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The role of gender and other socioeconomic factors in the adoption of the Contagious Bovine Pleuropneumonia vaccine: A literature review

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# The role of gender and other socioeconomic factors in the adoption of the

# Contagious Bovine Pleuropneumonia vaccine: A literature review

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# Abstract

This paper looks at the role of gender and other socio-economic factors in the adoption of the Contagious Bovine PleuroPneumonia (CBPP) vaccine in response to three research questions: What gender and socioeconomic factors affect the adoption of the CBPP vaccine? How do they affect the adoption? What can be done to enhance the adoption of CBPP? Answers to these questions were obtained through a review of literature on CBPP and technology adoption studies.

The review revealed that technology – including vaccine – adoption is gendered, with women tending to adopt less than men, especially in terms of consumer associated drivers.

CBPP vaccine adoption can be enhanced through one or a combination of up to four strategies, which include: price reduction and provision of subsidies by government and philanthropic projects especially in times of enhanced and unpredicted demand; convincing, evidence based, demonstration of benefits of vaccination over its alternatives using methods such as return on investment for every dollar used; gender sensitive advocacy strategies and messages; and carrying out human and livestock vaccination campaigns, simultaneously, in pastoral communities living in marginal areas.

***Keywords***

*Gender, adoption, Contagious Bovine Pleuropneumonia, vaccine, technology*

# Introduction

Livestock revolution represents the notion that the demand for livestock products by consumers in the global South will double by the year 2020. This is attributed to a combination of factors like population growth, rising per capita incomes and progressive urbanization among others (Delgado et al., 1999). Although these trends have been observed in some developing countries like China, other developing countries are not experiencing the same trends owing to their context specific differences (Pica-Ciamarra and Otte, 2009).

Vaccine technologies appear to have the potential to transform the livestock sector. If poor livestock farmers adopt the technology, production of animals, and animal source foods, can be enhanced, thus meeting the demands associated with the livestock revolution. In most low income countries, poor livestock farmers’ adoption of conventional livestock vaccine technologies is often low (Heffernan et al. 2008, 2011). Several drivers of the poor vaccine adoption have been identified and include economic drivers demonstrated by farmers’ low ‘willingness to pay’; delivery drivers and farmers’ perceptions and attitudes towards the vaccination itself (Heffernan & Misturelli, 2000, Bhattacharyya et al., 1997; Rezvanfar, 2007). What remains unclear is what drivers determine the poor adoption of vaccines in what circumstances (Heffernan et al., 2011).

This paper attempts to conceptualize the effect of gender and other socioeconomic factors on adoption of vaccines and how they affect the adoption. The conceptual framework developed from this study using findings from other studies will, propose causal relations while identifying the direction of the causality, between vaccine adoption and gender and other socioeconomic factors. Findings from this literature review will be used to inform the ongoing gender and socio-economic studies on the adoption and delivery of the CBPP vaccine.

# Literature review and methodology

This review is organized into two main sections, one on CBPP the disease and the other on vaccine technology adoption. The information in this section was obtained from multiple sources of published and gray literature obtained from books, journals, reports from the state's department of livestock and the internet.

## Contagious Bovine Pleuropneumonia

Contagious bovine pleuropneumonia is a highly contagious disease that affects cattle and water buffaloes. It is caused by a bacterium, *Mycoplasma mycoides mycoides* small colony biotype (MmmSC) (Masiga et al., 1996). It occurs in hyper-acute, acute, sub-acute, or chronic form, affecting their lungs. Occasionally, it affects the joints of calves. CBPP is spread through direct contact with cough droplets, facilitated by crowding of animals (Provost et al., 1987). According to the World Organization for Animal Health (OIE, 2008), CBPP is listed as a notifiable disease.[[1]](#footnote-1) Mortalities can be high when the disease appears for the first time in a naïve population (Newton and Norris, 2000).

### Production and productivity losses associated with CBPP

CBPP leads to livestock mortality, reduced productivity and ability of cattle to work. It also constrains genetic improvement (Otte and Chilonda, 2002). Attempts to classify losses associated with CBPP as direct or indirect have been futile with the classification often being unclear and incomplete. For example, direct losses are caused by mortality, vaccination campaign costs, disease surveillance and research programs; whereas indirect losses are caused by the chronic nature of the disease (Mlengeya 1995). Indirect losses included loss of weight, working ability, reduced milk yield, delayed marketing, reduced fertility, losses due to quarantine and consequent reduced cattle trade. In Uganda, Wesonga (1994) referred to direct effects as mortality from acute disease and indirect effects as low fertility, low birth weights, poor growth rates and poor carcass quality due to chronic disease. A study by Wanyoike (2009) showed that the estimated indirect annual production losses due to abortions and decreased calving rate caused by CBPP accounted for 27.4% of the total loss.

### Socio-economic impact of CBPP

Several authors have referred to CBPP as economically important and a major cause of economic loss. Socioeconomically, CBPP is a threat to the livelihoods of millions of cattle owners (Thomson 2005; Tambi et al., 2006). In Africa, Windsor and Wood (1998) summarized the types of economic losses associated with the disease as losses to the government, the cattle keeping communities and other associated cattle related activities. Masiga et al. (1996) estimated annual direct and indirect costs of CBPP at $2 billion in the 27 African countries where it occurs, but admitted that the economic evaluation of losses due to CBPP throughout Africa was not performed systematically. The total annual economic costs of CBPP have been calculated in twelve out of 22 infected eastern and western African countries at 44.8 million Euros (Tambi et al., 2006). Estimated annual losses in Africa caused by trypanosomosis are US$ 4.5 billion and by ECF between US$ 168 million (Mukhebi et al., 1992) and US$ 300 million (McLeod and Kristjanson, 1999). CBPP has also lead to losses associated with social welfare to the communities who depend on cattle namely; loss of dowry, loans, and gifts, leading to weakening of social ties of the communities. These are brought about by quarantines in areas affected by CBPP, leading to loss of income, employment, and food security (Bbalo, 1991; Twinamasiko, 2002; Wanyoike, 2009; Windsor and Wood, 1998).

### CBPP control

CBPP control and eradication strategies involve movement control, stamping out, vaccination, and treatment. Movement control and stamping out are considered to be too costly and logistically difficult to apply due to socio-cultural and trade practices (Tambi et al., 2006; Mariner et al., 2006a). In the context of developing countries, compensation for stamping out is unaffordable and most governments cannot police national borders effectively. Besides, transhumance and trade movements are essential for sustainability of pastoralism. This leaves vaccination and treatment as the main options for CBPP control. Treatment of affected cattle with antimicrobials has been officially discouraged (Mariner and Catley, 2004) as it alleviates the clinical signs, but does not prevent the spread of infection, and also creates a favourable environment of chronic carriers (Provost et al., 1987). This being the case, control by vaccination remains the most feasible option for CBPP.

### The current status of CBPP vaccination, successes and challenges

The current CBPP vaccine is effective when administered during vaccination campaigns. During this time, high levels of coverage (above 80%) are achieved (Bamhare, 2001). Mariner et al. (2006a) demonstrated that vaccination reduces the proportion of herds persistently infected with CBPP by 53-81% and the average mortality by 44% and that the livestock owner can save 2 US$ worth of mortality for every US$ spent on annual vaccination. An analysis of vaccination data for a 20-year period in Northern Nigeria showed a reduction in CBPP outbreaks with intensified vaccination (Nwanta and Umoh, 1992). Wanyoike (1999) also observed a sharp decline (of 89%) in number of outbreaks following vaccination of cattle during a 10-year period immediately after a major outbreak in Kenya. Under the 16 year CBPP control plan for SADC countries and within the emergency phase, high vaccination coverage of 70-90% led to a marked reduction in CBPP incidence in the Southern African region (Musisi et al., 2007).

### Vaccination policies

Existing policies on who delivers the vaccine, how vaccine is delivered, subsidies and so forth are either inappropriate or not being adequately executed (Thomson, 2004; Le Gall, 2009). The inappropriateness and /or poor execution could contribute to vaccination failure and needs to be evaluated. Where collecting animals at a central point during vaccination is a challenge, vaccination on-farm may be more appropriate and may require packaging of the vaccine in batches of fewer doses (McLeod and Rushton, 2007). Although Mariner et al. (2006b) suggested elective (non-compulsory) privatized vaccinations with the government supplying vaccines and enacting an enabling legislation, Kairu-Wanyoike et al. (2013) demonstrated that farmers are not exactly supportive of elective and private vaccination.

Full scale cost recovery or privatisation of vaccination against CBPP may lead to further reductions in vaccination coverage (Twinamasiko, 2002; Roeder, 1998) because livestock owners might prefer to pay for vaccination in an epidemic situation rather than for prevention, especially if the disease is absent (Mcleod and Wilsmore, 2002). In Senegal and Guinea, CBPP vaccinations are administered by private vaccinators with the government playing a regulatory and supervisory role, which may be more cost effective while raising vaccination coverage (Thomson, 2005).

Timing of vaccination is also critical. In the absence of disease, farmers may not present animals for vaccination particularly as herding the animals, protecting them from raiding and other farming activities may be more important (Wanyoike 1999, 2009; McLeod and Rushton, 2007). Farmers may also resist vaccination at certain times of the year when the body condition of the animals is not good (Wanyoike 1999, 2009).

The sero-conversion of CBPP vaccine (T144), currently in use, has been shown not to be associated with protection and the initial sero-conversion is only up to 60% rising to 80% only after the second vaccination (Yaya et al., 1999; Wesonga and Thiaucourt, 2000). Consequently, bi-annual vaccination, every six months, is recommended and harder to achieve than annual vaccination.

## Livestock technology adoption

In a study to examine the socio-economic determinants of adoption of improved livestock management practices among communal livestock farmers in northern Namibia, about five out of 10 livestock management practices disseminated to farmers were adopted (Musaba, 2010). Castration and vaccination were the most adopted. Dehorning, feeding livestock using cut and carry, crop residue and livestock marketing were the least adopted. Regression analysis indicated that adoption of livestock technologies increased with education, off-farm income, farmer training in animal health, and a farmer residing near extension offices. On the other hand, adoption of livestock technologies decreased with distance from the extension office with farmers located far away from the extension offices being less likely to adopt improved livestock technologies. Factors such as gender, age, experience, family labour size, cattle herd size, crop area, and extension group had no significant effect on adoption of livestock technologies in the study area (ibid). Another study that analysed the impacts of a vaccination programme for ECF in the Maasai ecosystem of South-western Kenya and north-eastern Tanzania revealed that immunization reduced calf mortality rates from 20 – 2 % (Prior price of ECF vaccination among smallholder farmers has been estimated at 15 – 25 USD and a cost-benefit of 1/3); male animals were more likely to be vaccinated than female animals because male animals were more likely to be sold (Homewood et al., 2006).

After applying ear tags to vaccinated cattle, they fetched 50% more sale price than non-ear-tagged cattle (Homewood et al., 2006). When the vaccine was sold to poor livestock owners, they vaccinated a smaller proportion of their calves and immature animals estimated at 30–34 % as compared to the wealthy households (up to 90%). Thus, wealth, both in terms of herd size and access to alternative and secure forms of income determined response to vaccination positively.

## Social and economic factors that affect technology adoption

Some socio-economic factors that affect technology adoption include household type e.g. number of wives, children and size, which has implications on labour availability; patterns of accumulation and trade including investing in property, petty trading, cross border livestock trade and raiding; education; livelihood strategies; caste; income; gender; local knowledge on the technology; group membership; state of health and illness and cosmology; farmer training, and a farmer location of residence; distance from the extension office; credit worthiness; and market (Homewood et al., 2006; Heffernan et al., 2008 and 2011; Musaba, 2010; Besley and Case, 2013). The list of factors that affect, or act as drivers to, technology adoption is indeed very long, which indicates that technology adoption is a complex subject of study and researchers should, therefore, identify specific drivers and focus on them.

## Gender and technology adoption

Gender refers to the socially constructed and normalized roles, responsibilities and status of women, men, girls and boys that are determined by culturally specified characteristics that define their social behaviour and the relationships among them. Gender differences are often manifest in four main ways: roles and responsibilities; access to resources; influence and control over resources; and distribution of benefits accrued from an event or process (Pratt and Hanson 1994; Hanson 2010). Sex differs from gender in that it is the biological state of being male or female (human and animals) and is represented by the presence of distinct anatomical features like gonads, mammary glands and beards/ manes.

Most gender based norms in majority of cultures are unfavourable to women, placing them in disadvantageous positions compared to men. Ideally, improved agricultural technologies would increase agricultural productivity of men and women farmers, increase the availability and affordability of food by consumers, especially poor women, and promote economic growth, thereby expanding non-agricultural business opportunities for both male and female farmers. Gender, therefore, plays an important role in technology adoption because gender affects farmers’ access to labour, land and other inputs and it also affects farmers’ preferences concerning outputs (Doss, 2001). It is difficult to predict, *a priori*, if and to what extent a technology will be adopted owing to the complex nuances and constant changes that take place in gender relations, which are constantly contested and negotiated according to men and women’s economic and political power (Doss, 2001; Doss and Morris, 2001). Further, owing to the complexity and heterogeneity of gender relations among households, it is not possible to generalize them at any scale.

Drivers of technology adoption include forms of labour required and how they are allocated among women, men, girls and boys; access to land and inputs; distribution of benefits; preferences for outputs; household decision making processes and the decisions on and allocation of costs and benefits among household members (Doss, 2001). In terms of labour for example, “the willingness to adopt new agricultural technology depends, in part, on the farmer’s expectation for increased output and/or alleviation of constraints of production (Doss, 2001; 2076).”

In addition to gender, biases to technology adoption are based on status and household structure. For example, the effects of gender on access to extension services and information are difficult to disentangle from the effects of income; utilization of information may depend on literacy levels and women usually have a lower literacy; access to draft oxen is also gendered with women and the poor less likely to own oxen, but sometimes being able to rent them usually at a later schedule than those who own them (Doss, 2001).

Although they are major contributors to livestock and agricultural economies, women may not adopt a new technology that is popular with men because they may have different preferences than, or face different constraints from, men. For example, attitudes towards livestock and livestock production between women and men are polarized (Kristjanson et al 2010), making it likely for livestock technologies attractive to women to be different from those attractive to men. Technology adoption may differ, for the same gender, from different geographical regions. For example, women in Kenya contributed up to 34% of their labour in milking, whereas women in Uganda contributed over 50% (Njarui et al., 2012). Changes such as commercialization of agricultural production and formalization of markets of these products may cause change in control or ownership of products, with a high likelihood of men taking over women’s products as production commercializes and markets formalize and move away from the farm gate (Njuki et al 2011). Preferences for production technologies, and hence their adoption rates, are likely to change with change in products under one’s control, which is influenced by the types of markets. It would, therefore, be prudent to factor in the gender dynamics around assets, markets and other institutions that influence the livelihoods of livestock owners (Njuki and Sanginga 2013), as well as the choices of technologies women and men are likely to use to improve their livelihoods. Other factors likely to influence technology adoption include a woman’s or man’s prevailing conditions e.g. asset endowments, vulnerabilities, and legal and governance systems (Pandolfelli et al 2008). Owing to these and other factors influencing technology adoption, establishing women’s and men’s needs and potential preferences for, and constraints to, adopting a technology *ex ante* is important (Doss, 2001). Generally, household technologies increase the welfare of women regardless of the type of decision making in the household, but the impact of agricultural technologies depends on the type of decision making in the household (Lawrence et al., 1999). Decision making on agricultural technology adoption appears to depend upon access to resources, rather than gender, but often, men have greater access to resources than women (Doss and Morris, 2001).

### Gender and vaccine adoption

Few studies on vaccine adoption have paid attention to gender. Human vaccine adoption studies with gender considerations demonstrate significant or remarkable gender differences, whereas animal vaccine adoption studies considering gender indicated that gender has no significant effect on adoption. For example, in a study aimed at identifying barriers and motivators to future HIV vaccine acceptability among low socioeconomic, ethnically diverse, men and women in Los Angeles County, USA, barriers to HIV vaccine for women were significantly related to their intimate relationships, negative experiences with health care providers and anticipated difficulties procuring insurance. Men from the same study were concerned that the vaccine would weaken their immune system or affect their HIV test results (Kakinami et al., 2008). These findings suggest that interventions to promote acceptance of the HIV vaccine should be different for women and men. Among women, interventions need to focus on addressing barriers due to gendered power dynamics in relationships. Among men, education that addresses fears and misconceptions about adverse effects of HIV vaccination on health and the importance of vaccination as one component of integrated HIV prevention may increase vaccine acceptability (Kakinami et al., 2008). From the foregoing evidence, therefore, acceptability for women differed in that it was not the acceptability of the vaccine by women, but the acceptability of the women, who used the vaccine, to their partners and families. Nevertheless, this version of acceptability seemed to be a driver of adoption by women more than men, whereas technical knowledge seemed to be a driver of adoption for men more than women.

With regard to livestock vaccine adoption, gender appears not to have an influence in adoption. A study in Bolivia on the uptake of livestock vaccination among poor farming communities and using the innovation diffusion theory, cluster analysis revealed that vaccination uptake of Anthrax, Foot and Mouth Disease (FMD), Swine Fever, New Castle Disease (NCD) and rabies was largely independent on demographic factors such as gender, age and/or economic standing (Heffernan et al., 2008). In another study in India, the adoption of particular vaccines among them FMD, Haemorrhagic Septicaemia (HS), Fowl Pox, NCD, Rabies, Tetanus and Typhoid was found to be strongly influenced by socio-cultural grouping i.e. caste, rather than other factors such as income, age, education-level or gender (Heffernan et al., 2011). These studies were not gender studies, as such, but studies that focused on vaccine adoption using gender as one of the analytical variables. They may have lacked the methodological rigor required for gender analysis for vaccine adoption. Furthermore, gender and social groupings such as caste are intricately intertwined and mutually reinforcing (Kabeer, 2000).

In a nutshell, gender influenced drivers of vaccine adoption are complex and layered. For the purpose of this study, the first layer has been labelled as primary drivers (Figure 1). These drivers influence other drivers, labelled as secondary drivers, which in turn influence the last layer, termed tertiary drivers that lead to the adoption or rejection of a technology. Some drivers qualify for more than one layer. Primary drivers include access to land and inputs, security of land tenure, perception of future tenure, decision making power, wealth/asset ownership. Secondary drivers include farmer expectation, utility of output, type of decision making and the role of habit after first adoption. Among the tertiary drivers include labour contribution, external intervention, access to land and inputs, utility of output, security and perception of tenure, capacity and decision to seek support for inputs (Figure 1).

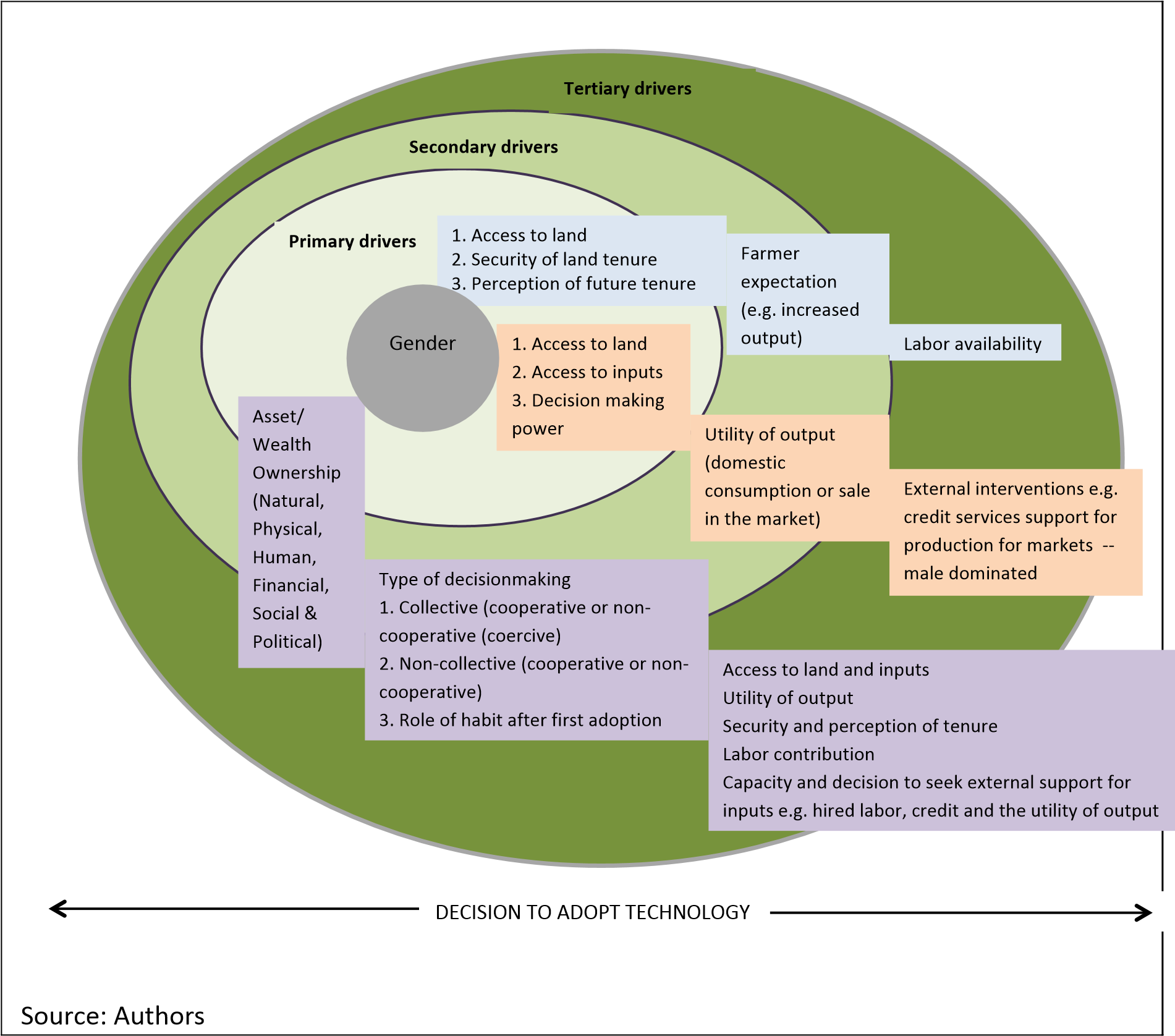
[**Insert figure 1 here**] 

Figure 1: A conceptual representation of causal relationships among gender associated drivers of technology adoption

Gender is the ultimate independent variable. Primary drivers are determined by the user’s gender, secondary drivers are determined by the primary drivers, and tertiary drivers are determined by secondary drivers. Once all drivers of adoption are established favourably, then a technology is adopted. The first category of drivers (access to land, security of tenure and perception of future tenure) determines the farmer expectation, which, in turn, determines their labour contribution. Using a CBPP vaccine as an example, if a woman from a male-headed household has no access to or security of tenure over the cows, demonstrated by, for example, being constantly denied access to milk and income from sale of milk and cattle from her household, she will lack expectation for the benefits from keeping cattle and will cease to invest her labour in the cattle production and will not be interested in adopting technologies to sustain the cattle production such as vaccination against CBPP. Similarly, if a woman is only able to access the milk and income from cattle because she is married and her marriage becomes precarious, she is unlikely to invest in cattle production enhancement technologies. In the second category, a woman whose access to land, inputs and decision making power is enabled can produce beyond domestic consumption and sell the surplus. If she is assured of continued control of production and income accrued, she is likely to seek external interventions to support production for markets e.g. credit to pay for CBPP vaccine. In the third category, men and women who own and control assets can decide collectively or in isolation what to do within their means, for example, they can buy livestock for trade and ensure that they maintain optimal production by adopting promising animal health and husbandry technologies. In male headed households, therefore, gender relations will determine how the variables in each of the three categories will determine technology adoption.

Utility of output represents what the product is ultimately used for. Women tend to produce more for domestic consumption and men more for the market because women have less control over, and ownership of land and other high value assets.

Wealth/ assets control and ownership is gendered, with men tending to have more assets than women, because of cultural practices that favour men. In many cultures, only men inherit wealth from their parents, giving men an asset “head-start” above women. Wealth can be measured in terms of assets, which are means/ resources/ capital through which people earn a living and define their lives (Bebbington, 1999). Assets enable people to have and use their agency (Meinzen-Dick et al., 2011). Agency is an acquired “enabling factor” that resonates within an individual and gives that individual the capability to be who s/he is and to act as s/he does. First, Bebbington (1999) identified five capital categories from which humans derive their livelihoods, namely, natural, human, physical, social and financial. Then Meinzen-Dick et al., (2011) added political capital, which was first described by Bauman (2005) to these five capitals and defined each as follows: natural resources capital (land, water, trees, genetic resources, soil fertility); physical capital (agricultural and business equipment, houses, consumer durables, vehicles and transportation, water supply and sanitation facilities, and communications infrastructure); human capital (education, skills, knowledge, health, nutrition; all embodied in the labour of individuals); financial capital (savings, credit, and inflows including state transfers and remittances); social capital (membership in organizations and groups, social and professional networks); and political capital (citizenship, enfranchisement, and effective participation in governance).

Much power is derived from wealth (asset ownership) and men, who are more often wealthier than women, are more likely to access and utilize this power than women.

# Discussion

This discussion focusses on the most likely drivers of vaccine adoption in relation to the CBPP vaccine.

## Most likely drivers of vaccine adoption

Literature review shows that gender-associated drivers of technology adoption have been documented, albeit in few studies. The dichotomy of categories of drivers into gender-associated and non-gender-associated drivers is strictly academic and an oversimplification of the reality. The association of gender with these drivers will be demonstrated whenever they are identified. Most vaccine adoption studies have been conducted on human vaccines and in industrialized countries, but some of the lessons identified may apply to livestock vaccine technology adoption in low income countries. Among the most likely drivers of vaccine adoption discussed in this section include: consumer related accessibility, affordability, and acceptability; political; and market-based drivers. Gender was not considered in the studies from which this discussion is drawn, but gender issues, identified in other relevant gender studies, will be integrated in the discussion.

### Consumer-associated drivers

Among the consumer associated drivers of veterinary vaccine adoption include the issue of accessibility to vaccines, affordability and acceptability (Heffernan and Misturelli, 2000), termed by the authors 3As of vaccine consumer-associated drivers.

***Accessibility***

Heffernan and Misturelli (2000) have documented that in Kenya, access to veterinary services, rather than affordability, appears to be the primary constraint to veterinary technology adoption. Households living in close proximity to donor or non-governmental organization (NGO) sponsored livestock drug stores tended to expend closer to ‘ideal’ levels of animal healthcare than those living further away. Values toward animal healthcare are, nevertheless, complex.

Few herders and farmers were spending close to the estimated ‘ideal’ on livestock drugs and the majority of expenditure was on curative rather than preventative measures. Although apparently willing, the ability of the poor to pay for treatments appears to be a limiting factor (Heffernan and Misturelli, 2000). What this finding suggests is that “willingness to pay” is a useful, but probably not sufficient, measure of technology adoption. Associated with access was knowledge on livestock health, which was poor and contributed further to the overall low uptake of veterinary technologies.

The gender gap in access to resources and knowledge is no longer disputable and has been discussed in detail elsewhere (Deere and Doss, 2006; Doss and Deere, 2008; Deere et al., 2012; Quisumbing et al., 2015). All authors agree that women have less access to resources/ assets than men owing to women’s historical and cultural subordination, which is then maintained through gender roles, practices, beliefs, attitudes and discourses. Because of established gender differences in access, women’s access to veterinary technologies, including vaccines is likely to be lower than that of men.

***Affordability***

Generally, affordability represents the ability of an individual, group or entity to pay for a good and service sustainably. At the micro scale, and in the context of animal health, affordability has been defined as the ability of poor households to pay for veterinary goods and services by evaluating how close households are to meeting the minimum necessary level of preventative and curative animal healthcare (Heffernan and Misturelli, 2000). By comparing ideal versus actual expenditure on preventative and curative animal health care, one is able to determine the affordability capacity of poor livestock keepers to uptake animal healthcare (Heffernan and Misturelli, 2000). Affordability can also be determined at the meso and macro scales and for other technologies.

Owing to its potential to represent many meanings, the concept of affordability is contested (Brooks et al.,

1999). Varying perceptions of ‘affordability’ lead to inconsistent policy positions. For example, in many countries’ public health systems, new vaccines remain relatively expensive. Even with decreased costs owing to subsidies, prices are a much higher percentage of GNP in developing than in developed countries, and costs of research and development, production and regulation are increasing. Gender is likely to affect affordability of vaccines because men and women often do not have equal amounts of money or resources that can be converted to money owing to the gendered differences in access and control of resources. Kakinami et al. (2008) attest to this claim with the finding, from the HIV study, that affordability was one of the barriers to HIV vaccine adoption by women, who were not able to purchase health insurance, whereas the issue never arose from men. A gender integrated study on the willingness to pay for the contagious bovine pleuropneumonia (CBPP) vaccine in northern Kenya, revealed that women, who owned significantly lower cattle wealth than men, were willing to pay significantly less money for cattle vaccination than men (Waithanji et al. 2018).

***Acceptability***

Two main drivers of vaccine acceptability include knowledge of the severity of the disease being vaccinated against and poor knowledge of the severity of the disease, with the former enhancing acceptability and the latter reducing it (Angelmar and Morgan, 2012). Perceptions on the effect of a vaccine in its totality can determine the acceptability of a vaccine. For example, if one perceives more positive outcomes from vaccination, they are likely to accept it more than if they perceived more negative outcomes. The belief that a product may cause the very harm it is supposed to prevent, e.g. a vaccine causing the disease it is supposed to protect against, such as reactors following ECF vaccination [sic], violates consumer trust and represents a safety product betrayal. This betrayal causes negative emotions such as anger, sadness, anxiety, fear and disgust and may cause the rejection of a product in a manner that is disproportionately larger than the harm caused (Angelmar and Morgan, 2012). In the study on HIV adoption mentioned earlier, women and men’s adoption of the vaccine was influenced differently by knowledge; men’s adoption was deterred by inadequate knowledge, whereas inadequate knowledge was not raised as a deterrent for women.

### Political drivers

Decisions to introduce new vaccines are influenced by procurement financing and economic constraints. Brooks et al. (1999) identified six themes related to this argument, namely : adoption of vaccines constitute political processes that take time, there exists confusion over vaccine priorities and policies, policies on vaccines are supply-driven not demand-sensitive, varying perceptions of ‘affordability’ lead to inconsistent policy positions, technical problems have been underplayed, and advocacy is more influential than any other factor in facilitating change. Explanations for the low prioritization of some vaccines more than others range from a historical drop in donor/ scientific interest in e.g. arboviruses; the ‘hidden’ nature of diseases – described as an ‘out of sight, out of mind’ diseases; no clear case definition; poor laboratory facilities; many unanswered technical questions over strategies; its relative lower priority in the face of major, highly visible problems such as meningococcal epidemics; and no clear advocates at country, regional or international level.

With regard to the confusion over vaccine priorities and policies, a lack of clarity on the priority of new vaccines by international policy makers is a major contributor. Attributing the confusion over policy or lack of consensus on the value of new vaccines to ‘lack of political will’ is, however, simplistic because the decision making process is itself complex and there is genuine uncertainty about what policy approaches are best in the long term. Dilemmas facing both donors and national policymakers include choosing between multiple and competing policy and funding priorities; and putting different and competing potential programmes on the policy agenda.

Difficult technical questions on vaccine efficacy appear to have been overlooked in the enthusiasm to make new vaccines available to larger numbers of people. The uncertainty about efficacy and other similarly important characteristics may cause those concerned with delivery of programmes at the country level to wait and see how policy and strategy develops in relation to new vaccines before including them in National Immunization Programs (NIPs). For the six Expanded Program on Immunization vaccines, questions on vaccine dosage, timing, cold chains and so on have been addressed.

In spite of advocacy being identified to be more influential than any other factor in facilitating change, an absence of global vaccine advocates has been noted (Brooks et al., 1999). If an agency has one or two individuals with sufficient authority and leeway to persuade others – whether groups or individuals – it can be more influential in facilitating vaccine adoption than any other factor, particularly at the country level.

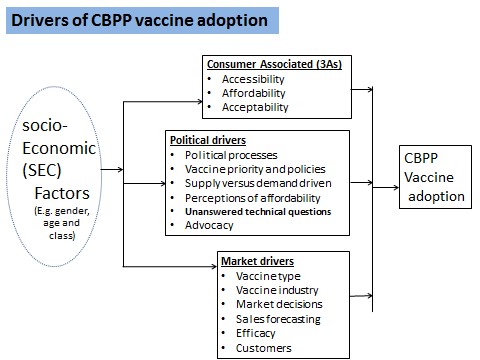
### Market-based drivers / Vaccine customers

Like for all market-based commodities, vaccines have market-based drivers that are key in the adoption of the vaccine technology. They include vaccine types; their efficacy; the vaccine industry; vaccine customers; vaccine marketing decisions; vaccine sales forecasting (Angelmar and Morgan, 2012)

In brief, vaccines are sold in public and private markets. In the public markets, governments buy and regulate the distribution of the vaccine, whereas in the private markets consumers and insurers buy the vaccine. Among the vaccine customers include consumers – the end users; prescribers – the physicians; organizations issuing vaccine recommendations such as the World Health Organization (WHO), the International Office of

Epizootics (OIE) – also called the World Organization for Animal Health, and National Immunization Technical Advisory Groups (NITAGs); and vaccine purchasers, who include governments and private/commercial purchasers (Angelmar and Morgan, 2012).

In summary, the drivers of vaccine adoption discussed in this section have been divided into three broad categories namely: consumer associated, political and market drivers (Figure 2). Each of these has a number of sub component drivers. The drivers’ effects on vaccine adoption are influenced by socio-economic characteristics such as class, gender, race, caste, religion, geographical location, political factors such as entitlement and enfranchisement of the person or group of people adopting. For example, due to the gender asset gap, access to vaccines by women may be lower than by men. Similarly access to vaccines by the poor could be lower than by the rich. Some drivers may be socioeconomic-status neutral, for example the political process that is associated with excessive delays prior to introduction of an existing vaccine in a new market.



**Figure 2: Schematic representation of the causal relations among socioeconomic factors and drivers of vaccine adoption**

# Conclusion and recommendations

Vaccine technology adoption issues are complex owing to the plethora of drivers that influence the adoption positively and negatively. These drivers carry different weights and change with context, including the type of vaccine, the community and period in time. The conceptual framework described here draws on vaccine and other technology adoption studies to guide the CBPP vaccine technology adoption study. Among the drivers proposed include the 3As of vaccine consumer -associated drivers (accessibility, affordability and acceptability), political and market based drivers. The framework therefore recommends four broad interventions that could be implemented to enhance adoption of the CBPP vaccine technology. They include the following:

1. The predictable demand intervention whereby the cost, and hence the price, of the potentially promising vaccine is lowered – through a combination of the use of cheap but effective antigens during vaccine development, introduction of government and philanthropic subsidies so that advanced vaccine purchase contracts that can cater for unpredictable demand can be made for the targeted vaccine.

1. Support for adoption of vaccine by demonstrating the vaccine’s value in terms of benefit per dollar invested in the vaccine, such as savings from preventing direct and indirect costs associated with the disease occurrence, as well as using anthropocentric measures such as the quality-adjusted life years (QALYs) and the disability-adjusted life years (DALYs). This could be achieved through economic modelling.

1. Investing in lasting advocacy strategies using media and other methods while paying attention to the likely gendered perceptions of risk and the values projected in the advocacy messages. Findings from a context specific gendered study of the factors that affect CBPP vaccine adoption would inform the advocacy and other communication strategies saving time spent from trial and error efforts that may end up being expensive and ineffective.

New or previously tested innovative strategies should be adopted. For example, carrying out human and livestock vaccination campaigns together in pastoral communities living in marginal areas in South Sudan enhanced coverage of both vaccinations while lowering the costs because the human and animal health projects shared logistical costs such as transport and maintenance of the cold chain. The timing of vaccination is crucial and should target a period when there aren’t too many activities in the community and when humans and livestock are accessible and healthy enough to withstand the stress associated with vaccination.

# Conflict of interest

The authors have no conflicting interest in relation to this work.

# References

Angelmar, R., & Morgan, P. (2012). Vaccine Marketing. *INSEAD Faculty and Research Working Paper*.

November 2012. Lyon, France.

Bamhare, C. (2001). CBPP Surveillance in in Vaccinated Areas: Namibia Experience with CBPP Vaccines

Prepared from the T1-44 and T1-SR Strains: In *Proceedings of the Second Meeting of the FAO-OIE-*

*OAU-IBAR-IAEA Consultative Group on Contagious Bovine Pleuropneumonia (CBPP), 24-26 October, 2000.* Rome, Italy, p79-87 Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Bauman, P. (2005). Sustainable livelihoods and political capital: Arguments and evidence from decentralization and natural resource management in India. *ODI Working Paper 136. UK: ODI.*

Bebbington, A. (1999). Capitals and Capabilities: A framework for analysing Peasant Viability, Rural Livelihoods and Poverty. *World Development*, *27* (12), 2012–2044.

Bbalo, G. C. (1991). *An Epidemiologic and Socio-economic Assessment of the Control of Contagious Bovine Pleuropneumonia (CBPP) in Western Province, Zambia. Suggestions as to future Strategies*. M.Sc.

Dissertation. University of Reading: Reading, UK.

Besley, B. T., & Case, A. (2013). Modeling Technology Adoption in Developing Countries. *The American Economic Review*, *83*(2), 396 – 402.

Bhattacharyya, A., Harris, T. R., Kvasnicka, W. G., & Gary, M. (1997). Factors Influencing Rates of Adoption of Trichomoniasis Vaccine by Nevada Range Cattle Producers. *Journal of Agricultural and Resource Economics*, *22*(1), 174–190.

Brooks, A., Cutts, F., Justice, J., & Walt, G. (1999). *Policy Study of Factors Influencing the Adoption of New and Underutilized Vaccines in Developing Countries*.

Deere, C. D., & Doss, C. R. (2006). the Gender Asset Gap: What Do We Know and Why Does It Matter?

*Feminist Economics*, *12*(1-2), 1–50. doi:10.1080/13545700500508056

Deere, C. D., Alvarado, G. E., & Twyman, J. (2012). Gender Inequality in Asset Ownership in Latin America Female Owners vs Household Heads - *Diana Deere - 2012 - Development and Change - Wiley Online Library.*

Delgado, C.; Rosegrant, M.; Steinfeld, H.; Ehui, S.; Courbois, C. (1999). Livestock to 2020: the next food revolution. *IFPRI Food, Agriculture, and the Environment Discussion Paper 28. Washington, D.C.*

*(USA): IFPRI.*

Doss, C. R. (2001). Designing Agricultural Technology for African Women Farmers: Lessons from 25 Years of

Experience. *World Development*, *29*(12), 2075–2092. doi:10.1016/S0305-750X(01)00088-2

Doss, C., & Deere, C. D. (2008). Gender and Asset Ownership: A Guide to Collecting Individual-Level Data,

Doss, C. R., & Morris, M. L. (2001). How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana. *Agricultural Economics*, *25*(1), 27–39. doi:10.1111/j.15740862.2001.tb00233.x

Hanson, S. (2010). Gender and mobility: New approaches for informing sustainability. Gender, Place and Culture, 17(1), 5–23. Retrieved from, https://doi.org/10.1080/09663690903498225

Heffernan, C., And Misturelli, F. (2000). *The Delivery of Veterinary Services to the Poor : Preliminary findings from Kenya A report for DFID’s Animal Health Programme.* (p. 88). London. Retrieved from <http://www.livestockdevelopment.org/adobedocs/vetpoor.PDF>

Heffernan, C., Thomson, K., & Nielsen, L. (2008). Livestock vaccine adoption among poor farmers in Bolivia :

Remembering innovation diffusion theory. *Vaccine*, *26*, 2433 – 2442. doi:10.1016/j.vaccine.2008.02.045

Heffernan, C., Thomson, K. I. M., & Nielsen, L. (2011). Caste , Livelihoods and Livestock : An Exploration Of

The Uptake Of Livestock Vaccination Adoption Among Poor Farmers In India. *Journal Of International Development*, *23*, 103–118. Doi:10.1002/Jid

Homewood, K., Trench, P., Randall, S., Lynen, G., & Bishop, B. (2006). Livestock health and socio-economic impacts of a veterinary intervention in Maasailand: Infection-and-treatment vaccine against East Coast fever. Agricultural Systems, 89(2-3), 248–271. doi:10.1016/j.agsy.2005.09.004

Kabeer, N. (2000). Social exclusion, poverty and discrimination towards an analytical framework. *IDS Bulletin Vol. 31 (4), 83-97*

Kairu-Wanyoike, S.W., Kaitibie, S., Taylor, N. M., Gitau, G. K., Kiara, H., Heffernan, C., Schnier, C., Taracha, E., McKeever, D., 2013. Exploring Farmer Preferences for Contagious Bovine Pleuropneumonia Vaccination: a case of Narok District of Kenya. *Prev. Vet. Med. 110, 356-369.*

Kakinami, L., Newman, Peter, A., Lee, S.-J., & Duan, N. (2008). Differences in HIV vaccine acceptability between genders. *AIDS care, 20(5), 542–546. doi:10.1080/09540120701867180.Differences*

Kristjanson, P., Waters-Bayer, A., Johnson, N., Tipilda, A., Njuki, J., Baltenweck, I., Grace, D. and McMillan, S. 2010. Livestock and Women’s Livelihoods: A review of the recent evidence. ILRI discussion paper No.20. Nairobi, ILRI,

Lawrence, P. G., Sanders, J. H., & Ramaswamy, S. (1999). The impact of agricultural and household technologies on women: a conceptual and quantitative analysis in Burkina Faso, *Agricultural Economics* **20**, 203–214.

Le Gall, F. (2009).Economic and Social Consequences of Animal Diseases. URL:

<http://go.worldbank.org/PMRI0CP0R0>[6 March 2013].

Mariner, J. C. & Catley, A. (2004). The Dynamics of CBPP Endemism and Development of Effective Control

Strategies: In *Towards Sustainable CBPP Control Programmes for Africa. Proceedings of the Third*

*Meeting of FAO-OIE-AU/IBAR-IAEA Consultative Group on Contagious Bovine Pleuropneumonia* 1214 November 2003. Rome, Italy, p76-80. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Mariner, J. C., Mcdermott, J. J., Heesterbeek, J. A. P., Catley, A., Thomson, G. & Martin, S. W. (2006a). A Model of Contagious Bovine Pleuropneumonia Transmission Dynamics in East Africa. *Preventive Veterinary Medicine,* **73,** 55-74.

Mariner, J. C., Mcdermott, J. J., Heesterbeek, J. A. P., Thomson, G., Roeder, P. L. & Martin, S. W. (2006b). A Hetereogeneous Population Model for Contagious Bovine Pleuropneumonia Transmission and Control in Pastoral Communities of East Africa. *Preventive Veterinary Medicine,* **73,** 75-91.

Masiga, W. N., Domenech, J. & Windsor, W. S. (1996). Manifestation and Epidemiology of Contagious Bovine Pleuropneumonia in Africa. *Revue Scientifique et Technique; Office International des Epizooties,* **15,** 1283-1308.

Mcleod, A. & Rushton, J. (2007). Economics of Animal Vaccination. *Revue Scientifique et Technique;Office International des Epizooties,* **26,** 313-326.

Mcleod, A. & Wilsmore, T. (2002). The Delivery of Livestock Services to the Poor. A Review. In: Perry, B. D.,

Mcdermott, J. J., Randolph, T., Sones, K. & Thornton, P. K. (Eds.). *Investing in Animal Health*

*Research to Alleviate Poverty.* Nairobi, Kenya. International Livestock Research Institute (ILRI).

Mcleod, R. & Kristjanson, P. (1999). *Economic Impact of Ticks and Tick-Borne Diseases to Livestock in Africa, Asia and Australia* Nairobi, Kenya. International Livestock Research Institute (ILRI). Final Report of Joint ESYS/ILRI/AIAR Tick Cost Project.

Meinzen-Dick, R., Johnson, N., Quisumbing, A., Njuki, J., Behrman, J., Rubin, D., Peterman, A. and Waithanji, E. (2011). Gender, Assets, and Agricultural Development Programs: A Conceptual Framework. *CAPRi Working Paper 99.* Washington, D.C.: CAPRI

Pandolfelli, L., Meinzen-Dick, R., and Dhorn, S. J. 2008. Introduction. Gender and collective action: motivations, effectiveness and impact. Journal of International Development 20 (1). 1 - 11.

Mlengeya, T. D. K. (1995). Current Status of Contagious Bovine Pleuropneumonia (CBPP) in Tanzania: In *National Conference of the Tanzanian Veterinary Medical Association.* 15 May 1995. Arusha, Tanzania, p1-11. Department of Veterinary Services, Dar-es-Salaam, Tanzania.

Mukhebi, A.W., Perry, B.D., and Kruska, R.L. (1992). Estimated economics of theileriosis control in Africa. *Preventive Veterinary Medicine, 12, 73-85*

Musaba, E. C. (2010). Analysis of factors influencing adoption of cattle management technologies by communal farmers in Northern Namibia. Livestock Research for Rural Development. Volume 22, Article #104. Retrieved February 3, 2011, from http://www.lrrd.org/lrrd22/6/musa22104.htm

Musisi, F. L., Bamhare, C., Belemu, J., Chisembele, C., Chitate, F., Kabilika, S., Kimera, S., Kitalyi, J.,

Musimbwe, L. & Njau, P. (2007). The Evolution of CBPP in Southern Africa: 2004-2006: In *CBPP*

*Control: Antibiotics to the Rescue. Proceedings of FAO-OIE-AU/IBAR-IAEA Consultative Group*

*Meeting on CBPP in Africa.* 6-8 November 2006. Rome, Italy, p89-101. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Newton, L. G. & Norris, R. (2000). *Clearing a Continent: The Eradication of Bovine Pleuropneumonia from Australia.* Collingwood, Australia. CSIRO Publishing.

Njarui D M G, Kabirizi J M, Itabari J K, Gatheru M, Nakiganda A and Mugerwa S 2012 Production characteristics and gender roles in dairy farming in peri-urban areas of Eastern and Central Africa. Livestock Research for Rural Development. Volume 24, Article #122. Retrieved from <http://www.lrrd.org/lrrd24/7/njar24122.htm>.

Njau, P. Z. & Kitalyi, J. I. (2007). Control of CBPP in Tanzania. Current Status and the Implementation of a Roll-Back Vaccination Plan: In *CBPP Control: Antibiotics to the Rescue. Proceedings of FAO-OIEAU/IBAR-IAEA Consultative Group Meeting on CBPP in Africa.* 6-8 November 2006. Rome, Italy, p107-113. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Njuki, J., Kaaria, S., Chamunorwa, A. and Chiuri, W. 2011. Linking small holder farmers to markets, gender and intra-household dynamics: Does the choice of commodity matter? European Journal of Development Research. 236. 426 – 443.

Njuki, J. and Sanginga, P. 2013. Introduction: Gender and livestock: Key issues, challenges and opportunities. In Women, livestock ownership and markets: Bridging the gender gap in eastern and southern Africa. Eds. Jemimah Njuki and Pascal Sanginga. Pages 1 – 8. Routledge, New York

Nwanta, J. M. & Umoh, J. U. (1992). Epidemiology of CBPP in Northern States of Nigeria. An Update. *Revue d'Elevage et de Medecine Veterinaire des Pays Tropicaux,* **45,** 17-20.

OIE (2008). *Terrestrial Animal Health Code.* Paris, France. Office International des Epizooties (OIE).

Otte, M. J. & Chilonda, P. (2002). *Cattle and Small Ruminant Production Systems in Sub-saharan Africa. A Systematic Review.* Rome, Italy. Food and Agriculture Organization of the United Nations(FAO).

Pica-Ciamarra , U and Otte, J. (2009). The “Livestock Revolution ”: Rhetoric and Reality. *RR Nr. 09-05*, *November* (09), 1–23.

Pratt, G. and Hanson, S. 1994. Geography and the construction of difference. Gender, Place and Culture, 1(1): 5–29. DOI: 10.1080/09663699408721198

Provost, A., Perreau, P., Breard, Le Goff, C., Martel, J. L. & Cottew, G. S. (1987). Contagious Bovine

Pleuropneumonia. *Revue Scientifique et Technique;Office International des Epizooties,* **6,** 565-679.

Quisumbing, A., Rubin, D., Manfre, C., Waithanji, E., van den Bold, M., Olney, D., Johnson, N., MeinzenDick, R. 2015. Gender, Assets and Market -oriented Agriculture: Learning from high-level crop and livestock projects in frica and Asia. *Journal of Agriculture, Food and Human Values Society, Vol.32 (1)* http://link.springer.com/article/10.1007/s10460-015-9587x?sa\_campaign=email/event/articleAuthor/onlineFirst

Rezvanfar, A. (2007). Communication and social-personal factors influencing adoption of dairy farming technologies among livestock farmers. *Livestock Research for Rural Development. Volume 19, Article 33.*

Roeder, P. (1998). Vaccines and Vaccination: CBPP Vaccine Requirements and Logistics: In *Proceedings of the First FAO-OIE-OAU/IBAR-IAEA Consultative Group on Contagious Bovine Pleuropneumonia.* 5-7 October 1998. Rome, Italy, p76-80. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Tambi, N. E., Maina, W. O. & Ndi, C. (2006). An Estimation of the Economic Impact of Contagious Bovine Pleuropneumonia in Africa. *Revue Scientifique et Technique;Office International des Epizooties,* **25,** 999-1012.

Thomson, G. R. (2004). Contagious Bovine Pleuropneumonia; Possible Future Strategies for the Control of the Disease in the PACE Region: In *Towards Sustainable CBPP Control Programmes for Africa.*

*FAO/OIE/AU-IBAR/IAEA Consultative Group on Contagious Bovine Pleuropneumonia. Third Meeting, Rome, Italy.* 12-14 November 2003. Rome, Italy. Food and Agriculture Organisation of the United Nations (FAO), Rome, Italy.

Thomson, G. R. (2005). *Contagious Bovine Pleuropneumonia and Poverty: A strategy for Addressing the Effects of the Disease in Sub-Saharan Africa. Research Report, DFID Animal Health Programme* Centre for Tropical Veterinary Medicine. University of Edinburgh, UK.

Twinamasiko, E. K. (2002). *Development of an Appropriate Programme for the Control of Contagious Bovine Pleuropneumonia in Uganda.* Ph.D. Thesis*.* University of Reading: Reading, UK.

Wanyoike, S. W. (1999). *Assessment and Mapping of Contagious Bovine Pleuropneumonia in Kenya: Past and Present.* M.Sc. Thesis*.* Freie Universitat Berlin and Addis Ababa University: Berlin, Germany.

Wanyoike, S.W. (2009). The Epidemiology and Socio-economics of Contagious Bovine Pleuropneumonia and its Control by Vaccination in Narok District of Kenya. Ph.D. Thesis, University of Reading, Reading, UK.

Waithanji, E., Mtimet, N., Muindi, P. 2018. Contagious Bovine Pleuropneumonia Vaccine Delivery and Adoption by Women and Men in North-Eastern Kenya. Eur J Dev Res. Doi 10.1057/s41287-018-0157-0 https://rdcu.be/WWA2 (In Press).

Wesonga, W. H. S. N. (1994). *The Epidemiology and Control of CBPP in Uganda.* M.Sc. Dissertation*.* University of Reading: Reading, UK.

Wesonga, H. & Thiaucourt, F. (2000). Experimental Studies on the Efficacy of T1SR and T1/44 Vaccine Strains of *Mycoplasma mycoides* subspecies *mycoides* (small colony) Against a Field Isolate Causing Contagious Bovine Pleuropneumonia in Kenya-Effect of a Revaccination. *Revue d'Elevage et de Medecine Veterinaire des Pays Tropicaux,* **53,** 313-318.

Windsor, R. S. & Wood, A. (1998). Contagious Bovine Pleuropneumonia: The Costs of Control in Central/Southern Africa. *Annals of the New York Academy of Science,* **849,** 299-230.

Yaya, A., Golsia, R., Hamadou, B., Amaro, A. & Thiaucourt, F. (1999). Essai Comparatif d'efficate des deux Souches Vaccinales T1/44 et T1SR Contre la Peripneumonie Contagieuse Bovine. *Revue d'Elevage et de Medecine Veterinaire des Pays Tropicaux,* **52,** 171-179.

1. A notifiable disease is any disease that is required by law to be reported to government authorities. The information allows the authorities to monitor the disease and undertake early interventions to prevent widespread outbreaks. [↑](#footnote-ref-1)