by the commissioner through the DVO and vaccinations are conducted for diseases where vaccines are available. Vaccines for epidemic diseases are always procured by government and occasionally by NGOs and the Food and Agriculture Organization (FAO) through the

government. The government through the Ministry of Agriculture Animal Industry and Fisheries (MAAIF) gives vaccines free of charge but does not always provide the local government with logistical support for conducting vaccination campaigns. The NGOs therefore come in to provide transport, fuel, training and mobilization of personnel (CAHWs) and livestock farmers. They register communities, provide the cold chains and meet all the costs for carrying out the vaccination campaigns. DVOs perform coordination and supervisory role in vaccination and actual vaccination is done by CAHWs.

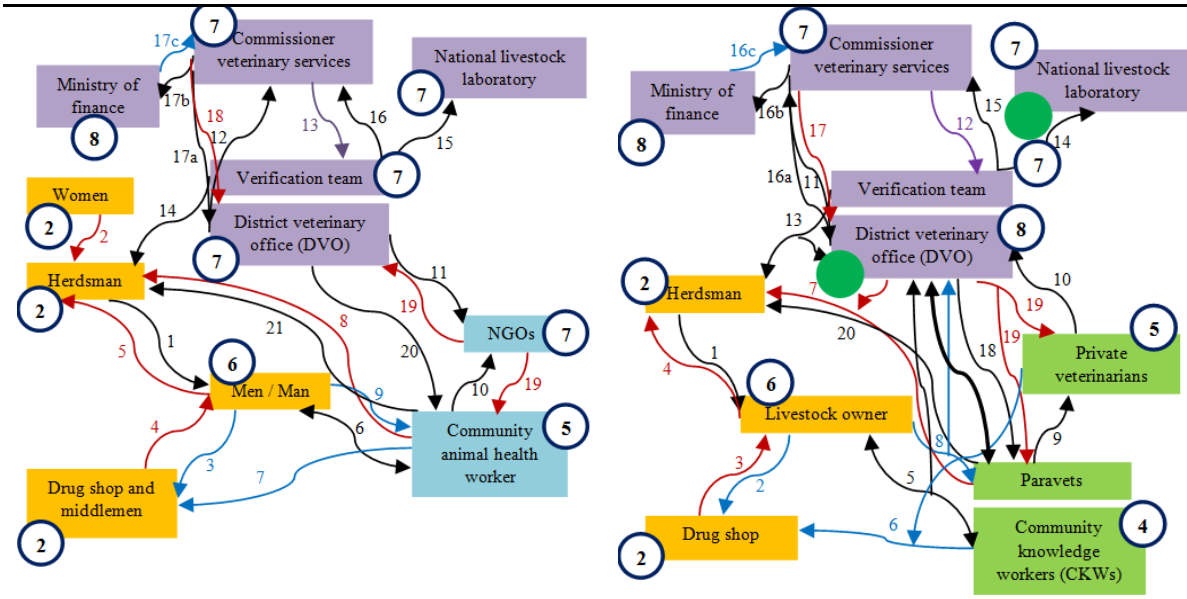
The respondents identified the Ministry of Finance Planning and Economic Development (MFPED) as the most important and influential actor in control of and treatment of epidemic diseases because it is "Mr. Money" was given a score of 8 as in the Figure 3.2 below. The respondent noted that the problem in vaccination and surveillance always comes from financing of these services. Active surveillance is not always done because of financial problems. The budgeting and financial releases are handled using "a fire fighting" approach. Money is only released when there is an outbreak as opposed to routine vaccination. The second most influential actors are NGOs like FAO and Italian Cooperation with the score of 7 because of the financial power see Figure 3.2a. The government veterinarians, Commissioner, and verification team were ranked as equally important as NGOs especially in coordinating these activities and technical guidance. The men were ranked more important than the CAHWs with score of 6 mainly because they help in restraining animals; they also control finances in case they are asked to cost share and above, all they the ones who identify and report the disease out breaks. The CAHWs were given score of 5 because they are involved in mobilizing farmers and conducting vaccination. The middlemen, drug shops, herdsmen, and women are the least influential because vaccines are procured by government and the service is offered by either NGOs or governments. Women and herdsmen role is always limited to identification of the diseases and middlemen and drug shop are important spreading information about disease outbreaks.

In the Intensive system, a total of 12 actors were identified as influential actors in control of control epidemic disease in Mukono district. In the case of epidemic disease outbreaks such as Foot and Mouth disease, the farmer will report to the paravets or the private veterinarian and who will then report to the DVO. The latter will then report the outbreak to the Commissioner Livestock Health and Entomology (CLH&E) of the Ministry of Agriculture, Animal Industry and Fisheries. On receiving such a report the CLH&E will

mobilize a team from the National Animal Disease Diagnostics and Epidemiology Centre (NADDEC) to go to the affected district and carry out an epidemiological investigation and also collect samples for confirmatory diagnosis. The samples collected are tested at the NADDEC laboratory and once a confirmation is done, the team will report the results to the CLH&E indicating the action to be undertaken. Based on the results, quarantine will be instituted by the CLH&E in case of epidemic diseases as an immediate control measures. This will be followed by a vaccination campaign for diseases where the vaccines are available. Once the disease has been controlled, the DVO of the affected district is required to officially request the CLH&E to lift the Quarantine. The CLH&E usually sends a team from the ministry to take samples to confirm the absence of the disease. Based on the results the CLH&E issues a letter lifting the quarantine.

Although it is the responsibility of the central government to provide vaccination services, farmers often seek vaccination services from private veterinarians who get the vaccines from private firms like ERAM limited, quality chemicals and other pharmaceuticals. In case of routine vaccination organized by government, the paravets and private veterinarians are given vaccines and farmers are charged a fee to cover their labor and transport costs. Fees vary depending on the disease for example 1000ugx for rabies (US$0.3), 1500ugx (US$0.45) for FMD and 2500ugx (US$0.9) for Lumpy skin disease. The farmers involved in exercise noted that all service providers (a government veterinarian, private veterinarian and paravets) charge the same price. Vaccination is often done at the farmer's home or farm.

Just like in the case of the pastoral system, respondents identified Ministry of Finance as the most influential actor in control of and treatment of epidemic diseases and they gave the ministry of Finance a score of 8 as shown in Figure 3.2b. The reason is that the ministry of Finance is one decide release the funds or not. The respondent noted that the problem in vaccination and surveillance always comes from financing of these services. Active surveillance is not always done because of financial constraints and even if the activity is budgeted like case of routine vaccinations, the Ministry of Finance often refuses to release the funds until outbreak occurs.



1. Herdsman and woman report the case to the man
2. Woman treats the animal using local drugs
3. Man buys drugs from the drug shop or market
4. Drug received by man
5. Man treats the animal
6. Man reports the case to CAHWs
7. CAHWs buys the drug
8. CAHWs treats the animal
9. Man pays the CAHWs
10. CAHWs reports to DVO or NGO vets
11. The DVO reports to NGOs
12. The DVO reports to commissioner
13. Money is given to VT to collect samples
14. VT, DVO and CAHWs collect samples
15. Lab for testing
16. Results communicated to the commissioner
17a. Commisioner issues the quarantine
17b. Request money from finance
17c. Finance release money
18. Vaccines are given to DVOs
19. DVOs ask CAHWs to organize farmers for vaccination
20. NGOs provide rescurces to CAHWs and DVOs
21. Animal are vaccinated

(X) Perceived influence level

a: Network of Actors involved in the treatment, prevention and surveillance of epidemic diseases in the intensive system

1. Herdsman reports the case to the man
2. Some owners buy drugs from the drug shop or market
3. Drug received by man
4. Man treats the animal
5. Man reports the case to paravets/veterinarians
6. Paravets buy the vaccines from the drug shop
7. Service providers treat the animal
8. Owner pays the CAHWs
9. Paravets and CKWs report to DVO or veterinarians
10. The veterinarians report to DVO
11. The DVO reports to commisioners
12. Money is given to VT to collect samples
13. VT, DVO and paravets collect samples
14. Lab for testing
15. Results communicated to the commissioner
16a. Commisioner issues the qurantine
16b. Request money from finance
16c. Finance releases money
17. Vaccines are given to DVOs
18. DVOs ask CAHWs to organize farmers fo vaccination
19. DVOs can give vaccines to private veterinarians or paravets
20. Animal are vaccinated

Poor relations between government veterinarian and paravets

Inadequate and unpredictable budgetary allocations

b: Network of Actors involved in clinical treatment, prevention and surveillance of epidemic livestock diseases

Figure 3.2 Actors' Influence in the prevention of epidemic diseases

The second most influential actors ranked as equally important are District Veterinary Officer (DVO), the Commissioner Livestock Health and Entomology under MAAIF and the National Surveillance Team because of their coordinating role and technical guidance and were given a score of 7. The livestock owners (farmers) were ranked more important than the paravets and private veterinarians because there are close to the animal and can easily recognize that the animal is sick and report the sickness to the service providers thus earning a score of 6. The private veterinarians were ranked as more important than the paravets/paraprofessionals because they have technical expertise and link closely with the government veterinarians who are more central actors in coordinating epidemic diseases control at district and national level. The private veterinarians were given a score of 5 and paravets a score of 4. Herdsmen and drug shops were given a score of 2 each for their role in reporting disease out breaks see Figure 3.2b.

3.3.4 Problems in treatment and control of epidemic diseases

The key challenges identified in implementation provision of disease control services such as vaccination and quarantine are:

1. Inadequate vaccines and budgetary allocations

Vaccines needed for vaccination exercises are never available insufficient quantities to apply them to all animals in the respective region. This according to the respondents is because of inadequate budgetary allocation to preventive service delivery. As result some animals are not vaccinated which later re-infect other animals. One veterinarian stated that "the persistence of FMD in Teso region in 2010 even after the implementation of vaccination exercise was because of inadequate vaccines. Out of the 50,000 units of the vaccine required for vaccination, only 10,000 were availed, rendering the containment of FMD disease difficult". Since vaccines are never sufficient, local governments depend on NGOs to implement successful vaccination campaigns. As remarked by one of government veterinarians, "In the pastoral areas, NGOs are indispensable to government and under the current situation; if NGOs pull out the government position is very weak. In recent massive vaccination exercises of goat plague (PPR) and CBPP for cattle in Karamoja region, most of the logistical and financial support was provided by NGOs and government could only

contribute vaccines." The government NAADS program does not finance veterinary services yet livestock is the main agricultural sector in Karamoja".

Budgetary allocations from government are inadequate and unpredictable government limiting the ability of DVOs, verification team, and other governments departments to implement vaccination tasks. When the ministry procures vaccines, it is expected to provide logistical support to the local government staff for implementation of the vaccination campaigns. However, the ministry does not provide such logistical support and therefore the government veterinarians are compelled to charge farmers for each animal vaccinated to recover such costs. The advantage in the intensive system is that farmers are able to pay for these services and even though the government veterinarians give the vaccines to the private veterinarians, the latter are able to recover their costs. Respondents also noted capture of funds meant for paying paraprofessionals including CAHWs by the veterinarians as problem. Respondents stated that, some veterinarians are corrupt when funds are allocated for a particular activity they mobilize the paraprofessionals to help to work later refuse to pay them or pay them a fee less than what they are supposed to receive. This results in to a poor response of CAHWs to vaccination exercises, creates a poor working relationship between veterinarians and CAHWs, and worsens the problem of shortage of staff. Respondents also noted that budgetary allocation to animal health and entomology are often low and unpredictable. This observation is supported by findings from a study of the Economic Policy and Research center, which reveals that the funds received for animal health services are less that allocated funds. Moreover, the allocated funds are less than the total expenditure (Economic Policy and Research Centre, 2009).

2. Political interference

The second problem is local political interference, mainly in the implementation of the quarantine services. Participants noted that, when quarantines are instituted, the veterinarians cannot enforce them because when markets are closed, the politicians make "a lot of noise" and some of them lift the quarantine on their own without seeking for approval from MAAIF. In Bukedea district for example, local politicians sent the veterinary officer on forced leave and lifted the quarantine. The main reasons why politicians lift the quarantines are to avoid loss in revenue that would be generated when livestock markets are open. Secondly, they feel that they to avoid political loses or gain

political support by lifting quarantine regulations that are unpopular. Farmers need to sell livestock for school fees and other needs. The implementation of quarantine is perceived to affect the farmers' welfare and is seen as a sign of failure of politicians to provide services. To avoid political fallout, politicians are incentivized to lift up quarantines. Apparently, the need for quarantines is not well understood.

3. Poor relations between government veterinarians and paraprofessionals

This was particularly a main problem in in the intensive systems. Paraprofessionals rarely report disease out breaks to the government veterinarians as mandated by the Animal Diseases Act 1964 revised edition 2005[3]. This Act provides for the prevention, control and eradication of animal diseases and requires that all outbreaks of epidemic animal diseases must be reported to the nearest veterinary authority who should in turn report to the Commissioner Livestock Health and Entomology within 24-48 hours using the fastest means. Their relationship is poor because government veterinarians perceive them as subordinates, and are not cooperative with paravets when they are consulted majorly because they are perceived as less qualified. Additionally, government veterinarians have no incentive to build good professional relationships with paravets since they have assured government salary. Worse still the veterinary surgeons act is outdated and ineffective in strengthening veterinary and paravet relations. The DVOs always depends on reports from private veterinarians. The relationship between the paravets and private veterinarians is good because the paravets often consults them and considered as colleagues irrespective of the level of training. This mainly because private veterinarians need to survive and it is through such networks with the paravets that they get new clients.

4. Poor management of government veterinarians.

Another serious problem identified by the respondents is poor personnel management. The personnel management can be explained in terms of limited opportunities for promotion in local government. These are limited because of the following reasons: it depends on the availability of funds, and is it influenced by local politicians. Merit and academic qualification is not given priority as long as the applicant has a bachelor's degree in veterinary medicine. Veterinarians noted that it is common in Uganda to find the District

[3] Animal Diseases Act 1964 http://www.ulii.org/ug/legislation/statutory-instrument/2005/38

Veterinary office (DVO) with a bachelor's degree and his subordinates' (veterinary officers) with master's degrees. This has created challenges in supervision veterinarians by the DVO. As a consequence, most DVOs do not assign duties to his subordinates' and staff are often absent from their duty stations. One of the government veterinarian stated that "I left my district to come to offer private services in another district because I have a master's degree and my boss has a bachelor's degree in veterinary medicine. He does not assign me responsibilities. So I decided to make myself productive, I get a government salary for free, I am in good terms with my boss and my business is doing well".

5. Policy inconsistency

The creation of autonomous institutions like National Agricultural Advisory Services (NAADS) which has its own governance structure has resulted in the duplication of responsibilities and multi or dual accountability. The NAADs program was established by an Act of parliament, the NAADS Act, 2001[4] to spearhead the transformation of extension services from public sector supply driven to private sector demand driven. Under NAADs, local governments have to hire NAADs staff and MAAIF staff in both crop and livestock. These staffs perform the same task but NAADS staff are facilitated and paid well. NAADs personnel are paid 400 Euros per month compared to the 135 Euros paid the under local government. This has undermined the traditional public services system because NAADs is running a parallel system yet is also under government/MAAIF. Also, under decentralized governance system, technical and financial lines of management are separated as district veterinary offices (DVOs) have to report to both MAAIF for technical matters, and the Ministry of Local Government and district local government for administrative matters. This has also destroyed the chain of command from the center to district which is a key to animal disease control (FAO, 2011; OIE, 2011).

Respondents stated that "Decentralization and NAADs has broken the chain of command. Disease reporting and quarantine implementation has become problematic. The DVO reports to Chief Administrative Officer (CAO) who is head of all civil servants in district, the District council and political heads who are locally elected leaders, and thus he has no incentive to report to central ministry. DVOs cannot report outbreak of certain disease because the local government of officials would fire them or suspend them from

[4] The NAADS Act, 2001
http://www.kituochakatiba.org/index2.php?option=com_docman&task=doc_view&gid=921&Itemid=36

office. The director of animal resources in Uganda noted a case of Bukedea district were the veterinarian was sent on forced leave to pave way for lifting the quarantine. If quarantines are issued, politicians can suspend the veterinarians to lift the quarantine since they are appointed by the district service commission and not public service. Therefore, veterinarians serve the interests of the local government leaders other than the technical leaders at MAAIF".

6. Exclusion of technical expertise in program planning

Another problem cited by respondents relates to planning and implementation of animal health programs or activities. Respondents noted that "the technical leaders of the department of Livestock Health and Entomology under MAAIF take only the third position in the decision making. Major decisions and policies are made in planning committees composed of economists and accountants without the technical expertise of the staff who then have to implement the animal health programs. Most respondents cited example of the so-called "Non Agricultural Technology and Agribusiness Advisory Services[5] (Non ATAAS), where planning and provision of agricultural services are planned based on commodities. Non ATAAS is part of MAAIF Agricultural Development and Investment Plan (DSIP) 2010/2011-2014/2015 with the objective of pursuing private sector led and market oriented agricultural development through a commodity approach (MAAIF, 2012). According to the respondents, this planning design does not reflect the implementation structure of the ministry and thus cannot be effectively implemented. The problem of exclusion of technical staff from MAAIF in agricultural policy reform is discussed in detail by Kjær and Joughin (2012) and has led to lack of ownership of reforms and the development of inadequate implementation strategies (Bahiigwa et al., 2005; Kjær and Joughin, 2012).

3.4 Synthesis, Discussion and policy recommendations

3.4.1 Synthesis

The study has identified a number of actors that are involved in the delivery of veterinary services in Uganda. The number and type of actor depends on the type of the service and

[5] Non ATAAS report http://www.agriculture.go.ug/userfiles/Final%20Synthesis%20Report%20-%20NON-ATAAS%20DSIP%2014%20November%20%202012-2.pdf

production system for example, CAHWs and NGOs are involved both in curative and preventive services in pastoral systems, but not in intensive productive systems. The NGOs' main influence in pastoral communities is in the provision of preventive services. The influence each actor has depends on following factors irrespective of the type of service and production system:

1) Control of financial resources
2) Closeness to the animal
3) Education level and availability of the service provider
4) Ability of the veterinarians to communicate with paravets and farmers
5) Relationship between the paraprofessionals and the veterinarians

Table 3.2 below shows the relationship between service type, production system and veterinary service delivery problems. The sign ☹ indicates that, for that particular service in the given production system, the problem is recurrent and ☹☹ means that the problem is very recurrent.

- **Clinical services:** As shown in table 3.2, drug abuse, delays in reporting, and staffing problem and government staff absenteeism are very recurrent problems in pastoral communities. Low staffing levels and absenteeism by the government veterinarians is mainly attributed to poor infrastructure in the pastoral areas. Also, language barriers between the veterinarians and community animal health workers and veterinarian and farmers were found to be a very recurrent problem in delivery of curative services in pastoral communities. In the productive system in Mukono, the recurrent problems in delivery of clinical veterinary services were drug misuse, and personnel management issues and poor paravets and veterinarians relations.
- **Preventive services:** In the case of preventive services, delayed reporting of epidemic animal diseases, capture of resources by the veterinarians especially during vaccination exercises, political interference, insufficient and unpredictable budgetary allocations were found to be very recurrent both productive areas and recurrent in pastoral areas. Absence of cooperation between paravets and veterinarians was considered recurrent problem in Mukono. Exclusion of

veterinarians in decision making at the ministry level was found to be major challenges in delivery of preventive services.

Table 3.2 Service type, production system and service delivery problems

Service and production system	Drug Abuse	Delayed reporting	Absensteism and staffing problem	Capture by veterinarians	Language problems	Finance and political interfearence	Paravets and Veterinarians relations
Clinical services (pastoral areas)	☹☹	☹☹	☹☹		☹☹		
Clinical services (productive areas)	☹	☹					☹☹
Preventive services (Pastoral areas)		☹	☹	☹	☹	☹	
Preventive services (productive areas)		☹☹		☹☹		☹☹	☺☺

3.4.2 Discussion and Policy options

The emerging picture is that challenges of veterinary service delivery in Uganda are linked to institutional pluralism, decentralization and budgetary constraints that limit effectiveness of the existing institutions. Consequently, given the existing fiscal challenges, the key to improving animal service delivery in Uganda rests on getting priorities, policies and institutions right. Creating an independent ministry responsible for livestock may be advantageous in advocating for veterinary policy, legislation and education. Countries like Kenya and Tanzania which have independent ministries of livestock have put in place veterinary legislation that guides the provision of veterinary services. For example, Tanzania passed a Veterinary Act in 2003[6] and Kenya in 2010,[7] but Uganda still depends on the Veterinary Surgeons Act of 1958[8] . Uganda, too, used to have an independent ministry of livestock industry and fisheries before 1992 but was merged with ministry of agriculture with the objectives of enhancing efficiency and effectiveness of public expenditures and rationalizing the use of resource (Kuteesa et al., 2006).

However, this turned out to be counterproductive and has negatively affected delivery of agricultural services including veterinary services (Semana, 2002). A number

[6] The Veterinary Act, 2003 http://www.mifugo.go.tz/documents_storage/Veterinary%20Act%2016%202003.pdf
[7] The Veterinary Surgeons and Para-Professionals Bill, 2010 http://www.kenyalaw.org/klr/fileadmin/pdfdownloads/bills/2010/Vet._Surgeons_and_Paraproffs_Bill__2010.pdf
[8] The Veterinary Surgeons Act of 1958 http://www.ulii.org/ug/legislation/consolidated-act/277

of other autonomous institutions such as National Agricultural, Research Organization (NARO) in 2005, NAADS (2001), and Dairy Development Authority (DDA) in 1998 were created to improve delivery of agricultural service including livestock (Lukwago, 2010). However, the creation these autonomous institutions have instead increased public expenditure while service delivery has stagnated or continued to decline. Programs under some of these institutions like NAADs could be implemented by the public extension system instead of running parallel systems that performing the same functions (Rwamigisa, 2013). This could reduce the financial or budget problems and rivalry that exists between MAAIF and some of these institutions.

Another challenge to provision of veterinary services identified in this study is limited number of active veterinary professionals and difficulty in attracting and retaining veterinary staff especially by local governments in marginal areas. This paper proposes three strategies to ensure availability of enough qualified veterinary staff in Uganda and they include the following: first, centralizing the administration of veterinary staff. This paper argues that administrative decentralization which was aimed at empowering farmers and local leaders to supervise and monitor extension staff is not appropriate for veterinary services because veterinary services requires an efficient chain of command to ensure the quality. Decentralized administration of veterinary staff fragments the chain of command and reduces the responsiveness of the veterinary system (Petitclerc, 2012). In addition, the local leaders or politicians have captured decentralized power and have used it to interfere with provision of preventive veterinary services.

Secondly, there is need to recruit holders of diploma in veterinary science at sub county level other than restricting to only degree holders. Veterinarians are difficult retain i, motivate and will require higher wages compared with paraprofessionals who hold diplomas in veterinary medicine (Leonard et al., 1999). The third strategy is supporting veterinary training and education. It is impossible to have enough qualified veterinary staff both diploma and degree holders to offer veterinary services in Uganda without appropriate funding. Funding of veterinary education needs to target students from pastoral or marginal areas. A government scholarship similar to the one of the Ministry of Health scholarships fund for hard to reach and priority areas[9] aimed at training medical personnel would be needed in animal health. As argued by Bellemain and Coppalle (2009) and Fanning et al.

[9] The Ministry of Health scholarships fund for hard to reach and priority areas http://health.go.ug/docs/scholarships.pdf

(2009) veterinary education is a key to improving governance of veterinary services and reduce animal disease economic and health risks.

3.5 Conclusion

In the delivery of veterinary services in Uganda, we have generated a number of key actors, determined their influence levels and examined governance challenges. Results have revealed that, the influence of actors depends on closeness to animal (care), controls of financial resources, education level, and availability of service provider in both production systems. In pastoral areas, a veterinarian's lack of understanding of the local language was found to be major problem provision of clinical services. Financial and budgetary indiscipline, political interference, poor legal environment, lower staffing levels, staff absenteeism, drug abuse, delayed reporting and capture resources by veterinarians were the major problems in the delivery of veterinary services. In addition, exclusion of technical staff from decision making process and policy illogicality has greatly affected provision of veterinary services. To improve veterinary service provision in Uganda, government needs to get it its policy right. The governance structure needs to address the governance challenges identified above. In particular, government needs to realign NAADS program within the ministry structures to avoid duplication of tasks and improve personnel management, strengthen veterinary legislation to support veterinarian and paraprofessional relations, invest in veterinary education and training to train more veterinarians and paraprofessionals. Additionally, government should reconsider the policy of hiring degree veterinarians at lower local government. It the diploma holder trained veterinary paraprofessionals who are willing to be in local communities even with low pay.

3.6 References

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4 DETERMINANTS OF REFERRALS FROM PARAPROFESSIONALS TO VERTERINARIANS IN UGANDA AND KENYA

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Abstract

Referrals between paraprofessionals and veterinarians are seen as a solution for improving disease surveillance, detection, and reporting as well as ensuring prudent use of antimicrobial agents in animals. This paper used data collected from paraprofessionals in Kenya and Uganda to identify factors influencing referrals to veterinarians by paraprofessionals using a probit regression model. The results show that the determinants of paraprofessional referrals to veterinarians include the following: paraprofessional's mobile phone ownership, gender, and training, as well as attendance of short term trainings, annual assessments, and membership in paraprofessional associations. The paper argues that legislation or supervision of paraprofessionals as well as expansion of mobile phone ownership by paraprofessionals, supporting the formation of paraprofessional associations, and investing in short term training are important factors for strengthening referrals from paraprofessionals to veterinarians.

Keywords: *Referrals, Paraprofessional, Probit model, Kenya, Uganda*

4.1 Introduction

In the 1980s, governments of developing countries shifted their policies for providing veterinary services from state-led to market-led approaches and limited their role to the supply of public goods services such as vaccination, meat inspection, and the control of zoonotic and contagious animal diseases. However, market-led approaches have performed below expectation, especially in rural and marginal areas because of pervasive market and governance challenges (Pica-Ciamarra and Otte, 2008; Racloz et al., 2013). As a result, the focus has shifted from the debate on market-led versus state-led services to improving the quality and coverage of both private and public veterinary services to reduce the negative impacts of animal diseases on public health and food security (Pica-Ciamarra and Otte, 2008). Over-reliance on the paraprofessionals in most developing countries, including Kenya and Uganda, has been associated with imprudent use of antimicrobial agents (De Haan et al. 2001; Peeling and Holden 2003). This has affected on-farm food safety management, resulting in increased antimicrobial resistance in both animals and humans (Pastoret and Chaisemartin, 2011; Schneider, 2006). Reducing the negative impacts of animal diseases on public health and food security requires effective and timely animal disease surveillance, detection, reporting, and response as well as a prudent use of veterinary drugs, in particular antimicrobial agents (Angulo et al., 2004; Dórea et al., 2011; Grace et al., 2012; Jebara, 2004; Kahn, 2006; King et al., 2004).

To improve the quality of veterinary services and reduce animal disease-related risks through correct disease diagnosis and adequate drug prescription, the expert committee of World Animal Health Organisation strongly recommends strengthening linkages between individual veterinarians and paraprofessionals (Vallat, 2004). Woodford (2004) and Ahuja and Kurup (2006) argue that paraprofessionals should refer to veterinarians to ensure appropriate prescription of drugs and adherence to standards of veterinary practice. In addition, Catley et al. (2004) argue that referrals would prevent misdiagnosis and incorrect drug usage, as well as improve disease surveillance and reporting. Referrals are also critical in sustaining the delivery of quality veterinary services, especially in marginal areas, which typically have the lowest ratio of veterinarians to animal population (Catley and Leyland, 2004; Diop and Bessin, 2004; Hassan, 2003; Leyland and Catley, 2002). Lastly, Koma (2000) argues that referral networks are important for veterinarians to stay in business since paraprofessionals already have well established markets due to the reluctance of farmers to pay premiums to veterinarians for

services that can also be provided by paraprofessionals. Moreover, paraprofessionals are closer and more easily accessible to farmers than veterinarians.

To the best of our knowledge, there has been no empirical study examining factors that influence referrals from paraprofessionals to veterinarians in a developing country. In addition, much of the focus on strengthening referrals between paraprofessionals and veterinarians has been on improving veterinary legislations and building the capacity of regulatory institutions to supervise paraprofessionals. However, no study has been conducted to examine whether such supervision indeed has a positive impact on referrals between paraprofessionals and veterinarians. As argued by Leonard (2000), supervision may increase conflict between veterinarians and paraprofessionals because veterinarians tend to treat paraprofessionals as subordinates rather than as colleagues. This often interferes with a positive relationship between paraprofessionals and veterinarians and negatively affects referrals (Leonard, 2000). Moreover, legislation and supervision have budgetary implications because they may involve recruiting more veterinarians who have to be paid and facilitated to perform their duties. According to Rubarema (2010), this makes veterinary legislation less attractive to policy makers. Therefore, alternative ways of building referral networks need to be devised.

The objective of this paper is to assess whether supervision and other factors influence referrals from paraprofessionals to veterinarians. To achieve this objective, the paper uses cross-sectional data from service provider surveys conducted in Kenya and Uganda. A probit regression model is applied to determine the factors that influence the likelihood of a paraprofessional's decision to refer a case to a veterinarian in any given year.

4.2 Materials and Methods

4.2.1 Data

The data used in this study were collected in 2012 from animal health service providers in the districts of Kiambu and North Pokot in Kenya and in the districts of Mukono and Amudat in Uganda. Mukono and Kiambu districts are located in a region where intensive livestock production systems are practiced, while Amudat and North Pokot districts are located in a region characterized by pastoral systems. The two production systems differ in terms infrastructure and in the supply of and demand for animal health services. These are

the most important factors influencing the development of sustainable animal health service delivery systems and also the category of veterinary paraprofessionals operating in the particular area (Woodford, 2004). Most veterinary paraprofessionals in the pastoral areas, often called Community Animal Health Workers (CAHWs), have no formal education but receive a short training of about three weeks (Mugunieri et al., 2004). The other categories of paraprofessionals are those with diplomas or certificates in animal health and are mainly found in the intensive system (Oruko and Ndung'u, 2009).

According to the World Animal Health Organization (OIE), a veterinary paraprofessional is "a person who, for the purposes of the Terrestrial Animal Health Code, is authorized by the veterinary statutory body to carry out certain designated tasks (dependent upon the category of veterinary para-professional) in a territory, and delegated to them under the responsibility and direction of a veterinarian" (OIE, 2013). This definition implies that all service providers do not hold degrees in veterinary medicine qualify as veterinary paraprofessionals if they are mandated and recognized by the veterinary statutory body. For the purpose of this analysis, we consider all service providers who lack a degree in veterinary sciences as paraprofessionals. This is because many service providers are not mandated by the veterinary statutory body and are not under the direction or supervision of veterinarians (even in Kenya).

To collect data for this study, a total of 88 service providers, including 6 veterinarians and 82 paraprofessionals were interviewed. In Uganda, 12 out of the estimated total of 15 paraprofessionals operating in Mukono district were interviewed, and 26 out of the estimated 30 paraprofessionals operating in Amudat district. In Kenya, 42 out of the estimated 55 paraprofessionals operating in Kiambu district were interviewed. The only two paraprofessionals in North Pokot district were also interviewed. There are few paraprofessionals in this district because Kenya's veterinary board outlawed paraprofessionals who lack formal training in animal health. They are the only service providers in this district. However, paraprofessionals from Amudat district extend their services to North Pokot district. The two districts border each other, movement is free and the inhabitants are of the same tribe (the Pokots). In the pastoral districts of Amudat and North Pokot, we were not able to interview veterinarians because the only veterinarian operating in each district could not be reached during the three weeks we were present in each district, because they were always absent from the district. In Mukono district, we were only able to interview one veterinarian because out of 11 veterinarians residing in this

district, he was the only one actively involved in the provision of veterinary services. In Kiambu district, we were able to interview five veterinarians, three of whom were private service providers and two were government veterinarians.

The sampling design consists of non-probabilistic sampling techniques, namely convenience and snowball sampling, because animal health service providers were difficult to reach and some lack animal health training and were therefore not willing to be interviewed because of their illegal operations. Magnani et al. (2005) argue that when sampling hard-to-reach and 'hidden' subpopulations, non-probabilistic sampling techniques are best, yet are subject to sample selection bias. The target was to interview as many service providers as possible. Therefore, any service provider whom the research team could meet was interviewed. In the last two days of the survey, the researchers waited for service providers at animal drug shops, which were meeting points for all service providers and the easiest way of reaching them. As an incentive to participate in the interviews, service providers received US $10 as compensation for their time. The compensation is, on the average, equivalent to the professional fee charged by veterinarians to handle a case. As a result, we interviewed over 80% of the paraprofessionals in the study districts. This sampling strategy follows Marshall (1996), who proposes generating a large sample to represent the population if probability sampling is not possible. Thus, we are confident that the sample size is a good representation of the underlying population in each livestock production system. As we have no reason to assume that the service providers who could not be reached are inherently different from our sample, the number of excluded service providers will not introduce a significant bias in the study. However, care should be taken when attempting to apply the results to other areas which have different characteristics. Data were collected using a structured questionnaire, which was administered using handheld Android tablet computers programmed with the "Survey To-Go" software.

The data are clustered based on districts. Therefore, paraprofessionals' responses could be correlated or invariant within the district or cluster, which makes ordinary or standard probit regression models unsuitable because it could lead to erroneous hypothesis testing. To address this problem, a probit model with robust standard errors was estimated by clustering at the district level. This allows us to obtain heteroscedasticity and within-cluster error correlation consistent estimators (Cameron and Trivedi, 2009), permitting us

to perform valid hypothesis testing in the presence of heteroscedasticity and within-cluster error correlation (Arellano, 1987).

4.2.2 Model Specification

To examine determinants of referrals, the observed outcome y equals 1 if the paraprofessional referred a case to a veterinarian in the previous year and equals 0 otherwise. If the probability of a paraprofessional referring to a veterinarian is denoted as p, then the probability mass function for the observed outcome y is $p^y(1-p)^{1-y}$, with $, E(y) = p \ and \ Var(y) = p(1-P).$ Considering the discrete nature of a paraprofessional's decision to refer or not, qualitative choice binary models are most suitable, including linear probability, logit, and probit models (Scott and Freese, 2006).

Using binary models, the probability of a paraprofessional referring to a veterinarian p is expressed as a function of the underlying predictor variables represented by a vector x. The outcomes of the models can be given a latent variable interpretation to provide a link with the linear regression model. Since y is the observed binary outcome that a paraprofessional referred a case to a veterinarian in the previous year, the underlying continuous unobservable or latent variable y^*can be expressed as the following single index model:

$$y^* = x'\beta + \mu \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Although y^* is not observed, we can observe that

$$y = \begin{cases} 1, & y^* > 0 \\ 0, & y^* \leq 0 \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Therefore,

$$Pr(y = 1/x) = Pr(x'\beta + \mu > 0) = F(x'\beta) \ldots\ldots\ldots\ldots\ldots (3)$$

The linear probability model suffers from three important shortcomings: the error term μ is heteroscedastic and may possess elements of non-normality; and the predicted value of the dependent variable may not fall within the unit interval (Wooldridge, 2002). Whereas generalized least square models may solve the problem of heteroscedasticity, the problem of estimating parameters of a threshold decision model remains unresolved when truncating values of the dependent variable through logit analysis (Jones et al., 1989; Press and Wilson, 1978; Scott and Freese, 2006). The probit model overcomes problems of the

other models because of its ability to generate bounded probability estimates for each observation (Tambi, 1999). For this reason, we apply the probit model in this study.

To estimate a probit model, we consider the classical model of rationality which considers paraprofessionals as rational agents who are interested in maximizing their utility such that the likelihood of the j[th] paraprofessional referring a case to a veterinarian will depend on the following utility indexes:

$$U_j = \{U_{1j} U_{2j} \dots \dots U_{ij}\} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

Utility indexes are linearly related to a vector of explicit attributes or features of the paraprofessional and can be expressed as in the subsequent function of specific attributes or features of a paraprofessional below:

$$U_{ij} = X_{ij}\alpha_{ij} + \mu_{ij}(j = 1. \dots J)(i = 1 \dots . N) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (5)$$

In Equation (5), X_{ij} is a row vector of the j[th] paraprofessional attributes, α_i denotes a column vector of parameters to be estimated, and $\mu_j \sim MVN(0, \Omega)$ where *MVN* is a multivariate normal distribution function. The random error term μ_{ij} is included in Equation (5) to capture the effects of all unmeasured variables that influence the likelihood of the j[th] paraprofessional referring a case to a veterinarian. The higher the utility index U_{ij}, the higher the likelihood is that a paraprofessional refers to a veterinarian. Therefore, a paraprofessional will refer if the utility of referring $U_{ij} > \omega_{ij}$, where ω_{ij} is a constant threshold (Kwakyi and Epperson, 1989; Tambi, 1999).

The likelihood of a paraprofessional referring to a veterinarian is assumed to be independent of other paraprofessionals' decisions to refer, such that μ_j are independently distributed:

$$\mu_j = \{\mu_{1j} \dots\dots\dots\dots\dots\dots \mu_{ij}\} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (6)$$

where $\mu_j \sim MVN(0, I_i)$ and the covariance matrix I_i is the identity matrix of order m.

Based on Scott and Freese (2006), the probit model on which the utility function depends can be specified as:

$$\Pr(y = 1/x) = \int_{-\infty}^{\beta+\alpha x} \frac{1}{\sqrt{2\pi}} exp^{-\left(\frac{t^2}{2}\right)} dt \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (7)$$

where y is a vector of binary variables, such that $y = 1$ if a paraprofessional referred a case to a veterinarian in the previous year and equals 0 otherwise, and x is a vector of predictor variables that predict or explain a paraprofessional's decision to refer to a veterinarian. These variables are assumed to be independent and uncorrelated with the error term (Tambi, 1999; Wooldridge, 2002)

A maximum likelihood (ML) probit model was estimated using STATA 12. The ML estimates of the parameters maximize the value of the probability density function $Pr(y = 1/x)$. Diagnostic tests to detect the presence of collinearity were performed by computing the correlation coefficients and the variance inflation factor for all variables in the model. As mentioned above, sample selection bias could arise from the non-random selection and clustering of paraprofessionals (Moulton, 1990; Cameron and Trivedi, 2009). A probit model with cluster robust standard errors was estimated to account for the sample selection bias.

To predict the effect of the change of a predictor on the probability of a paraprofessional referring to a veterinarian in the previous year, marginal probabilities are computed. For continuous variables, such as the number of untrained paraprofessionals and age, marginal effects were estimated at their mean values of the predictor variable. The marginal probability was computed by multiplying the computed coefficient estimate α_i with the probability density function $n(X_{ij}\alpha_{ij})$ of the probit model evaluated at mean values of the predictor variables. For dichotomous predictors, the marginal probability was calculated as the difference between the standard probability density function of the probit model when $X_i = 0$ and $X_i = 1$ for the discrete variable.

The descriptions of the predictor variables are presented in table 4.1. Paraprofessionals were categorized as those with formal training in veterinary science or animal health and those with no formal training in animal health. Those with no formal training in animal health include (a) those with formal education that hold diplomas or certificates in related fields like crop or general agriculture and (b) those with just three weeks of training in animal health. The paraprofessional associations are the Kenya Association of Livestock Technicians (KALT) and the Community Based Animal Health Works' Associations, which are formed by service providers with the support of donors such as the European Union (EU) through development organizations such as the Food and Agricultural Organization (FAO). The supervision of paraprofessionals is, in principle, regulated by the Veterinary Statutory Board, which works with local governments

veterinarians. The board is supposed to assign each trained paraprofessional to a veterinarian as the basis to be licensed to offer services in the particular area. However, as indicated above, the number of veterinarians employed by the local governments is very limited especially in the pastoral production systems. This limits the ability of the Veterinary Statutory Board to regulate the activities of paraprofessionals. However, the veterinarians employed by NGOs often act as supervisors of some paraprofessionals. They also organize training seminars for paraprofessionals. In the intensive system, paraprofessionals also can enrol for short course at nearby universities.

Table 4.1 Description of variables used to analyse referrals from paraprofessionals to veterinarians based data collected from 82 paraprofessionals in Uganda and Kenya

Variable	Description	Impact
Refers	1 if the paraprofessional referred a case to a veterinarian in the previous year,0 otherwise	NA
Phone	1 if the paraprofessionals owns a phone, 0 otherwise	+
Gender	1 If male and 0 if female	-
Age	The age of the paraprofessional	-
Education	1=No-education, 2=Primary, 3= High school, 4=Certificate, 5=Diploma ,6=Degree	-
Assess	If the paraprofessional is annually assessed and supervised by a veterinarian, 0 otherwise	+
Seminars	1 if the paraprofessionals has attended short term trainings (seminars), 0 otherwise	+
Association	1 if the paraprofessional is a member of a service provider association, 0 otherwise	+
Disease	1 If the most prevalent animal disease is an contagious disease (Anthrax, FMD, PPR and CBPP), 0 for non-contagious disease (ECF, Anaplasmosis, Mastitis and Helminths)	+
System	1 if the paraprofessional is from pastoral systems, 0 otherwise	+
Training	1 if the paraprofessional has formal training in animal health, 0 otherwise	-
Number of the Untrained	The number of paraprofessionals not trained in animal health operating in the operation area as reported by paraprofessionals	-

Diseases were classified as contagious and non-contiguous animal diseases since this classification captures the "nuisance" potential of the disease to the local economy (local trade and animal movements) as well as clinical severity (Cros et al., 2010). Clinical severity is known to influence referrals (Bickell et al., 1992). Out of the eight diseases reported by paraprofessionals, those that have the potential for very serious and rapid spread, namely Anthrax, Foot and Mouth Disease (FMD), Peste des Petits Ruminants (PPR), and Contagious Bovine Pleurapneumonia (CBPP), were categorized as contagious diseases, while East Cost Fever, Anaplasmosis, Mastitis, and Helminths were categorized as non- contagious (non-notifiable) diseases. In Kenya and Uganda, contagious animal

diseases are required by law to be reported to government authorities or government veterinarians. On the other hand, tick borne disease and other non-contagious diseases are handling by livestock farmers and private veterinary service providers (Choudhury et al., 2011; GOK, 2008).

4.3 Results

4.3.1 Diseases handled by paraprofessionals

Table 4.2 shows the most prevalent animal diseases observed paraprofessionals in their operation areas. About 91% of the respondents in the intensive system reported non-contagious disease as the most prevalent disease and only 9% reported contagious disease. Similarly, 61% of the paraprofessionals in the pastoral system reported non-contagious disease and 39% reported contagious disease as the most common disease. Among the non-contagious diseases, East Cost Fever was reported as the most prevalent disease in pastoral areas, while mastitis and East Cost Fever were reported as the most prevalent diseases in the intensive livestock system. Contagious bovine pleurapneumonia (CBPP) and Foot and Mouth Disease (FMD) were reported as the most common contagious diseases in pastoral system, while Anthrax and FMD were reported as the most common in the intensive livestock system.

Table 4.2 Classification of animal diseases and their prevalence by livestock production system

Disease	Classification of the disease	Overall sample		Pastoral system		Intensive System	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Anthrax	Contagious	02	2.44	00	0.00	02	3.70
East Cost Fever (ECF)	Non-contagious	33	40.24	17	60.71	16	29.63
Anaplasmosis	Non-contagious	06	7.32	00	0.00	06	11.11
Foot and Mouth Disease (FMD)	Contagious	05	6.10	02	7.14	03	5.5
Peste des petits ruminants(PPR)	Contagious	02	2.44	02	7.14	00	0.00
Mastitis	Non-contagious	26	31.71	00	0.00	26	48.15
Helminths	Non-contagious	01	1.22	00	0.00	01	1.85
Contagious bovine pleurapneumonia (CBPP)	Contagious	07	8.54	07	25	00	0.00
Total		82	100	28	100	54	100

4.3.2 General characteristics of paraprofessional

In this section, we present data on the general characteristics of the paraprofessionals and on their referrals in the two production systems for the two countries. As shown in Table 4.3, about 35% of paraprofessionals referred a case to a veterinarian in the previous year. The proportion of paraprofessionals that referred cases to veterinarians in the intensive livestock production system is significantly higher than in the pastoral system. However, the proportion of paraprofessionals that referred cases to veterinarians in the previous year in Kenya is not significantly different from those in Uganda. This result suggests that regardless of the country, in the study areas paraprofessionals from pastoral areas are less likely to refer cases to veterinarians. The proportion of paraprofessionals owning phones in the intensive system and in Kenya was significantly higher compared to those in the pastoral system and in Uganda, respectively. In terms of gender, the proportion of female paraprofessionals was significantly higher in the intensive system and in Kenya relative to that in the pastoral system and in Uganda, respectively.

Table 4.3 Characteristics of paraprofessionals by livestock production system and country

Variables	Overall sample		Livestock Systems			Country		
	Mean	Std.dev	Intensive	Pastoral	Difference	Kenya	Uganda	Difference
Refer	0.354	0.481	0.444	0.179	0.266**	0.409	0.289	0.120
Phone	0.854	0.356	1.000	0.571	0.429***	0.979	0.718	0.261***
Gender	0.854	0.356	0.796	0.964	-0.168*	0.750	0.974	-0.224**
Age	36.33	9.646	35.907	37.143	-1.235	35.841	36.895	-1.054
Education	3.476	1.259	4.204	2.071	2.132***	4.023	2.842	1.181***
Assess	0.463	0.502	0.593	0.214	0.378***	0.545	0.368	0.177*
Seminars	0.085	0.281	0.130	0.000	0.130	0.000	0.184	-0.184**
Association	0.427	0.498	0.481	0.321	0.160	0.545	0.289	0.256*
Disease	0.195	0.399	0.093	0.393	-0.300**	0.091	0.316	-0.225*
Untrained	4.731	6.773	4.556	5.071	-0.516	1.364	8.632	-7.268***
Training	0.512	0.503	0.778	0.000	0.778***	0.955	0.000	0.955***
System	0.341	0.477						

The proportion of paraprofessionals who are annually assessed and are members of a paraprofessional association was significantly higher in Kenya, while the proportion of paraprofessionals who had ever attended short term trainings (seminars) was significantly higher in Uganda. Notably, none of the paraprofessionals in the pastoral system or in Kenya had attended short-term training or seminars since starting work. Moreover, the

proportion of paraprofessionals annually assessed was significantly higher in the intensive system. However, the proportion of paraprofessionals who were members of paraprofessional associations and those who had attended short-term training since beginning work are not significantly different in the two production systems.

The mean number of paraprofessionals not trained in animal health as reported by paraprofessionals is significantly higher in Uganda as compared to Kenya. The proportion of paraprofessionals who reported contagious diseases as being the most common disease in their operation areas was significantly higher in Uganda and in the pastoral system compared to that in Kenya and the intensive system, respectively. This suggests that contagious diseases are more prevalent in pastoral systems relative to intensive systems and in Uganda relative to Kenya. This could be the case because paraprofessionals in pastoral areas and in Uganda do not have formal training in animal health, and because the pastoral districts studied have few or absentee veterinarians, which affects referrals, disease surveillance, reporting, and prevention.

4.3.3 Relationships among the study variables

To assess the association of the predictor variables, we examine Pearson correlation coefficients (see Table 4.4). The results show that owning a mobile phone and being female, being regularly assessed, and being a member of a paraprofessional association are positively and significantly associated with referrals to veterinarians. Male paraprofessionals, those that operate in the pastoral livestock production system, and those trained in animal health are less likely to refer cases to veterinarians. There are also significant correlations between various predictors, such as a negative correlation between gender and assessment as well as gender and age. These results suggest that male paraprofessionals are younger and are less likely to be supervised compared to their female counterparts. ‘Paraprofessionals’ training in animal health is positively and significantly correlated with owning a mobile phone, education, assessment, and association membership. The results also imply that female paraprofessionals are more likely to be trained in animal health, that trained paraprofessional are less likely to attend short trainings or seminars, that contagious diseases are less prevalent in the areas where animal health trained paraprofessionals operate, and that trained paraprofessionals do not operate in areas where many untrained paraprofessionals operate. The results also reveal that paraprofessionals from pastoral areas are less likely to refer cases to veterinarians, to own

mobile phones, to be assessed, to be trained in animal health, and to have attained a higher education level as compared to those operating in the intensive production system.

Although the variable representing the production system was correlated with most predictors, this variable was not dropped when estimating the probit model because most of the predictors may be strongly dependent on the livestock production system. Moreover, its variance inflation factor was 7.79, which indicates moderate collinearity as values from 5 to 10 represent moderate collinearity (Midi et al., 2010). This does not discount the regression analyses (O'brien, 2007). In addition, the variable representing paraprofessionals' training, which is shown in table 4.4, is correlated with most predictors. This variable, too, was kept in the model because some of the predictors, such as attending seminars or trainings and membership in associations, depend on the training of paraprofessionals. The variance inflation factor for this variable equals 10.26, which indicates moderate collinearity. According to O'brien (2007), VIFs between 10 and 20 do not by themselves discount the results of the regression analyses.

4.3.4 Empirical probit estimates

The estimates derived from the probit model are presented in Table 4.5. The statistical test of significance is the likelihood ratio test, which follows chi-square distribution with 10 degrees of freedom and the z-test with a significance level of 5%. Based on the goodness of fit measured by McFadden R-squared with the likelihood ratio as the basis of inference, the predictor variables explain 41% of the variation of paraprofessionals' decisions to refer cases to veterinarians. The null hypothesises that all predictors are jointly zero can be rejected ($p< 0.001$), indicating that the model is overall statistically significant.

The results indicate that the prevalence of notifiable or contagious diseases and paraprofessionals' assessment, phone ownership, and membership in a paraprofessional association increase the probability that a paraprofessional refers to a veterinarian. On the other hand, being male and operating in an area with more informally or untrained paraprofessionals have a negative influence on a paraprofessional's decision to refer to a veterinarian. No evidence was found to suggest that age and attendance of short term trainings or seminars significantly influence referrals from paraprofessionals to veterinarians. Several diagnostic checks were undertaken, which confirm the findings presented in Table 4.5.

Table 4.4 Pearson correlation coefficients showing the relationship among the study variables including referrals from paraprofessional to veterinarians in Uganda and Kenya

	Refer	Phone	Gender	Age	Education	Assess	Seminars	Association	Disease	Untrained	Training	System
Refer	1.000											
Phone	0.234*	1.000										
Gender	-0.343**	-0.072	1.000									
Age	0.145	0.001	-0.228*	1.000								
Education	0.188	0.310**	-0.131	-0.097	1.000							
Assess	0.489**	0.172	-0.253*	0.133	0.274**	1.000						
Seminars	0.139	0.117	0.122	0.033	0.168	0.062	1.000					
Association	0.290**	0.155	-0.144	0.079	0.163	0.130	-0.009	1.000				
Disease	-0.042	-0.209	0.132	-0.204	-0.199	-0.135	-0.149	-0.169	1.000			
Untrained	0.003	0.020	0.194	0.053	0.028	0.217*	0.418***	-0.046	0.038	1.000		
Training	0.161	0.425***	-0.325**	-0.077	0.543**	0.233*	-0.315*	0.237*	-0.204	-0.516***	1.000	
System	-0.264*	-0.58***	0.216*	0.056	-0.789***	-0.35**	-0.201	-0.167	0.319**	0.042	-0.731***	1.000

Level of Significance of Pearson correlation coefficient: * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 4.5 Probit regression model describing the association between referrals from paraprofessionals to veterinarians and predictor variables based on the sample of 82 paraprofessionals from Uganda and Kenya

Variable	β[a]	SE[b]	95%CI[c]	P-value[d]
Phone	0.285	0.035	0.21 - 0.35	0.000
Gender	-0.531	0.105	(-)0.74 - (-)0.32	0.000
Age	0.004	0.006	(-)0.01 - 0.02	0.535
Supervision	0.583	0.129	0.32-0.83	0.000
Seminars	0.009	0.079	(-)0.14-0.16	0.908
Association	0.374	0.106	0.16- 0.58	0.000
Epidemic Disease	0.441	0.086	0.27 - 0.61	0.000
Training	-0.732	0.108	(-)0.94 - (-)0.52	0.000
Untrained	-0.040	0.008	(-)0.05 - (-)0.02	0.000
System	-0.456	0.080	(-)0.61 - (-)0.30	0.000

McFadden R squared = 0.381; N=82; [a] marginal effects; [b] standard error; [c] 95% confidence interval; [d] P-value of the overall effect

4.4 Discussion

Results from the descriptive statistics show that the proportion of paraprofessionals who referred to veterinarians in the previous year is 0.34. The predicted probability of a paraprofessional referring to a veterinarian in the previous year was 27%. These results generally indicate a low level of referrals from paraprofessionals to veterinarians. Referrals are particularly low in pastoral livestock production systems. Below, we discuss the factors that had a significant influence on these referrals.

Table 4.5 shows that paraprofessionals' ownership of a mobile phone increases the probability of referring to a veterinarian by 0.285 (i.e. 29 percentage points) assuming all other factors are held constant. This is likely because mobile phones reduce the costs of information, communication, and access (Aker, 2011; Muto and Yamano, 2009; Urquieta and Alwang, 2012), which may enable paraprofessionals to easily communicate and refer cases to veterinarians. This result is supported by a study examining referrals between general practitioners and veterinary specialists (Amanda, 2007). Rapid and effective communication is also needed to build strong social connections or networks (Bayes, 2001). This suggests that mobile phones and mobile network coverage are imperative to building strong referral networks between paraprofessionals and veterinarians.

Paraprofessionals operating in areas where contagious diseases are more prevalent are more likely to refer to veterinarians by 44.1 percentage points compared to paraprofessionals in areas where non-contagious disease are more prevalent, assuming all other factors are held constant. These results suggest that paraprofessionals who deal mainly and more frequently with contagious animal diseases are more likely to refer to veterinarians. This finding is supported by a study on referrals between general practitioners and specialists in human health care (O'Donnell, 2000). Admittedly, the paraprofessionals interviewed in this study stated that they only refer to veterinarians if the case is complicated, a disease is a contagious one, and if the animal fails to respond to the treatment.

Paraprofessionals who are annually assessed or supervised are by 58.3 percentage points more likely to refer to veterinarians as compared to paraprofessionals who are not assessed or supervised, assuming all other predictors are held constant. This result is in agreement with findings by Abodunrin et al. (2010) who studied determinants of referral practices of Tradition Birth Attendants in Nigeria and found that a high number of supervisory visits are associated with more frequent referral. This finding suggests that a well-established veterinary structure enabling the supervision of paraprofessionals would significantly influence referrals to veterinarians. Moreover, supervision is important in building paraprofessionals' confidence in veterinarians and their skills. A study by Brunetto et al. (2011) on the supervisor-nurse relationship shows that supervision increases a nurse's satisfaction (trust) with his or her supervisor and reduces role ambiguity. The literature also suggests that regulation and supervision in the veterinary structure should be designed in a collegial manner, as failing to do so could result in distrust (Aghion and Algan, 2010) and thus reduce referrals. In fact, Leonard (2000) argues that a low level of referrals from paraprofessionals to veterinarians may be explained by the fact that veterinarians treat paraprofessionals as subordinates rather than as colleagues. Similar implications have been found for nurses (Brunetto et al., 2011). The results also show that membership in a paraprofessional association positively influences referrals. This is mainly true for paraprofessionals who have a formal training in animal health since Pearson correlation coefficients show that there is an association between paraprofessionals with animal health training and membership in a paraprofessional association. This result provides evidence for the need to organize and support the formation paraprofessionals' associations.

The marginal probability of the gender variable suggests that male paraprofessionals are by 53.1 percentage points less likely to refer to veterinarians relative to their female counterparts, assuming all other factors are held constant. This is consistent with findings by Chan and Austin (2003) and Franks et al. (2000), who found that female physicians have higher referral rates. We also found that the increase in the number of paraprofessionals in the area who lack training in animal health is negatively associated with referrals by paraprofessionals working in that area. This suggests that in areas with more untrained paraprofessionals, referral networks are more difficult to build. This could result from the fact that veterinarians may have been driven out of such areas, implying the phenomenon of a "lemon market" in animal health: As farmers cannot distinguish between poor or good quality services, only providers of cheap and low quality services remain in the market (Ly, 2003). The term "lemon market" was coined by Akerlof (1970) with reference to the market of used cars. He pointed out that because sellers of used cars have more information while the average buyer cannot readily distinguish a poor quality used car ("lemon") from a high quality used car, sellers of high quality used cars are likely to be driven out of the market.

Problems of referrals are also more severe in pastoral areas because most paraprofessionals and clients are not well educated and cannot speak English, which restricts them from interacting with veterinarians. Most veterinarians are not from the same ethnic background, which is a further obstacle, as also found by Eregae (2003). It is, therefore, not surprising the paraprofessionals in pastoral systems are less likely to refer cases to veterinarians as compared to those in intensive systems. Although notifiable or contagious animal diseases are more prevalent in pastoral areas, the absenteeism of veterinarians in these areas also limits referrals. As highlighted above, we were not able to interview any veterinarians in the pastoral districts due to the following reasons. First, there was only one veterinarian employed by government in the districts we analysed. Second, according to respondents' information, government veterinarians are typically absent from their duty station in these districts and therefore are not performing their mandated regulatory and supervisory roles. Nevertheless, supervision significantly influences referrals there.

The results also show that paraprofessionals who have had formal animal health training are less likely to refer to veterinarians. This result is supported by Rosenthal et al. (1996), who found that physicians with experience and specialized knowledge on

particular cases are less likely to refer to specialists. This is to be expected because paraprofessionals with formal training are capable of handling most cases themselves as compared to those with no formal training, which reduces the need to refer cases to veterinarians.

This study has identified a number of factors influencing referrals by paraprofessionals to veterinarians in Kenya and Uganda. A better understanding of these factors is needed to build linkages between paraprofessionals and veterinarians. This is of particular importance in improving disease surveillance and reporting, as well as ensuring correct disease diagnosis and drug prescription. The results can be used to help paraprofessionals more easily consult with veterinarians and refer cases to them. This would also benefit veterinarians by increasing their clients, thereby providing them with recognition for their quality services. The results of this study are also useful in guiding investment decisions by government, regulatory institutions, and development partners that aim at improving referrals from paraprofessionals to veterinarians. Such investments include hiring more veterinarians in local governments to work with paraprofessionals who are operating privately, supporting the formation of paraprofessional associations, providing paraprofessionals, especially those in pastoral areas, with mobile phones and support the expansion of mobile network coverage in those areas.

The results from this study reveal that supervision, an increase in the number of trained veterinarians, and a reduction in the number of untrained animal health paraprofessionals are among the factors that increase referrals from paraprofessionals to veterinarians. But then, this requires a strong veterinary legislation and a well-established and staffed veterinary structure (FAO, 2011). Although the costs of implementing veterinary legislation, establishing well-structured veterinary infrastructure, and supervising paraprofessionals would be significant for national budgets (Rubarema, 2010), policy makers need to prioritize veterinary legislation and funding because it has significant externalities with regard to both humans and animals. A recent report by the International Livestock Research Institute (ILRI) on the global mapping of hot spots for zoonotic diseases, such as tuberculosis (TB), brucellosis and Rift Valley fever, finds that 13 zoonoses are responsible for 2.4 billion cases of human illness and 2.2 million deaths annually (Grace et al., 2012). Grace et al. (2012) estimate that approximately one in eight heads of livestock (ruminants) in poor countries, including Kenya and Uganda, are affected by brucellosis, which decreases milk and meat production in cattle. Moreover, consumers

of these livestock products are at risk of getting infected with brucellosis if the source animal was infected (Baldi and Giambartolomei, 2013; Bender et al., 2006; Taylor et al., 2001). Therefore, improving referrals may decrease the prevalence of such diseases and have a significant impact on both human and animal health, which would have implications not only for national budgets via lower health costs, but also through economic development by improving individuals' well-being.

The presence of zoonotic diseases worsens poverty and hunger situations among livestock dependent communities. The ILRI study quoted above found a 99 per cent correlation between country levels of protein-energy malnutrition and the burden of zoonoses. In most developing countries, the zoonoses burden is worsened by poor disease surveillance and reporting systems, resulting in delayed response and massive under-reporting. For example, Grace et al. (2012) estimate that 99.9 per cent of livestock losses do not appear in official disease reports in Africa. As Catley et al. (2004) argue, improving referrals between paraprofessionals and veterinarians is key to improved disease surveillance and reporting in developing countries and in ensuring timely response to disease outbreaks.

Results from this study also have policy implications with regard to private sector engagement. We found that expanding paraprofessionals' mobile phone access, encouraging paraprofessionals to form associations, and conducting seminars or short-term trainings would improve linkages and promote the development of referral networks between paraprofessionals and veterinarians, thus improving the quality of veterinary services.

This study has some limitations. Cross-sectional data rather than case specific data were used since we had to rely on self-reported data by paraprofessionals. Thus, case-specific information such as diagnostics and subclinical infections as well as client-related factors could not be included in our analysis. In addition, we were not able to verify from veterinarians whether a specific paraprofessional had in fact referred cases to them in the previous year. Nonetheless, studies on referrals often rely on cross-sectional data (Bachman and Freeborn, 1999). In addition, self-reported data about referrals have been found to be useful in analysing referrals in human health care (Bachman and Freeborn, 1999; Sobal et al., 1988). Interviewing clients for case-specific information on whether their cases were referred from the paraprofessional to the veterinarian would be problematic, especially in developing countries, because clients (farmers) are often unable

to differentiate between paraprofessionals and veterinarians as both are called "animal doctors" (Leonard, 2000). Paraprofessionals are, thus, the gatekeepers to referrals in animal health care.

There may also be a concern that the relatively low sample size (82) could mean that the results are not representative. However, in each study site, we interviewed more than 80% of the paraprofessionals that are actively engaged in providing veterinary services. As we have no reason to assume that the sample is biased, the results can be considered to be representative of the study area. In addition, our sample size compares well with the sample size of 72 in a study by Tambi (1999), which estimated determinants of demand for private veterinary services. Although we recommend that future studies collect longitudinal data which capture client- and case specific information on veterinarians and paraprofessionals, this study provides a good understanding of determinants of referrals between paraprofessionals and veterinarians.

4.5 Conclusions

Improving referrals can result in better disease surveillance as well as in better reporting and response to contagious animal diseases, thereby reducing the disease burden (risks) for both humans and animals . However, referrals by paraprofessionals to veterinarians are currently very low, mainly because of low mobile phone network coverage, a high number of paraprofessionals not adequately trained in animal health, and low levels of supervision. Therefore, investments in training, expanding mobile phone network coverage, providing mobile phones to practicing paraprofessionals, increasing the number of trained paraprofessionals and veterinarians, as well as increasing the supervision of paraprofessionals is vital in building referrals networks in the provision of animal health services.

4.6 References

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5 DO PARAPROFESSIONALS PROVIDE QUALITY VETERINARY SERVICES? RESULTS FROM A ROLE PLAY EXPERIMENT IN RURAL UGANDA

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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 in each round. Statistical tests were performed to establish whether the quality of services provided by different types of paraprofessionals and veterinarians differ. Learning curves for service providers were constructed to examine whether the quality of services provided by paraprofessionals improves as they continue to interact with veterinarians. Belief updating curves were constructed for farmers to examine whether they change their beliefs about paraprofessionals after receiving information about the quality of their services. A probit regression model for binary panel data was estimated to determine the factors that influence farmers' decisions to change service providers. The results show that the ability to identify the signs of different diseases and 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 to perform these tasks 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 trained in general agriculture and social sciences to perform these tasks. This is not the case for paraprofessionals with no formal training or education. Farmers do not easily change their

beliefs about paraprofessionals even if they receive information on their lack of ability to diagnose diseases correctly and describe the correct drugs. Belief updating depends not only on the outcome of the previous round, but also on the gender of the farmer and the livestock production system. This paper argues that the slow pace in which farmers update their beliefs about paraprofessionals limits paraprofessionals' willingness to learn or consult with veterinarians. However, the use of "animal health cards" (records of diagnoses and treatments) could induce paraprofessionals to provide services of better quality and to enable farmers to measure the quality of services, thus improving the quality of veterinary services in the long run.

Key words: *Belief updating, lemon market, role play game, veterinary services, Uganda*

5.1 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, 1996). 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). Service providers interact repeatedly with farmers and if farmers fail to differentiate the quality of the service, high quality service providers are displaced or nudged off the market since the institutions that are required to ensure the quality of veterinary services in developing countries are missing or weak (Leonard, 2000). 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). 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, this "information externality" related to this interaction has not been analyzed 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? (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 (2011) 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, Thys, and Elyn, 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.

5.2 Materials and Methods

5.2.1 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[10] and the OIE technical disease cards[11].

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.

5.2.2 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 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

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

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.

Table 5.1 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

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 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.

5.3 Results

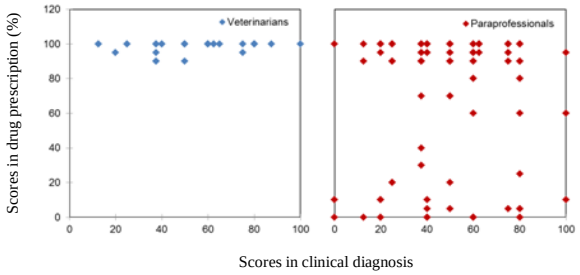
5.3.1 Analysis of service quality by disease

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

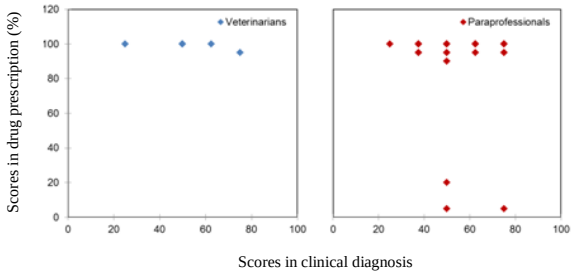
government animal health assistants trained in veterinary science, who acted as veterinarians in the role play in the pastoral area. Paraprofessionals included service providers with a diploma and or a certificate in agriculture or social science. Community animal health workers (CAHWs) are those service providers who have received some training in animal health services, but do not hold a diploma or certificate.

Figure 5.1 is composed of 6 figures. Figure 5.1a 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.

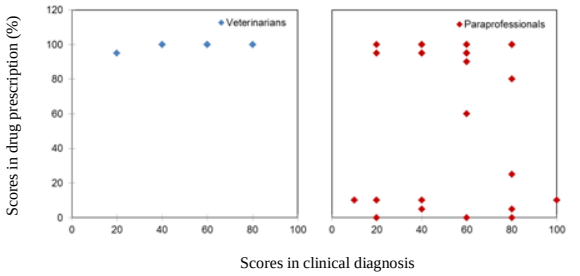
Figures 5.1b to 5.1f are scatter diagrams for clinical diagnosis and prescription for each disease. The results show that there is a major problem in drug prescription by paraprofessionals, especially in the treatment of ECF and Anaplasmoisis (see Figures 5.1b and 5.1c below). Six of the cases in ECF 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 Oxytetracycline, 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 Oxytetracycline.



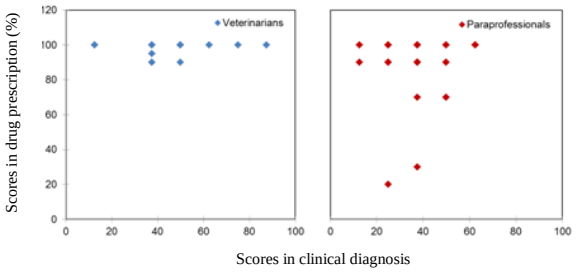
a) The scatter diagram tor veterinarians and paraprofessionals overall scores in diagnosis scores in the treatment



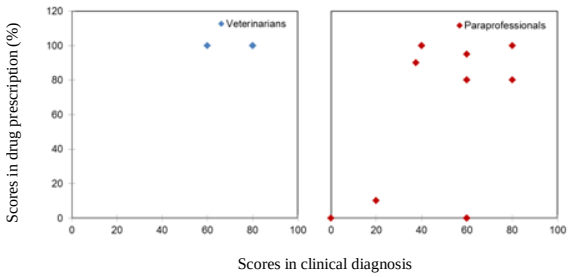
b) Veterinarians and paraprotessionals scores in the treatment of East Coast Fever



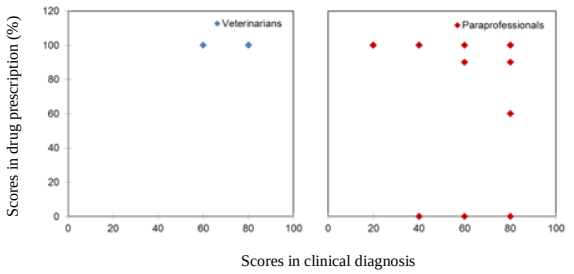
c) Veterinarian and paraprofessionals scores in the treatment of Anaplasmosis



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

For Anaplasmoisis, 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 Anaplasmoisis were distributed over different paraprofessionals in both production systems. In the intensive system, these service providers prescribed mainly multivitamins, Oxytetracycline, Butarex, Suriname, and Diminazene. In the pastoral areas, the prescriptions were mainly Oxytetracycline, 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 Oxytetracycline. 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 ($p<0.05$).

5.3.2 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.

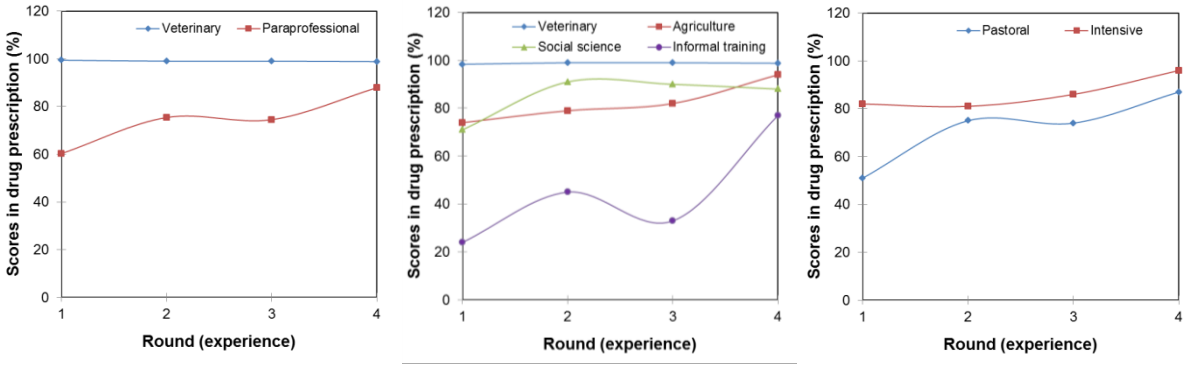
To test whether there is a significant difference in drug prescription regarding field of training, production system, and rounds, the Kruskal-Wallis test was performed. The results show that the mean scores of drug diagnosis differed significantly by field of training and production system ($p<0.01$). 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 5.2 below). Figure 5.2 is composed of three figures (Fig a-c). Figure 5.2a 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 5.2b 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 5.2b, 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 $p<0.05$.



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 5.2 The learning curves and quality of veterinary services

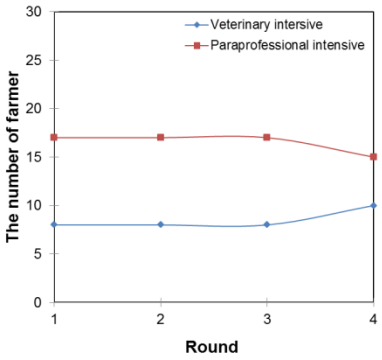
The learning curves of paraprofessionals with no formal education took the shape of a sigmoid curve. In round one the score was 24%, in round two it was 45%, in round and 33% and in round four 77%. The poor performance in round one to three can be explained by the unwillingness to consult with veterinarians, 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 5.2c 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

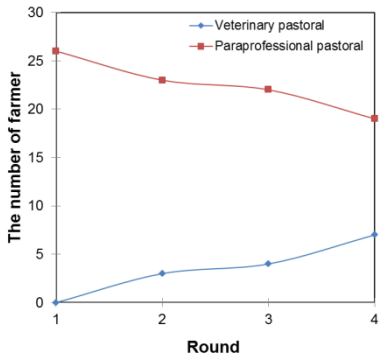
To measure the effect of information on demand, the demand for services of the veterinary and paraprofessionals was measured in each round. Moreover, farmers' belief updating curves were constructed to assess whether farmers update their beliefs about different types of service providers. The farmers' belief updating curves are shown in Figure 5.3 which composed of four figures (a-d). Figure 5.3a and 5.3b 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 ($p<0.05$).

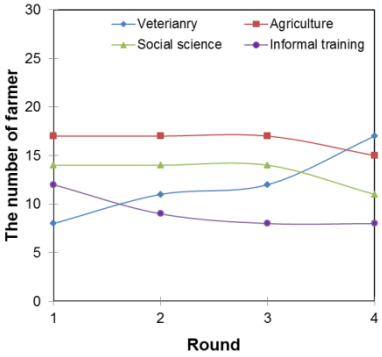
Figure 5.3c shows the results for the farmers' belief updating curves with regard to service providers by field of training. Service providers with agricultural training were found only in the intensive livestock system while those with no formal training and with social science training were found only 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.



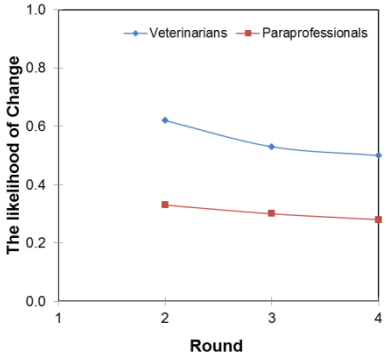
a) Farmers' belief updating curves about Service providers in the intensive production system



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 5.3 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 5.2). 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.

Table 5.2 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

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.

5.4 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 (Stepanov, Abramson et al , 2010; Thomassen, 1998). 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) argues, mentorship arrangements between paraprofessionals and professionals should be developed to ensure quality.

The results contradict the findings by Peeling and Holden (2004), Oakeley et al. (2001) and Admassu et al. (2005), which show that paraprofessionals provide quality services. For example, 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 analyse decisions and behaviours 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). They 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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6 DISCUSSION AND CONCLUSIONS

Animal diseases pose a great threat to animal production and are a major source of waste and inefficiencies (FAO, 2011). They also present a serious threat to human health arising from zoonotic and food borne diseases (Grace et al., 2012; Perry and Grace, 2009; Randolph et al., 2007). To minimize losses in animal production and risks to humans, it is important to build cost-effective institutional arrangements that address governance challenges in the provision of veterinary services to increase livestock productivity, enhance economic growth, and ensure food security (FAO, 2011; Forman et al., 2012; IFAH, 2012; Sansoucy, 1995). Building strong and cost-effective institutional arrangements for providing veterinary services or animal health care systems requires a clear understanding of the institutional frameworks and actors involved (FAO, 2011; IFAH, 2012). This thesis aims at making a contribution towards addressing challenges encountered in the provision of veterinary services by examining the institutional environment and actors involved in the provision of animal health services. The thesis: develops a framework for analyzing institutional arrangements for providing veterinary services based on market failures, governance attributes, and contextual factors; examines supply and demand processes to identify challenges in the provision of veterinary services; and assesses competencies of different service providers using innovative tools, such as Process Net-Map and role play experiments. This final chapter presents a summary of the main results, outlines the contributions of the thesis to the existing literature, discusses methodological and data limitations, and makes recommendations for veterinary policy and future research.

6.1 Summary of the main results

Chapter 2 presented a framework for the economic analysis of institutional arrangements for providing veterinary services based on transaction cost economics theory. Riviere-Cinnamond (2004) argue that the economic analysis of veterinary markets should focus on the analysis of supply and demand processes to provide a broader view of veterinary markets to include transaction costs that arise from the economics of governance attributes, such as political interference, self-interested behavior, and transaction costs. Similar views were expressed by Ahuja (2004) who argues that economic frameworks for analyzing the

provision of veterinary services should account for political, institutional, and context-specific factors that influence the provision of veterinary services. As an analytical basis, Williamson's "discriminating alignment hypothesis" was adopted. This hypothesis states that services with different attributes have to be aligned with different institutional arrangements that vary in their competencies to achieve an economically efficient result. Using this framework, we hypothesized that if a service is characterized with transaction-intensity and high care-intensity, a paraprofessional system has a comparative advantage over the veterinary system. If a service is characterized by high measurability problems, professionals will have a comparative advantage over paraprofessionals. However, if the scope for corruption and political interference is high and if a service exhibits mixed attributes in terms of measurability, externality, care intensity, and transaction intensity, an integrated or referral system has a comparative advantage over professional or paraprofessional systems.

The results from an empirical analysis of animal health service provision in Kenya and Uganda show that paraprofessional services are indeed used because they offer the needed care and attention to clients because they are located closer to clients and, thus, have lower transaction costs resulting from repeated transactions, while veterinarians are required for technical expertise. Furthermore, the results reveal the existence of a synergistic relationship between veterinarians and paraprofessionals. The use of paraprofessional services is positively related to the availability of professionals and the use of professional veterinarian services is positively related to the availability of paraprofessionals. The results support our hypotheses that if a service is characterized with transaction and care-intensity, the paraprofessional system has a comparative advantage over the veterinary system and if a service is characterized with high measurability problems, professionals will have a comparative advantage over paraprofessionals. However, clinical services have a mix of these attributes and paraprofessionals alone cannot be relied upon to provide these services. A referral systems or an integrated animal health system is required if paraprofessional and professional veterinarians work together. Using the transaction costs framework, we found that pastoral livestock production systems have a greater necessity for government interventions compared to intensive livestock systems. However, empirical results show that both the private and public sector are strong in the intensive livestock system compared to the pastoral livestock system. The major contribution of this chapter to the literature is that animal health service policies

need to consider the service attributes and the context in which animal health services are being offered. The institutional arrangements or policy options adopted should be able to strengthen the relationships between paraprofessionals and professional veterinarians.

Chapter 3 applied a participatory research method, namely, a mapping tool called Process Net-Map, to examine the process of animal health service delivery in order to identify the main influential actors and elicit governance challenges in the provision of clinical and preventive veterinary services in both pastoral and intensive livestock productions systems. This is the first study that examines the process of providing animal health services and elicits problems encountered in the provision of these services. The number and type of actors, their influence, and governance challenges depend on the type of service, production system, and institutional level or administrative unit, such as household, local government, and national level (Woodford, 2004). Although most studies on pastoral livestock production systems have shown that Community Animal Health Workers (CAHWs) play an important role in the provision of clinical veterinary services (cf. Catley et al., 2004; Peeling and Holden, 2004), our results reveal that the role and influence of CAHWs in providing veterinary services is limited because of their inadequate training and low level of education which limits them from referring cases to veterinarians and interacting with them. Moreover, they do not have drugs and financial resources to operate drug shops. As a result, farmers prefer to buy drugs and treat animal themselves. A similar observation was observed in northern Ghana (Mockshell et al., 2013). In the provision of preventive services, such as vaccination, we found that CAHWs play an important role, but resource capture by veterinarians has greatly reduced the morale of the CAHWs.

In the intensive livestock production systems, Ly (2003) and Oruko and Ndung'u (2009) find that paraprofessionals dominated animal health markets. Results from the Process Net-Map analysis in this thesis also reveal that paraprofessionals are more influential than veterinarians in the provision of clinical services in the intensive livestock production system. However, competition and poor relations between veterinarians and paraprofessionals in the provision of clinical veterinary services have greatly affected the provision of preventive services, such as vaccination and disease surveillance. This is worsened by the fact that most paraprofessionals in Uganda are trained in general agriculture rather than in animal health (see Chapters 4 and 5). The quality of services that they provide is generally low (see Chapter 5). In both pastoral and intensive livestock

production systems, absenteeism by government veterinarians, limited opportunities for career progress, weak veterinary structures, and inadequate and unpredictable budgetary allocations are found to affect the provision of veterinary services. Moreover, the provision of preventive veterinary services mainly depends on decisions of officials from the Ministry of Finance Planning and Economic Development (MFPED) rather than officials from the Ministry of Agriculture. Active surveillance and routine vaccinations are not always implemented because of financial problems. Budgeting and financial releases are handled using "a fire fighting" approach. Money is only released when there is an outbreak as opposed to routine vaccination. The Ministry of Finance Planning and Economic Development (MFPED) does not consider vaccinations a priority without a disease outbreak. The budgetary allocations on disease control and prevention are re-allocated to other activities, such as administration. Considering these governance challenges at the macro level, it is therefore important to support paraprofessional and professional veterinary relations for two reasons: (1) to ensure that farmers receive better quality services amidst these problems and (2) to help build a coalition to pressure the government to create an environment that facilitates the adoption of good veterinary practices from improved relationships between paraprofessionals and professionals. As argued by Heaney and Lorenz (2012), coalition and strong pressure from interest groups influence policy process and policy makers. The success of the British veterinary profession and association between 1881 and 1919 was based on these kinds of coalitions that resulted in the recognition of the certificate holders in 1879 (Boden, n.d.).

Chapter 4 identified factors that influence referrals of cases from paraprofessionals to veterinarians. To the best of our knowledge, this is the first study carried out in a developing country that aimed to assess the factors that influence the decisions of paraprofessionals to refer cases to veterinarians. The findings suggest that mobile phones and mobile network coverage are imperative to build strong referral networks between paraprofessionals and veterinarians and that this could be because mobile phones reduce the costs of information, communication, and access (Aker, 2011; Muto and Yamano, 2009; Urquieta and Alwang, 2012). The results also suggest that paraprofessionals who more frequently deal with contagious animal diseases are more likely to refer cases to veterinarians, which may be because these diseases are supposed to be reported to government veterinarians or because paraprofessionals have limited skills to handle such diseases. Female paraprofessionals are more likely to refer to veterinarians than male

paraprofessionals, which may be because female paraprofessionals are more likely to be supervised. Referrals were also found to be limited in pastoral areas mainly because paraprofessionals and clients are not well-educated and cannot speak English, which restricts them from interacting with veterinarians. Most veterinarians are not from the same ethnic background, which is a further obstacle and is supported by findings in Eregae (2003). Moreover, the sheer number and availability of veterinarians in pastoral areas are limited, which also limits referrals.

In Chapter 5, we examined interaction among farmers, veterinarians, and paraprofessionals in the provision of clinical veterinary services using a role play experiment. The main objective was to provide empirical evidence on a topic that is contested both in the literature and in debates on veterinary policy: the quality of services provided by paraprofessionals with no formal veterinary training. Studies by Peeling and Holden (2004), Oakeley et al. (2001), and Admassu et al. (2005) offer evidence that paraprofessionals provide quality veterinary services. However, Curran and MacLehose (2002) attribute these to poor research design and argue that the conclusion that paraprofessionals provide quality services needs to be confirmed by well-designed studies. Our results show that the ability to identify the signs of different diseases and the accuracy of prescriptions by veterinarians are not significantly different from that of paraprofessionals who are trained in veterinary science. However, the ability of service providers who are not formally trained in veterinary medicine to perform these tasks is significantly lower than that of service providers trained in veterinary science. This finding point to the limited effectiveness of short-term trainings typically provided to community animal health workers or to persons with formal training in fields other than veterinary science.

The role play suggests that the continued interaction between paraprofessionals and veterinarians gradually leads to an improvement in the ability of paraprofessionals trained in general agriculture and social sciences to perform these tasks and that this is dependent on the monetary and social incentives offered by farmers. This is not the case for paraprofessionals without any formal training or education. Therefore, the findings indicate that paraprofessionals with non-formal veterinary training and formal training in a different field that are not able to perform correct drug prescriptions could perform better over time if they work closely with veterinarians. The study also indicates that the provision of curative services by community animal health workers without any formal training is

rather problematic. Thus, Chapter 5 provides evidence of the importance of veterinary education and the strengthening of veterinarian-paraprofessional relations in ensuring the provision of quality veterinary services. The chapter also demonstrates the potential of role play experiments in measuring the quality of veterinary services. One can derive from the study that the use of animal health cards or animal medical cards has a strong potential as a tool to enable farmers to distinguish and measure the quality of clinical veterinary services they receive. The tool can also 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 prescriptions in these books. Obviously, such a system will have to be linked to appropriate incentives to ensure that record keeping takes place.

6.2 Limitation of methods and recommendations for future research

This study employed a range of methods and techniques, including qualitative, experimental, and quantitative, each of which has its own limitations and strengths. In Chapter 2, we developed a conceptual framework for analyzing veterinary services centered on Williamson's discrete alignment approach derived from transaction cost theory of economics of governance. The main limitation of applying this approach arises from the difficulty in measuring transaction costs, thus leading to estimation of reduced form equations between observed attributes and institutional arrangements (Masten et al., 1991). These estimations are based on proxy variables for specific attributes (Battu et al., 2002; McMaster and White, 2013). However, there are no universally agreed proxies for specific attributes of governance (Carter and Hodgson, 2006; David and Han, 2004). As argued by Carter and Hodgson (2006), even if the reduced form estimates are consistent with Williamson's model, this does not mean that transaction costs are minimized. In addition, the framework has also been criticized because it is focused on comparative static analysis rather than dynamic analysis, and thus ignores the role of innovation, learning, and complementary institutions (Amable, 2000; Langlois, 1992; Nooteboom, 2004). However, Birner and von Braun (2009) have demonstrated that such effects can be captured. The shifts in hypothetical transaction costs, as demonstrated in Chapter 2, reflect the effect of innovations (mobile phones) and learning (acquiring skills), as well as the complementarity of institutional arrangements (referrals). Overall, despite the methodological and data limitations, the major contribution of this analytical framework can be seen in integrating

governance challenges into the economic analysis of veterinary services and in offering a number of policy options that address these challenges in efforts to improve veterinary service delivery in developing countries.

In Chapter 3, the Process Net-Map tool was applied to identify actors and elicit governance challenges in the provision of veterinary services. The implementation of the Process Net-Map exercise requires assembling stakeholders that have experience in the service delivery process and having a good understanding of the influence (power) among participants (Schiffer and Hauck, 2010). The challenge, therefore, is the selection of network members to participate in the mapping process as it requires prior knowledge of the main actors. Moreover, all actors at all levels of service delivery need to be represented to provide information regarding their roles and to facilitate the complete mapping of actors and identification of challenges and strategies for addressing them. To overcome these limitations, we conducted in-depth interviews to generate insights on which type of actors to invite to participate in the "Process Net-Map". However, it was not possible to bring all actors, especially those involved in the provision of preventive veterinary services, together. As a solution, we conducted multiple net-maps at different levels and later joined them together. In addition, we conducted in-depth interviews with some respondents who did not participate in Process Net-Map to corroborate and validate information generated during the Process Net-Map and to fill-in missing information, which is recommended by Fiol and Huff (2007).

In Chapters 2 and 3, the need for improving the relations between paraprofessionals and professional veterinarians was highlighted. In Chapter 5, we found evidence that the interaction between paraprofessionals and veterinarians will lead to an improved quality of veterinary services if paraprofessionals have at least some type of formal training. The important question that remained was how to improve those relations. In Chapter 4, we assessed the determinants of referrals from paraprofessionals to veterinarians. This assessment had some data limitations. The data used was cross-sectional rather than case-specific, like data on the history of previous treatments. We relied on self-reported data by paraprofessionals and, thus, client-related factors and information from veterinarians were not included in the analysis. In addition, we were not able to verify from veterinarians whether a specific paraprofessional had referred cases to them in the previous year. In addition, the sample size used was small and from only two districts in each country. Although we recommend future studies to collect longitudinal data which capture client,

case specific, and veterinarian and paraprofessional information for a richer analysis of referrals, this chapter still provides a good understanding of the determinants of referrals between paraprofessionals and veterinarians.

In Chapter 5, we used a role play game to measure the quality of services provided by different service providers and to assess whether the interaction between paraprofessionals and professional veterinarians will result in improved service delivery. In the implementation of the role play game, it was assumed that farmers do not treat the animals themselves because this would have posed ethical challenges (considering official restrictions on the application of veterinary drugs). Yet, in reality, farmers do treat animals themselves. Secondly, transaction costs arising from accessing service providers and drug costs were considered as a dead weight loss and assumed not to affect the farmer's choice of a service provider. Thirdly, the game assumed that the risk of an animal dying when correctly treated is zero, even though an animal in reality can die with the right treatment because of delayed reporting and drug administration (Casadevall and Scharff, 1994). Thus, for future research, we recommend that a natural experiment should be conducted in a way that farmers are given a book containing animal health medical cards and that farmers should record all the details for each case treated.

6.3 Policy recommendations

Considering the governance challenges inherent in the provision of animal health services, this thesis aimed at generating policy options that can work in environments in developing countries where governance challenges are widespread. The results presented in the chapters above provide a range of insights on the policy options needed to address and mitigate these inherent governance challenges.

a) Strengthening the relationship between paraprofessionals and professional veterinarians

The results provide evidence regarding the need for a strong and well-integrated referral system among farmers, paraprofessionals, and professional veterinarians, the government and drug sellers. In Chapter 2, we hypothesized that referral systems would be the most cost effective in providing animal health services and this was confirmed by the empirical results which showed the existence of a synergistic relationship between veterinarians and

paraprofessionals. In Chapter 3, the results revealed that farmers, paraprofessionals, professional veterinarians, the government, and private actors are interlinked and that all of them have significant and different roles in the provision of animal health services. For example, livestock owners or other household members monitor animals and are often the first to notice that animals are sick. But, they do not have the necessary skills, knowledge, and drugs. Therefore, they have to depend on service providers. Since paraprofessionals are geographically closer to households than veterinarians, they are the first to receive cases of sick animals and refer cases they cannot handle to veterinarians who can handle such cases or report to the local and central government depending on whether the disease requires notification. However, the point of weakness in these linkages is in the poor relationships between paraprofessionals and professional veterinarians. Farmers have no or limited access to veterinarians, but paraprofessionals can access veterinarians. Therefore, strengthening paraprofessional and professional veterinarian relations is important in ensuring timely reporting, treatment, and reduced tendencies of self-treatment, thus reducing waste and efficiency in animal production. In Chapter 4, we found a number of factors that influence relations between paraprofessionals and professional veterinarians, including the supervision of paraprofessionals by professionals, expansion of mobile phone ownership by paraprofessionals, formation of paraprofessional associations, and investment in short-term training. Formation of veterinary and paraprofessional associations will be useful to forge a sense of unity, professionalism, and local reputation, as well as to build linkages between paraprofessionals and veterinarians (Boden, 1996; Leonard et al., 2002; Ly 2002; Catley, 2004).

b) Improved targeting of livestock extension service delivery

The results from this study can be used to target interventions in the provision of livestock extension services. In Chapter 3, we found that livestock owners and herdsmen, a group often neglected, are influential in the provision of veterinary services. Our findings show that women play an important role in the detection and treatment of livestock diseases, especially in pastoral systems. However, women and herdsmen or herd managers have been found to be less likely to receive extension services compared to male livestock owners (Ragasa et al., 2013). This finding implies that veterinary extension services should focus not only on household heads, but also on female household members and herdsmen.

This could contribute to timely reporting, treatment, and disease control, thus reducing the risk of animal loss and disease spread to other animals, livestock farms, and humans.

c) Public veterinary systems should target pastoral areas

The results from this thesis show that private professionals and paraprofessionals trained in veterinary science have come to play an important role in intensive livestock production systems after the withdrawal of the government. However, this is not the case in pastoral livestock production systems, where experience has shown that market failures could not be overcome. Our findings also indicate that the effort to close this gap by promoting community animal health workers with no formal and rather limited informal training has proven to be a rather problematic answer to this problem, especially when these service providers are expected to fulfill a major role in providing curative services, as this may lead to an inefficient use or potentially dangerous misuse of veterinary drugs. These insights suggest that stronger government engagement in the provision of veterinary services in pastoral or extensive livestock system is required. The study findings indicate that there are more government veterinarians in the intensive livestock system than in pastoral systems because of the difficulty in attracting and retaining veterinary staff in pastoral areas. Leonard et al. (1999) show that veterinarians are difficult to retain and motivate and that they will require higher wages compared to paraprofessionals who hold diplomas in veterinary medicine. Our study results indicate that such paraprofessionals are a viable alternative to veterinarians with university degrees. Therefore, governments should consider recruiting paraprofessionals trained in veterinary science who hold diplomas. They could be hired at lower levels of government, such as sub counties in the case of Uganda. This group of service providers is more likely to stay and work in rural areas than veterinarians with university degrees. As further discussed below, governments and donors could support the training of para-professionals who come from pastoral areas, such as by providing specific scholarship opportunities for students from those areas. This could further increase the likelihood that graduates will work in their areas of origin and that communication problems from difference languages would be reduced.

d) Enabling farmers to measure the quality of services they receive

A stronger focus on government services in pastoral areas will be more effective if it is combined with measures that empower clients to hold service providers accountable. This will help overcome governance challenges inherent in public sector service provision and which led to privatization in the first place. One of the principle problems of empowering clients is the difficulty of the livestock owner to measure the quality of animal health service they receive from service providers. Animal health service providers are consulted because they are assumed to have specialized knowledge or skills, but the livestock keepers have limited ways of knowing whether the service providers' skills and efforts are appropriate to solve their problem (Ly, 2003). If a farmer is not able to measure the quality of service received, that farmer's ability to provide the right incentives to the service provider is limited. The use of animal health medical cards, as suggested in Chapter 5, may offer an avenue to address this problem. Most farmers in the game expressed excitement in the use of animal health cards as a tool to hold service providers accountable. The tool can also be useful in providing proper record keeping and monitoring of antimicrobial agents used in animals. Farmers should be encouraged to use exercise books and service providers could be asked to write their diagnosis and prescription in these books. The tool could help farmers distinguish qualifications of different services providers and the quality of services they offer. The tool could also help reduce or eliminate non-educated paraprofessionals in the market and reduce competition. In France, the veterinary association developed the VETELEVAGE software package for monitoring of prescription and use of medicines at the farm level. The computerized register is shared by farmers and veterinarians. Veterinarian interventions and prescriptions as well as farmer interventions and administered treatments are recorded. The application makes it easy to monitor herd performance, treatment protocols, and antibiotic prescriptions (Brard, 2013). Obviously, a computer system is not applicable in the pastoral areas under consideration in this thesis. However, similar principles could be applied. Pilot projects and experiments with such systems will be useful in developing and testing report card systems. The experience with citizen report cards could be useful (cf. Thampi and Sekhar, 2006).

e) Investing in veterinary education

The results in Chapter 5 indicate that paraprofessionals without any formal education have insufficient capacity to perform a correct prescription of drugs, which has rather problematic effects. Therefore, there is a need to invest in veterinary education to ensure that enough qualified veterinary staff (both diploma and degree holders) are available to offer veterinary services. As indicated above, there would be advantages if promising students from pastoral areas have access to this type of training. Governments in developing countries could support and encourage recognized universities or tertiary institutions to establish training centers in livestock producing areas to encourage the training of veterinary para-professionals. In human health care, most tertiary training institutions are available in the marginal or rural areas in most developing countries, including Uganda and Kenya. Regrettably, this is not the case for animal health. This approach would have a considerable potential for increasing enrolment rates because of reduced access costs (Benson, 2001). In addition, development partners (donors and NGOs) and governments could establish scholarship programs that target the training of community-based animal health workers or students from livestock producing areas or hard-to-reach and marginalized livestock producing areas. A similar scholarship[12,13] program is being implemented in Uganda by the Ministry of Health to support human resource development in the provision of human health care services in marginal areas**.** Such an intervention for animal health would ensure that marginal areas have sufficiently qualified veterinary staff to offer quality veterinary services. Otherwise, the livestock sectors in those areas will continue to be disadvantaged by unqualified service providers and as a result drug misuse, disease outbreaks, and delays in disease reporting and surveillance challenges will persist. This will inflict significant losses to farmers, health care systems, and to the economy as a whole. In conclusion, without investment in veterinary education, weak paraprofessional and professional veterinarian relations, a reliance on non-formally trained paraprofessionals, and the inability of livestock producers to measure the quality of services they receive, the animal health care system cannot effectively address threats from emerging and re-emerging animal diseases.

[12]The Ministry of Health scholarship fund for hard-to-reach and priority areas (http://health.go.ug/mohweb/?page_id=695).
[13] The Ministry of Health scholarship fund for hard-to-reach and priority areas (http://health.go.ug/docs/scholarships.pdf).

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APPENDICES

Appendix A: Household Questionnaire

Question ID	Question	Answer
1	University of Hohenheim, Institute of Social and Institutional Change for Agricultural Development in Tropic and Sub tropics and Food Security Centre. Research Project on Institutional Arrangements for Livestock Service Delivery. This survey questionnaire module is to be used in a household survey for livestock keepers	
2	Location of household:	
	Latitudes	
	Longitudes	
	Altitudes	
3	Enumerator Name	Lokomo simon peter Brenda Nanyonga Amongin Georgin Achilla John Bosco Eragu Kyambade Miriam John Ilukor
4	Date of interview	
5	Name of Respondent	
6	District	Amudat Masaka Pokot Kenya Kakemega
7	Sub – county	Karita Amudat Loroo
8	Parish (LC2)	
9	Village (LC1)	
10	A1: Household size	

A2-Loop Iteration 1

Question ID	Question	Answer
11	Name of the house hold member	
12	Age and if less than one year write 00	
13	Sex of the HH member	Male/Female
14	OFF-FARM ACTIVITY: Does household member engage in off-farm activities?	Yes/No
15	RELATIONSHIP TO HEAD	1= Head 2=Spouse (wife/husband) 3=Child (son/daughter) 4=Grandchild 5=Parent/parent-in-law 6=Son/daughter-in-law 7=Other relative 8=Adopted/foster/stepchild 9=House-help 10=Non-relative

16	Education	1=None 2=Primary 3=Middle/JSS 4=Vocational 5='O' level/SSS 7='A' level 8=College training 9=Tech/Proof 10=Tertiary 11=Koranic 12=Don't know
17	Can he or she read or write?	Yes/No
18	Marital status	1=married, 2=consensual union, 3=separated 4=divorced 5=widowed 6=never married
19	Occupation	1=Farming 2=Teaching 3=Artisan 4=Office worker 5=Civil servant 6=Health worker 7=Trading 8=Unemployed 9= Non- Agric labor 10=Student/ Pupil 11= Infant
20	Religion of the household member	1=Traditional 2=Muslim 3=Christian 4=No religion
21	Migration: Does this HH Member migrate during the year?	Yes/No
22	If yes, how many months	
23	What % of time is spent on farming? If a household member has farming in addition to another occupation	
24	Does your HH own land	Yes/No
25	How many parcels	
26	Do you want to add information about another HH member	Yes/No

Land Holding Iteration 1

Question ID	Question	Answer
27	Parcel number	
28	Name of the Parcel	
29	Size in acres	
30	Use of the parcel	1= Crop 2= Livestock 3=Mixed 4= Fallow 5= Forested 6=Settlement
31	Date when the parcel was acquired. (note we are mainly interested in the year)	
32	Mode of acquisition	1 = Purchased 2 = Inherited

		3 = Rented 4=Agift
33	Tenure	1 = Freehold with title 2 = Freehold without title 3 = Rented 4 = Communal 5=Leased
34	How is the parcel used for livestock	1=Grazing 2=Growing feed for livestock 3=Housing
35	Do you want to add more information about another parcel	Yes/No

B: FARM INPUTS-loop Iteration 1

Question ID	Question	Answer
36	Farm inputs in the farm	Spraying machine Tractor Plough Trailer/cart Ear tag application Hoe Axe Rake Shovel Cooling machine Hay equipment Fencing equipment Vehicle Drenching gun Feed /Water trough Water pump Irrigation pipe Computer Feedlot equipment Breeding equipment
37	How many	
38	Price u bought it	
39	Add more information about another farm equipment	Yes/No

OTHER SOURCES OF INCOME-loop Iteration 1

Question ID	Question	Answer
40	OTHER SOURCES OF INCOME	Petty trade Employment as casual labor Formal employment Remittances from relatives Government pensions Dividend on shares Interest on savings Renting out houses
41	Average income per year	
42	Add more information about another income source	Yes/No

D1-Loop Iteration 1

Question ID	Question	Answer
43	Can you please tell me each individual crop that your household planted in last year?	1=Bananas 2=Cassava 3=Maize 4=Sorghum 5=Sweet potatoes 6=Ground nut 7=Beans 8=Coffee 9=Millet
44	What area was planted in acres	
45	What type of cultivation did you use?	1= Mono-crop/2= Inter-crop
46	Type of fertilizer used	0 = None/1= Manure 2 = Chemical/3 = Both
47	Cost of land preparation	
48	Tools Used	1= Manual tools 2= Animals & machinery 3 =Tractor services
49	Cost of the seed per kg	
50	Quantity of the fertilizer in Kgs	
51	Cost of the fertilizer used per bag	
52	What was the total labour that was hired to produce crop for each of the following activities? (man days)	
	Land clearing	
	Planting	
	Weeding	
	Harvesting	
53	Hired labour costs per day per person on average?	
54	Total amount that was harvested (see the units in the next question)	
55	Units of the harvests	Kg/Bag/Basin/Calabash/Tin
56	Total amount that was sold?	
57	Unit Price for which it was sold	
58	Where did you sell most of the crop	1= Farm gate 2 = Village market 3 = Distant market 4 = Buyer's premises 5 = Cooperative /Association Premises 6 = Central collection point 7 = Farmer's House
59	Who was the main buyer of your crop?	1 = Exporter 2 = Farmer cooperative or association 3 = Consumers 4 = Relative/Friend 5 = NGO 6 = Local Women 7=I sell at the local market 8=Middlemen
60	What was the average value of sale	
61	If you did not sale at the farm gate what do you estimate to be the total transportation cost to the point of sale?	
62	How were you paid?	1 = Paid in full on delivery 2 = Paid certain amount on delivery and rest later

		3 = Paid full amount later 4 = Given inputs/credit prior to delivery
63	Do you want to add information for another crop	Yes/No
64	Does your hh keep cattle	Yes/No

E-Loop Iteration 1

Question ID	Question	Answer
65	Type livestock kept	Improved sheep Improved Goat Sheep Improved Cattle Local Cattle Bullock Chicken Pigs Local Goats
66	Type of breed of the animal	1 = Holstein Friesian 2 = Ayrshire 3 = Guernsey 4 = Jersey 5 = Sahiwaal 6 = Zebu 7 = Boran 8 = Ankole 9 = Torgenberg 10 = Angora goat
67	No. of animals for selected Livestock type	
68	No. of Male, value and number sold in last one year	
	Number male	
	Value in Uganda shillings	
	Number sold	
69	No. of Female, value per animal and number sold	
	Number female	
	Value in Uganda shillings	
	Number sold	
70	No. of Young animal, value and number sold	
	Number young animal	
	Value in Uganda shillings	
	Number sold	
71	Where did you sell them from	At the farm Market
72	For how long have you been keeping livestock species (Years)	
73	Did your parents keep this livestock species	Yes/No
74	Are animals owned by different household members	Yes/No
75	How did you acquire the Animal	1= NGO 2=Government 3=Parent 4=Friend 5= Bought Using my own resources 6= Cattle raids
76	Improved variety mode of acquisition	1=NGO 2=Government 3=Parent

		4=Friend
77	What is livestock farming system for this animal	1=Intensive 2=Extensive
78	What extensive grazing system do you use	Tethering Communal grazing Nomadic pastoralism
79	What intensive grazing system do you use for grazing	Zero grazing Paddock Strip grazing
80	Did you have to buy the fodder	Yes/No
81	Cost purchasing fodder in Uganda shillings	
82	If no, what is source of fodder	Cut and carry from my own farm Cut and carry from another farmers farm
83	Cost of transporting to the farm	
84	How long did it take to carry / transport (estimate time per day X 30 days)	
85	Did you have to buy feed supplements	Yes/No
86	How many times in last 12 months	
87	Cost of buying feed supplements per bag	
88	Cost of transporting the feed by Bag	
89	Most important three reasons for keeping livestock	1=Meat/2=Cash 3=Milk/4=Estate 5=Gift/6=Status 7=Culture
90	Add more information on another livestock	Yes/No
91	In the last one year, did you use AI services	Yes/No

F1-loop Iteration 1

Question ID	Question	Answer
92	The service was administered by	1= Vet office 2=Vet-Assistant 3= CAHW 4=NGO
93	Did you have to pay for the service	Yes/No
94	Type of organization that is offering the scheme	1=Govt 2=NGOs 3=Private 4=Animal research institute
95	How much did you pay per animal in Uganda shillings	
96	How were you able to contact the service provider?	1=Public transport 2=Personal phone 3=Walk 4=Ride a motorbike /Bicycle
97	How long was the visit of the person? (hours)	
98	Did you have to pay for his food?	Yes/No
99	Amount	
100	Did you have to pay for the person's transport costs	Yes/No
101	Amount	
102	How satisfied were you with the performance of the person?	1= Very satisfied 2=somewhat satisfied 3=somewhat dissatisfied 4=Very dissatisfied
103	Reasons for dissatisfaction?	
104	Add more information about another time you received AI	Yes/No

	services	
105	In the last one year, have you ever used a bull service scheme?	Yes/No

F2-Loop Iteration 1

Question ID	Question	Answer
106	How many times have used a bull service scheme in last 12 months	
107	Source of the Bull	1=Govt 2=NGOs 3=Private 4=Animal research institute
108	Who keeps the Bull	1=Farmer 2=Government official 3=Extension staff
109	Did you have to pay for the service	Yes/No
110	How much did you pay per animal in Uganda shillings	
111	How do you use the service	1= Bring the bull to my home 2= Take the cow to the bull 3=Communual
112	Do you pay a fee to person in charge of the bull	Yes/No
113	How satisfied were you with the performance of the bull service scheme?	1= Very satisfied 2=somewhat satisfied 3=somewhat dissatisfied 4=Very dissatisfied
114	Reasons for dissatisfaction?	
115	Add more information about another time you used the service	Yes/No
116	Have there been any livestock cases which require treatment last 12 months? or has any livestock suffered from any livestock diseases in last one year?	Yes/No

F3-Loop Iteration 1

Question ID	Question	Answer
117	Livestock diseases	Mastitis East Cost fever Foot and mouth disease Bovine tuberculosis Anthrax Rift valley fever East Cost fever Foot and mouth disease
118	How often did it occur in year	
119	Did you seek treatment	Yes/No
120	Last treatment month of the disease	January February March April May June July August September

		October November December
121	How did you treat the disease?	1=Self treated 2= Advice from drug seller 3=Livestock worker (CAHW, Vet, P)
122	If self-treated what did you do?	1. The use of local herbs 2=Seek advice from local drug seller 3= Advice from another farmer
123	If livestock worker name of person	
124	From which organisation?	1=NGO 2=CAHW 3=Private Vet 4=Drug seller 5=Government 7=LGA 8=Traditional animal doctor 9=Vet. Service department
125	Are you satisfied with the services of the livestock service provider?	Yes No
126	How satisfied were you with the performance of the person?	1 =Very satisfied 2 = Somewhat satisfied 3 = Somewhat satisfied 4=Very dissatisfied
127	What type of animal was affected by this disease?	1=Sheep 2=Goat 3=Cattle 4=Chicken 5=Pig
128	How did you contact the livestock service provider	1 = By phone 2 = By bicycle 3 = By motorcycle 4 = By car 5= without request
129	How long did it take the livestock service provider to come? in Hours	
130	Did you have to pay for veterinary medicine	Yes/No
131	Amount in Uganda shillings	
132	Did you have to pay for the person's time?	Yes/No
133	Amount in Uganda shillings	
134	How long was the visit of the person? (hours)	
135	Did you have other expenses (e.g. for offering tea or food?)	Yes/No
136	Amount in Uganda shillings	
137	Did you have to pay for the persons transport costs?	Yes/No
138	Amount in Uganda shillings	
139	Was there any other community members present at that visit?	Yes/No
140	How many	
141	Did the animal die?	Yes/No
142	Do you have any knowledge or methods of controlling?	Yes/No
143	Add more information about another visit and disease or another time you seeked forthe service	Yes/No

F7

Question ID	Question	Answer
144	Do you know any case where there was livestock quarantine?	Yes/No
145	Was there any quarantine service in the past year?	Yes/No
146	Who was involved in the quarantine service?	1= Government 2= NGO 3= Local community leaders 4=Other
147	Which type of animals was quarantine issued on?	1=Sheep 2=Goat 3= Cattle 4=Pigs
148	Which disease	East Cost fever Foot and mouth disease Bovine tuberculosis Anthrax Rift valley fever PPR CBPP CCPP
149	Was it enforced	Yes No
150	How did the quarantine affect you?	Could not sell Animal died No effect Could not buy an animal
151	Estimate the cost of the lost animals to you	

F8-Loop

Question ID	Question	Answer
152	How do you rank the attitude of the Service provider (1-4)	
	CAHWs	
	Governement veterinarian	
	Private veterinarian	
	Ethno Veterinarian	
153	Rank in terms of Accessibility (1-4)	
	Govt. Vet. officer	
	Private Vet. officer	
	CAHWs	
	Traditional vets	
154	Rank in terms of value of information	
	Government Veterinarian	
	Private veterinarian	
	CAHWs	
	Ethno Veterinarian	
155	Rank in terms of time spent with you	
	Government Veterinarian	
	Private veterinarian	
	CAHWs	
	Ethno Veterinarian	
156	Rank them in terms of having drugs you need.	
	Govt. Vet. officer	

	Private Vet. officer	
	CAHWs	
	Traditional vets	
157	Rank service delivery systems in terms of cost of drugs	
	Govt. Vet. officer	
	Private Vet. officer	
	CAHWs	
	Traditional vets	
158	Rank in terms of number of service providers availability	
	Government Veterinarian	
	Private veterinarian	
	CAHWs	
	Ethno Veterinarian	
159	Rank them based on effectiveness of the treatment	
	Govt. Vet. officer	
	Private Vet. officer	
	CAHWs	
	Traditional vets	
160	Rank them in terms acceptability and reliability	
	Govt. Vet. officer	
	Private Vet. officer	
	CAHWs	
	Traditional vets	

F9-Loop Iteration 1

Question ID	Question	Answer
161	Type of livestock sold	1=Improved goat, 2=Local goat 3=Improved cattle, 4=local cattle, 5=Sheep, 6=Pig, 7=Poultry
162	How many did you sell (please refer to the particular sale)	
163	Unit price	
164	Who was the main buyer for the livestock?	1=Slaughter house 2 = Traders from the city 3 = Farmer cooperative or association 4 = Consumers 5 = Relative/Friend 6 = NGO 7 = Local Women 8= I sell them at the local market 9=Sold at home
165	What was the distance in kms	
166	Total transportation cost	
167	How were you paid?	1 = Paid in full on delivery 2 = Paid certain amount on delivery and rest later 3 = Paid full amount later 4 = Given inputs/credit prior to delivery
168	What form was the payment?	1 = Cash 2= Cheque

		3=Barter trade
169	How satisfied are you with the marketing channel?	1= Very satisfied 2=Somewhat satisfied 3=Somewhat dissatisfied 4=Very dissatisfied
170	Do you have access to market information?	Yes/No
171	How did you receive your market information?	1= From a friend through use of a mobile phone 2= Agric. market Information service 3=From local the market
172	Do want more information about animal sold	Yes/No

G-services Iteration 1

Question ID	Question	Answer
173	Have you ever received or performed following services in your farm? Vaccination, Spraying, Dipping, Castration and Deworming	Yes/No
174	Select the Service	Vaccination Spraying Dipping Castration Deworming Branding
175	How Often did you use this service in last one year	
176	Did you hire people to help in offering this service?	Yes/No
177	Number of people hired	
178	Unit costs per labour per day	
179	Do you pay them per day	Yes/No
180	Hours of HH labour spent per day in the activity	
181	Are family member paid for the service	Yes/No
182	Do you need to add more information about another service	Yes/No

H

Question ID	Question	Answer
183	H1. Do you have a savings account with any formal or informal financial institution?	Yes No (no financial institution around but interested) No (not interested)
184	H2. Did you access credit for farming purposes in the last one year?	Yes/No
185	Form of credit	Cash In Kind
186	Type of provider:	1 = Bank 2 = Cooperative 3 = Trader / shop 4 = Money lender 5 = Friends and relatives 6 = Merry-go-rounds
187	Purpose of loan?	1=cropping activity 2=Livestock activity 3= Home consumption

		4=Health expenditure 5=School fees 6=Marriage
188	Amount (sh) (if kind estimate value)	
189	Interest rate in %	
190	Payment interval	1 = per Day 2 = per Week 3 = per Month 4 = per Year
191	Have you had problems in repaying the loan	Yes/No

I-Institutions

Question ID	Question	Answer
192	Are you a member of any FB0 or farmer related to livestock?	Yes/No
193	Name of the FBO	
194	Who facilitated the formation of this FBO or farmer group	NAADS group NGOs Community members themselves
195	Member since which year	2011 2010 2009 2008 2007 2006 2005 2004 2003 2002 2001 2000 1999 1998 1997 1996 1995 1994 1993 1992 1991 1990 1989 1988 1987 1986 1985 1984 1983 1982 1981 1980
196	Do you have any function in this FBO?	Yes/No
197	If yes: which function or position	
198	How many members are there in this group?	
199	What are the major activities of this FBO?	1=credit supply

		2=joint purchase of inputs 3=joint selling of outputs 4=joint agro-processing 5=FBO receives agricultural extension 6=Joint cultivation
200	During the last one year how often do have meetings	Once a week Twice a month Once a month 4 times a year 3 times a year once a year
201	During the past one year how many times have you attended FBO meeting?	
202	Were there meetings during the last year that you did not attend?	Yes/No
203	In case you do not attend all FBO meetings, what are major reasons for not attending	1=had other work to do 2=topic not of interest 3= Family problem 4=Transport challenges 5=I did not like my leaders
204	In last meeting how long did it take? (Hours)	
205	Did you lose opportunity to earn income because you went for this meeting	Yes/No
206	how much	
207	How much did you spend to sustain yourself in the meeting	
208	Did you a receive an allowance from the association or FBO meeting	Yes/No
209	How much	
210	Do you have to pay a membership fee to be a member?	Yes/No
211	How much per year	
212	Did you have to pay a fee/contribution when the FBO was established?	Yes/No
213	how much?	
214	Does your FBO have a constitution of by laws?	1. Yes 2. No 3. Don't know
215	Were you involved in the development of the constitution/bylaws?	Yes/No
216	To your knowledge, were your FBO leaders or leaders of other association involved in any meetings that local government (LG) organized to plan livestock related activities in this District/area?	Yes/No
217	Was there a discussion among the FBO members on what LG should do?	Yes/No
218	How much influence do you think your FBO has on LG's priorities?	1 = high 2 = some 3 = little 4 =no influence
219	To your knowledge, were your FBO leaders involved in any meetings that the District council organized to plan their activities in this District/area?	Yes/No
220	Was there a discussion among the FBO members on what the District council should do?	Yes/No
221	How much influence do you think your FBO has on the District Council's priorities?	1 = high 2 = some 3 = little 4 = no influence
222	How much influence do you think your FBO has on the	1 = high

	NAAD's priorities in the sub county?	2 = some 3 = little 4 = no influence
223	List your three most important benefits for being a member of the FBO?	

J-Records

Question ID	Question	Answer
224	Do you keep farm records?	Yes/No
225	Why not	
226	Which type of farm records do keep?	1=Crop farm records 2=Livestock farm records 3=Marketing farm records
227	Have you ever received training on farm record keeping?	Yes/No
228	Which organization offered the trainings?	1=NGO 2=Government extension 3= CAHW
229	Does your farm records follow particular format or structure	Yes/No
230	In your view what are the 5 main constraints to livestock production?	1. Availability of drugs 2. Availability of transport 3. Market services 4.Lack of credit 5.High cost of livestock service delivery 6.Information service 7.Long distance to travel to service provider 8.Lack qualified livestock workers 9. Insecurity 10. water

Appendix B: Service Provider Questionnaire

Question ID	Question	Answer
1	Introduction: This is a PhD study for John Ilukor on Institutional Arrangements Livestock Service Delivery. This is a survey questionnaire module administered to livestock service providers. Information that your are going to provide will be used for academic purpose only. Please can you tell us your name.	
2	Start time	
3	A1. Interviewer:	Miriam Kyambade Kabogo C Brenda Nayonga Georgin Amongin Ronnet Atukunda John Ilukor Namaganda C Awori Eris
4	Date: __ __ / __ __ / 2011	
5	A2. Supervisor:	John Ilukor Regina Birner
6	A3. District Name:	Amudat Masaka Nakapiripirit Pokot-Kenya Kabras Kakamega Mukono
7	A4. Sub county Name:	Karita Loroo Amudat Moruita Mukono Kabras Kapenguria Kyampisi NBabaale Nakisuga Mpaata Ntunda Ntengeru Seeta Namuganga Nagonje Mukono Municipality Nama Ngoma
8	A5. What is your work operational area	Subcounty Parish Villages District
9	A6. Number of Operational area :	
10	A7. Were you ever transferred from another operational area within the district?	1=Yes 2=No
11	A8. If yes, which one?	Karita Loroo Amudat Moruita

		Namulu Loregai Kamongole Lolochat Nabilatuk NAKAPS tc Kyampisi Ntejeru Nabaale Mpaata seeta namuganga Nagooje mukono municipality Nama
12	A9. What is your position?	1=Veterinary Officer 2=Senior Veterinary Officer 3= Principal Veterinary officer 4= Community Animal Health Worker 4= Private Veterinarian 5= Ethno veterinarian(Traditional Vet) 6=Animal Husbandry Officer 7=Hides Improvement Officer 8=NGO Veterinary Officer Paravet
13	Do you have a phone	Yes/No
14	Telephone number	

B: Background

Question ID	Question	Answer
15	B2. Sex of the respondent	1=Male 2=Female
16	B3. Age of the respondent in years	
17	B4. What is your highest level of education?	1=None 2=Primary 3=High School 4=Certificate 5=Diploma 6=Degree 7=Masters 8 = PhD 10=Don't know
18	B7. What is your family home town?	
19	B9. What is the name of the community where you stay?	
20	B10. Are you the first generation of your family to reside here?	1=Yes 2=No
21	B11. For how many years have you lived here?	
22	B12. For how many years has your family lived here?	
23	B13. Do you have livestock?	1=Yes 2=No

B14 - Loop Iteration 1

Question ID	Question	Answer
24	B14. Indicate livestock in your farm (Provide information for the last one year)	
	Livestock Kept in the farm (1 = Grade Cows, 2 = Grade bulls,3 = Grade calves, 4 = Cross cows,5 = Cross bulls, 6 = Local cows, 7 = Local bulls, 8 = Local calves,9 = Dairy goats, 10 = local goats,11 = Sheep,12 = pigs)	
	Breeds (1 = Holstein Friesian,2 = Ayrshire,3 = Guernsey, 4 = Jersey,5 = Sahiwaal, 6 = Zebu, 7 = Boran,8 = Ankole, 9 = Torgenberg, 10 = Angora goat, 11 = local goat,12= local sheep)	
	Number currently owned	
	Number purchased during the year	
	Number born during the year	
	Number sold during the year	
	Number died during the year	
	Number stolen during the year	
	Average value per head	
25	Do you want to Add another type of livestock in the farm?	Yes No

C. Field Activities

Question ID	Question	Answer
26	C1. How many sub-operational areas do you cover?	
27	C2. How many livestock keeping households are there in these entire communities in total?	
28	C3. How many livestock keeping households do you work with?	
29	C4. Do you work with any households headed by a woman?	1=Yes 2=No
30	C5. If yes, how many households?	
31	C6.What are your major three types of animals kept in your operational area?	Catlle Goats Sheep Pigs Chicken
32	What is the largest herd size of the livestock keepers that you work with?	
	Cattle	
	Goats	
	Sheep	
	Pigs	
	Chicken	
33	C8. What is the average herd size of the livestock keepers that you work with?	
	Cattle	
	Goats	

	Sheep	
	Pigs	
	Chicken	
34	C9. What is the smallest Herd size of the livestock keepers that you work with?	
	Cattle	
	Goats	
	Sheep	
	Pigs	
	Chicken	
35	C10. What percent of the livestock keepers that you work with in each livestock category produce mainly for home consumption?	
	Cattle	
	Goats	
	Sheep	
	Pigs	
	Chicken	
36	C11. What are some of the most important ways you come into contact with the livestock keepers that you work with	1 = I meet them as an FBO 2 = They call me 3 = I visit them in their homes 4 = They visit me at my house 5 = Trainings and demonstrations 6 = They visit me at the LG office
37	While in villages treating animals; do you at times provide treatment for humans as well	Yes/No
38	If yes what are the main activities do you offer to sick people	Injecting Prescribing drugs Minor Operations Sell drugs to them First aid

C12-loop Iteration 1

Question ID	Question	Answer
39	C12. Please describe some of the livestock related topics/technologies that you recently promoted or demonstrated to farmers in the last one year.	
	Type of technology(1=disease identification and control, 2=Animal Vaccination, 3=Deworming, 4=Parasite control, 5=Livestock housing and construction techniques,6=Castration, 7= Artificial Insemination, 8=Prevention of Zoonotic diseases,9=Feed Preparation)	
	Was this topic requested by someone? 1= Yes, 2=No	
	Did you use physical demonstration materials?1=Yes, 2=No	
	If yes, how did you acquire these?1=from office, 2= personal resources,3= farmers provided, 4=NA	
	Do they pay for the service? 1=Yes, 2=No	
	If no who meets the costs?1=NGO, 2=	

	Government, 3=a farmer 4 = NA	
	What % of livestock keepers use the technology?	
40	Do you want to add more information about the technology	Yes/No

C13-loop Iteration 1

Question ID	Question	Answer
41	C13. Which of the following livestock service activities were you involved in the past one year?	
	Activity(1=Vaccination, 2=Spraying, 3= dipping,4=Deworming, 5=Artificial Insemination, 6=Quarantine)	
	Did you participate in the this activity?1=yes, 2=No	
	Was it a free service?1=yes,2=No	
	If no, How much did you charge per animal? if yes 99	
	Were CAHWs involved in provision of these services? 1=yes, 2=No	
	If yes did you have to pay them? 1=yes,2=No, 3=NA	
	How much did you pay the CAHWs (Paravets) for the exercise? if no=99	
	How many animals were involved in the exercise?	
	If you did not perform these services, what would be the loss to livestock keepers per animal?	
	What was the cost of veterinary medicine, per animal in these exercises?	
	How much did you spend on transport?	
42	Add more information	Yes/No

C14-Loop Iteration 1

Question ID	Question	Answer
43	C14. What are some of the most prevalent livestock diseases in your area of jurisdiction (Please indicate the diseases that have occurred in the area in last one year)	
	Five most common livestock diseases in your area of operation(1=Anthrax, 2=East coast fever, 3=Anaplasmosis,4=F&M,5=Trips ,6=RV, 7=Brucelloisis,8=PPR,9=Mastitis,10=Babiosis,12=Helmint hs Infestation, 13=CBPP, 14=CCPP , 15=lumpskin	
	Is the disease treatable?1=Yes, 2=No	
	Were you called upon to treat the livestock? 1=Yes, 2=No	
	Which livestock get mostly affected? 1=Cattle, 2=Goats,3=sheep,4 = Pig	
	How many livestock died due to the disease	
	Value of the animals that died of the disease	
	For animals that survived, estimate the value of loss due to	

	the disease?	
44	Do you want to add more information about another disease	Yes/No

D1- Loop Iteration 1

Question ID	Question	Answer
45	D1. In the last one year, how often did you hold consultations with the following types of people? (prompt for all)	
	Professional persons you meet; 1=Traditional Animal Health Practitioner, 2=Community Animal Health Workers, 3= Veterinary Staff, 4=Livestock stock Researcher	
	Frequency (1=Never, 2= A few times a year, 3=About once a month, 4=Several times a month	
	Reasons (1=Sharing Knowledge, 2=Supervision, 3=Casual)	
	Are there service providers to whom you refer or consult with (1= yes, 2 = NO)	
	If yes who do you refer farmers to (1= vete office, 2=Animal health officer, 3=Colleague, 4=NA	
	Paravet	
46	Add more information	Yes No

E1-loop Iteration 1

Question ID	Question	Answer
47	E1. Please tell us about your occupational history, beginning with your current position and working backwards in time.	
	Position Title and Grade (1=Animal Husbandry Office, 2= Veterinary Assistant, 3=Veterinary Officer, 4=Senior Vet Officer, 5=Principal Vet Officer, 6=District Production Officer)	
	Office / Location(1=District HQ, 2=Sub county	
	From when?	
	To when?	
	Annually assessed? 1=Yes, 2=No	
48	Add more information	Yes/No

Formal education Iteration 1

Question ID	Question	Answer
49	E2. Information on professional training either before or since you started work?	
	Name of training or certificate	
	Training organization	
	Year	
	Duration	
	Did the training include a gender component (yes, No, gender specific)	
	How do you describe the training (Very Useful, Somewhat useful, Not very useful, not all useful)	
50	Add more information	Yes/No

Transport

Question ID	Question	Answer
51	E4. Do you have access to a motorbike or vehicle for work?	Yes/No
52	E5. If yes, is it:	Individual Shared
53	E6. If individual, was your motorbike or vehicle:	1=Purchased from local government 2=Purchased on own 3=Given free from local government 4=Given free from other project 5=Provided by an NGO
54	E7. When did you acquire it? _____(	
55	E8. On average, how much do you spend per month on mobility for your job? (Amount in local currency)	
56	E9. On average, how much do you receive in transport and travel allowances per month? (Amounts in local currency) please type 999 if service provider is self-employed or privately employed	
57	Are you aware of the existence of any kind of award in your district in recognition of services delivery to farmers	Yes/No
58	Name of the award	
59	Does it have monetary value	Yes/No
60	Monetary value of the a ward	
61	E10. Have you ever received an award for good performance, such as Farmers Day Best Extension Agent?	Yes/No
62	E11. If yes, please specify name of award:	
63	When you were recruited did receive orientation	Yes No Not Applicable
64	Were you given instructions or guidelines on professional actions	Yes No Not Applicable
65	Are always subject to performance appraisals say at the end of year	Yes No

		Not applicable
66	How do perceive this appraisal	Useful in guiding professional conduct Just for formality Always conduct in free and fair manner The appraisal is always biased
67	E12. In the past one year, have any of the livestock service providers been subjected to sanctions for unprofessional conduct?	Yes/No
68	E13: If yes, how often did this happen? Approximately. _____times	
69	E14. What were the causes of this disciplinary action?	1=Failure to submit report on time 2=Poor work performance 3=frequent complaints from farmers 4=Conflict with supervisor 5=Soliciting or accepting bribe 6=Other (specify):_____ _____ 7= Abusing farmers
70	E15. What was the sanction?	=Withholding of transport allowance 2=Salary decrease for a specified length of time (suspension) 3=Warning 4=Demotion 5=Public censure and reprimand 6=Other (specify):_____ _____
71	E16. a) Are you a member of any professional body such as a veterinary association or any form of professional association?	Yes/No
72	b) If yes: which one:	
73	Member since	
74	E17. a) Are you aware of any other professional body of livestock service providers?	Yes/No
75	b) Name	
76	c) Are you aware of anybody who has been disciplined by the professional body that you have named above?	Yes/No
77	If No or yes why	

F. Perceptions of Work Environment

Question ID	Question	Answer
78	F1. In your own view, what are the three biggest problems facing the livestock keepers that you work with? (ask and do not prompt for the answers)	1=Access to credit 2= Access to water 3=Weather failure 4=Pests and diseases 5=Diseases 6=Marketing of farm produce 7=Other (specify): _____ 8= insecurity 9=Staff or veterinarians
79	F2. Have you ever had an experience working with Community Animal Health workers or	Yes/No

	Paraprofessionals?	
80	How many community animal health workers are in your operational area	
81	F3. According to you, what are the three main contributions of CAHWS or paraprofessionals?	
82	F4. What are the three main weaknesses of the CAHWS or paraprofessionals?	
83	What are the main challenges faced by CAHWs in their service delivery	
84	F5. According to you, do you think there is need to integrate CAHWS into Government livestock service delivery systems?	Yes/No
85	As CAHWS, do you think your activities should regulated and you should be recognized by government	Yes/No
86	Explain	
87	F6. What needs to be done in order to ensure this?	
88	F6. Why not?	
89	Do you believe that paraprofessionals and Community Animal health workers are a replacement for retrenched certificate holders for government staff	Yes/No
90	Explain your answer	
91	Have you had experience working with former frontline workers that were retrenched by government	Yes/No
92	Can CAHWs be compared with the former frontline certificate holders animal health assistant that were retrenched by government	They have same experience and training CAHWs are ill-trained They serve the same purpose CAHWS are more trained and equipped than the frontline Office CAHWS are more effective than frontline Officers CAHWS are less effective than Frontline Officers They are have same qualifications No difference in their effectiveness

G. Beliefs of Work Environment

Question ID	Question	Answer
93	G1.Veternary association is very competent in supervising activities of veterinary professionals or practitioners?	Strongly agree Agree Disagree Strongly Disagree
94	G2. Livestock service providers respect the decisions of veterinary association	Strongly agree Agree Disagree Strongly Disagree
95	G3. Working with the private sector is not all that beneficial to small scale livestock keepers as the private sector is only interested in making profits.	Strongly agree Agree Disagree Strongly Disagree
96	G4. Without subsidies on veterinary drugs, livestock keepers will not keep improved	Strongly agree Agree

	breeds	Disagree Strongly Disagree
97	G5.I feel that your work is recognized by livestock keepers and co-workers	Strongly Agree Agree Disagree Strongly Disagree
98	I always work in isolation (alone)	Strongly agree Agree Disagree Strongly Disagree
99	G6. Your salary and/or other benefits received allows you to maintain a decent standard of living	Strongly Agree Agree Disagree Strongly Disagree
100	G7. There is a tendency of livestock service providers to over prescribe drugs	Strongly Agree Agree Disagree Strongly Disagree
101	G8. Livestock service providers always charge a fee for free services to meet transport costs	Strongly agree Agree Disagree Strongly Disagree
102	Livestock service providers often offer services on credit	Strongly agree Agree Disagree Strongly Disagree
103	G9. Livestock keepers always pay their bill if the service is offered on credit	Strongly agree Agree Disagree Strongly Disagree
104	In case a farmer does not pay at all, you can always seek court action (local and policy) and you would get paid	Strong agree Agree Disagree Strongly Disagree
105	G10. Regular visits to the livestock keeper motivates livestock keepers to pay	Strongly agree Agree Disagree Strongly Disagree
106	G11. You have all the resources available to carry out your work satisfactorily	Strongly agree Agree Disagree Strongly Disagree
107	G13. Corruption or misuse of funds is a problem in the district	Strongly agree Agree Disagree Strongly Disagree
108	Misuse of funds is not a serious problem in livestock sector	Strongly agree Agree Disagree Strongly Disagree
109	There is no money to steal in livestock sector	Strongly agree Agree Disagree Strongly Disagree
110	Livestock sector is always marginalized in terms of resource allocation in local government	Strongly agree Agree Disagree Strongly Disagree
111	G14. There is no political interference in your work.	Strongly agree Agree

		Disagree Strongly Disagree
112	G15. Most of your colleagues are well-qualified to do their job.	Strongly agree Agree Disagree Strongly Disagree
113	G16. Livestock keepers never complain about the performance of livestock service providers	Strongly agree Agree Disagree Strongly Disagree
114	G17. Complaints from livestock keepers are taken very seriously by the service providers	Strongly agree Agree Disagree Strongly Disagree
115	G18. Your activities are always supervised appropriately	Strongly agree Agree Disagree Strongly Disagree
116	Quality of supervision is always appropriate	Stongly agree Agree Disagree Strongly Disagree
117	Supervises have sufficient incentives to supervise	Stongly agree Agree Disagree Strongly Disagree
118	G19. Your workload is adequate.	Strongly agree Agree Disagree Strongly Disagree
119	G20. The farm distances from where you stay are manageable.	Strongly agree Agree Disagree Strongly Disagree
120	G21. Livestock production is disadvantaged compared to crop production	Strongly agree Agree Disagree Strongly Disagree
121	Explain your answer	
122	G22. Supply of inputs for your work comes regularly and timely	Strongly agree Agree Disagree Strongly Disagree
123	G23. Mobility to your operational area is easy.	Strongly agree Agree Disagree Strongly Disagree
124	G24. Your salary motivates you to work better	Strongly agree Agree Disagree Strongly Disagree
125	G25. You are satisfied with your job	Strongly agree Agree Disagree Strongly Disagree
126	People in your organization work for required hours and sometime over time	Strongly agree Agree Disagree Strongly Disagree

H. Decentralization and liberalization:

Question ID	Question	Answer
127	H1: Have you worked for government before the current LG District Offices (headed by LC5 or decentralization) were created or do you have knowledge about how it used to function?	Yes/No
128	H2: What has become different in livestock service delivery due to this reform?	
129	H3: How has it improved delivery of livestock services?	
130	H4. Have you heard about plans to have NAADS staff to replace Local Government Service staff?	
131	How might these affect livestock service delivery?	
132	H6. What should be done to correct or promote resulting impacts of these policy	
133	What is your salary scale or salary (99)	

Appendix C: Animal Health Medical Card

Cooperative and Integrative Game-Animal Health Card

Date:…../…../…….. **Amount a farmer receives:**…..…….....….**Balance:**…..…….....…….....

No. of Animals:…….....

Disease: English Name…… Local Name:..…..……**District Code:**…..……

Farmer ID:……**Education level: (1)** Primary, (2) secondary (3) tertiary

Sex: Male or female……..**Phase No:**…… **Village:**……

CBAHWS/PARAVET/ Veterinarian ID:…….....….…...

Telephone:……..……....

Cardinal Signs and Disease Diagnosis:

.....

.....

.....

.....

Drug Prescription and management

.....

.....

.....

.....

Consultation & Professional Fee:……..

Drug cost:……...

Transport fee:…….

Outcome:……..…….....

Referral Case: Direct refer 1 yes, 2 No……

Reason for referral: 1 Response poor, 2 Busy, 3 Others…….....……

Veterinarians ID:…….....

Telephone:……..

Cardinal and Disease Diagnosis:

.....

.....

.....

.....

Drug Prescription and management:

.....

.....

.....

.....

Professional fee:……..……..

Drug costs:……..……..……..

Fee to Paravet:…….……...

Transport fee:…….

Outcome:……..…..…..

--END--

CURRICULUM VITAE

John Ilukor

Date of birth: June 3, 1981

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EDUCATION

PhD Student of Agricultural and Institutional Economics at Food Security Centre, University of Hohenheim, Institute of Social and Institutional change in Agricultural development in Tropics and Sub-tropics. PhD thesis on "Economic analysis of institutional arrangement for providing animal health services: an application of transaction cost theory of economic organization." Methods employed include experiments, surveys, and social network analysis.

M.Sc. in the Collaborative Master's Program in Agriculture and Applied Economics (Major in Environment and Resource Economics), from August 2008 to June 2010, Makerere University, Uganda, and University of Pretoria South Africa; M.Sc. thesis on "An Economic Assessment of Farmer Adaptation to Climate Change Using Innovation in Crop Technologies in Uganda."

B.Sc. in Quantitative Economics, July, 2005, Makerere University Kampala, Institute Statistics and Applied Economics

PROFESSIONAL EXPERIENCE

September-December 2013: Impact Assessment of Prosopis invasion and participative management approaches in Afar region Ethiopia

2006to date: Lecturer at Makerere University Business School, subjects taught include economics, econometrics, mathematics, and research methods

2008-2010: Research assistant in collaborative project of Makerere University, Montana University and the International Potato Research Institute (CIP) on trade-off analysis modelling

2009-2010: Research assistant for International Food Policy Research Institute (IFPRI) projects on "Making rural services work for the poor" and "Reconstruction and ensuring accountability of agricultural livelihood projects in post conflict areas: a case of Northern Uganda"

WORKSHOPS AND CONFERENCES

Poster Presentation at First International Conference on Global Food Security, September 39 - October 2, 2013, Noordwijkerhout, the Netherlands

Attended African Association of Agricultural Economists conference on Commercializing Agriculture in Africa: Social, Economic and Environmental Impacts, September 22-25, 2013, Tunis, Tunisia

Presented papers at Tropentag conference on Agricultural development within the rural-urban Continuum, University of Hohenheim Stuttgart-Hohenheim, September 17 - 19, 2013.

Poster Presentation at International Society for New Institutional Economics Conference June 20-22, 2013, Florence, Italy

Poster Presentation at OIE Global Conference on Responsible and Prudent Use of Antimicrobial Agents for Animals: International solidarity to fight against antimicrobial resistance, March 13-15, 2013, Paris, France.

Attended 5-Day Workshop on the Behavioural Econometrics of Risk, Uncertainty and Time Preference at the Research Unit in Behavioural Economics and Neuroeconomics (Ruben) and the Center for the Economic Analysis of Risk (CEAR) University of Cape Town, January 28 to February 03 2013

Presented a paper titled "A transaction-cost framework for analyzing institutional arrangements for providing veterinary services in developing countries" during 24th Annual Conference of the European Association for Evolutionary Political Economy (EAEPE) with theme - Economic Policy in Times of Crisis October 18-21, 2012, Krakow, Poland

Presented a paper on the analysis animal health services delivery in Uganda: Analysis of Veterinary Service Delivery in Uganda: An Application of the Process Net-Map Tool during the Tropentag 2012 conference September 19-21, 2012 University of Göttingen

Presented on "The role of Farming Systems Research in future research challenges" at the World Food Day Colloquium at the University of Hohenheim

Attended NASAC-KNAW conference on "Impact of and adaptation to climate change in relation to food security in Africa", February 23-25, 2011, Hilton Hotel, Nairobi, Kenya

Presented on climate change adaptation strategies in Uganda at a workshop on GTZ/BMZ-funded climate change projects, May 2-3 2010, ICRAF campus, Nairobi, Kenya

Attended workshop “Climate Change Adaptation and Mitigation”, March 3-5, 2010, ILRI campus, Addis Ababa, Ethiopia

Attended GTZ workshop on Minimum Data Modelling in the context of adaptation to climate change, June 24-26, 2009, ILRI campus, Nairobi, Kenya

PUBLICATIONS

John Ilukor, Regina Birner, Mesfin Tilahun Gelaye and Negusse Gebreyohannes Yigzaw 2015. Economic Impact of Prosopis Juliflora on Animal Health and Production: A Case of Afar Region, Ethiopia. A paper presented during Regional Conference on Invasive Species in ASAL: Managing Prosopis Juliflora for better (agro-) pastoral livelihoods in the Horn of Africa 01 – 02 May, 2014 Desalegn Hotel, Addis Ababa, Ethiopia

Mesfin Tilahun Gelaye, John Ilukor, and Regina Birner 2015, "Households’ demand for mitigation of Prosopis Juliflora invasion in the Afar Region of Ethiopia: a contingent valuation" A paper presented during Regional Conference on Invasive Species in ASAL: Managing Prosopis Juliflora for better (agro-) pastoral livelihoods in the Horn of Africa 01 – 02 May, 2014 Desalegn Hotel, Addis Ababa, Ethiopia

John Ilukor, Mekdelawit Yeshitila Minyleshewa and Regina Birner 2015. A Cost Benefit Analysis of Prosopis Juliflora Participatory Management Approaches: A Case of

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AUTHOR'S DECLARATION

I hereby declare that this doctoral thesis is a result of my own work and that no other than the indicated aids have been used for its completion. All quotations and statements that have been used are indicated. Furthermore, I assure that the work has not been used, neither completely nor in parts, for achieving any other academic degree.

Stuttgart, 2015

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