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The role of gender and other socio-economic factors in the adoption of the contagious bovine pleuropneumonia (CBPP) vaccine

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Contents

Acronyms

ADIP	Accelerated Development and Introduction Plan
CBPP	Contagious bovine pleuropneumonia
CCPP	Contagious caprine pleuropneumonia
ECF	East Coast fever
EPI	Expanded Program on Immunization
FAO	Food and Agriculture Organization of the United Nations
FMD	Foot and mouth disease
GAVI	Global Alliance for Vaccines and Immunization
GDP	Gross Domestic Product
GNP	Gross National Product
HS	Haemorrhagic Septicaemia
HYV	High Yield Variety
NCD	New Castle disease
NGO	Non-Governmental Organization
NIP	National Immunization Program
NITAG	National Immunization Technical Advisory Group
OIE	International Office of Epizootics
PPR	Peste des petits ruminants
RVF	Rift Valley fever
SADC	Southern African Development Community
USA	United States of America
USD	United States dollar
WHO	World Health Organization

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Executive summary

This paper focuses on the role of gender and other socio-economic factors in the adoption of the contagious bovine pleuropneumonia (CBPP) vaccine. The study reported here responds to three questions: What socio-economic factors affect the adoption of the CBPP vaccine? How do they affect the adoption? What can be done to enhance the adoption of CBPP? The study pays special attention to gender as a distinct socio-economic category because communities often use gender to define differences between women and men, and to justify, sustain and reinforce inequalities between women and men with the resultant subservience of women. Answers to these questions were obtained through a review of literature on CBPP and technology (including vaccine) adoption studies.

Technology, including vaccine, adoption is gendered, with women tending to adopt less than men, especially in terms of consumer associated drivers (accessibility, affordability and acceptability) referred to by the authors as the 3As. Other socio-economic factors, such as class and geographical location appear to have a greater influence than gender in terms of political and market based drivers of vaccine adoption.

Adoption of CBPP vaccine can be enhanced through one or a combination of up to four strategies which include: reduction of prices through reduction of cost in production and 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 using innovative ways such as carrying out human and livestock vaccination campaigns, simultaneously, in pastoral communities living in marginal areas.

Introduction

The livestock revolution represents the notion that the demand for livestock products by consumers in the global South will double by the year 2020 because of the combination of population growth, rising per capita incomes, progressive urbanization and other factors (Delgado et al. 2001). Although these trends have been observed in some 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 especially if poor livestock farmers present their animals for vaccination because vaccination can enhance the efficiency of production of animal source foods (ASF) in order to meet the demands associated with the revolution. The reality in most low income countries, however, is that conventional livestock vaccine technologies are often poorly adopted by poor livestock farmers (Heffernan et al. 2008, 2011). Several drivers of the poor vaccine adoption have been identified. These include economic drivers demonstrated by farmers' 'willingness to pay' (Kairu-Wanyoike et al. 2014); delivery drivers (Heffernan and Misturelli 2000) and perceptions and attitudes towards vaccination itself (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 what gender and other socio-economic factors affect adoption of vaccines and how they affect this adoption. The conceptual framework developed in this study has, using findings from other studies, proposed causal relations while identifying the direction of causality, between vaccine adoption and gender and other socio-economic factors. Findings from this desk study have been used to inform gender and socio-economic studies on the adoption and delivery of the contagious bovine pleuropneumonia (CBPP) vaccine in Ijara subcounty of northeastern Kenya.

Literature review

The literature review is organized as follows: CBPP (description and importance of CBPP, production and productivity losses associated with CBPP, socio-economic impact of CBPP, the control of CBPP, the current status of CBPP vaccination successes and challenges and vaccination policies); technology adoption (in general and then livestock technology adoption); social and economic factors that affect technology adoption; and gender and technology adoption (gender and vaccine adoption).

Contagious bovine pleuropneumonia (CBPP)

Description and importance of CBPP

Contagious bovine pleuropneumonia (CBPP) is a highly contagious disease of cattle and water buffalo caused by a bacterium, *Mycoplasma mycoides mycoides* small colony biotype (MmmSC) (Masiga et al. 1996). It occurs in the hyper-acute, acute, subacute, or chronic form, affecting their lungs. Occasionally, it affects the joints mainly in calves. Principally, it spreads 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[1] disease. Mortalities can be high when the disease appears for the first time in a naïve population (Newton and Norris 2000).

In southern Africa, CBPP was present in Angola, Zambia and northern Namibia and it was associated with cattle movements from Angola (Musisi et al. 2004). In 1995, an outbreak in Botswana was eradicated by stamping out (Masupu 1998). In West and central Africa, Senegal has self declared to be provisionally free from CBPP and does not practise vaccination (Masiga et al. 1998; OIE 2008). In eastern Africa, the disease is endemic in Kenya, Ethiopia, Uganda, Rwanda and Burundi (FAO 1997). The disease is suspected to have spread from Kenya to Tanzania in 1995 after a 25-year absence (Bolske et al. 1995). In Eritrea, CBPP appeared from cattle imports (Kebkibah 2004).

The consequences of animal diseases in livestock can be complex and generally go well beyond the immediate effects on affected producers. These diseases have numerous impacts, including: productivity losses, loss of income, loss of wellbeing of livestock keepers and their dependents, prevention or control costs, suboptimal use of production potential.

Production and productivity losses associated with CBPP

Biologically, CBPP affects production through 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, Mlengeya (1995) attributed direct losses to mortality, vaccination campaign costs, disease surveillance and research programs and

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.

indirect losses to the chronic nature of the disease. 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 related indirect effects, which included low fertility, low birth weights, poor growth rates and poor carcass quality due to chronic disease. Tambi et al. (2006) considered direct production losses as reductions in cattle numbers, beef, milk and draught power and costs of control (cost of vaccination and antibiotic treatment). 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. Le Gall (2009) observed that direct losses are usually much smaller than indirect losses.

Socio-economic impact of CBPP

In Europe and America, CBPP was said to be of great economic importance (Lindley 1973), which prompted a robust response and legislation for animal disease control before its eradication in the late 19th Century (DEFRA 2006). Several authors have referred to CBPP as economically important and a major cause of economic loss. Socially and economically, 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 to be 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 USD 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 impact of CBPP is more apparent if the disease occurs in naïve cattle populations, but in endemic situations the impact is more difficult to establish and, therefore, often underestimated (Thomson 2005). The difficulty in assessing the economic impact of CBPP arises from the need for large amounts of epidemiological and economic input data. These data, when available, are usually in the domain of different institutions, both public and private, and involving various groups of stakeholders (Lesnoff et al. 2004).

Residual socio-economic consequences to the inhabitants in Botswana, following massive CBPP outbreaks in 1995, included infant malnutrition, loss of livelihoods and incomes (Windsor et al. 2000). Ripple effects were felt far into the local economy and the wider national economy, measuring seven times higher than the costs caused by direct losses (Le Gall 2009). 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[2] (Tambi et al. 2006), which is modest when compared to the annual losses caused by trypanosomosis and East Coast fever (ECF) in Africa which stand USD 4.5 billion for trypanosomosis and USD 168 million (Mukhebi et al. 1989) and USD 300 million respectively (McLeod and Kristjanson 1999) for ECF. Further, CBPP can drain the economy through resurgences that reclaim resources that have been diverted to other national activities following the virtual disappearance of the disease. For instance, CBPP re-emerged in various countries (Botswana, Tanzania, Zambia and Kenya Maasailand) after many years of absence (Bolske et al. 1995; Amanfu et al. 1998; Wanyoike 1999; Mangani 2004).

CBPP also affects the social welfare of cattle keeping communities. Windsor and Wood (1998), without elaborating, mentioned that quarantine affects the social wellbeing of people. Pastoralists culturally exchange livestock for a number of reasons including dowry, loans, gifts or support in times of losses (Twinamasiko 2002). Quarantines interfere with such social activities and the consequences of breaking traditional quarantines may break up social ties (Bbalo 1991). That quarantines can highly disrupt a community's sociocultural activities was recorded as early as the beginning of the 20th Century (Hodgson 1999).

Death of animals may lead to destitution and in some instances social ridicule. The pain is often immeasurable as evident in the sentiments given by the Karamoja of Uganda and the Maasai of Kenya on losing a cow (Twinamasiko 2002; Wanyoike 2009). As seen in the case of Namibia, CBPP causes constant fear of associated losses in a community and interferes with the livelihoods of households. When animals die there is loss of income and food insecurity due to loss of family milk and draught power. Households also cannot pay for services (Hodgson 1999; Boonstra et al.

2. 1 Euro = 1.37 US dollars (http://www.google.com/#q=exchange+rate (on 27 February 2014).

2001; Paskin 2003). Other people associated with livestock keeping such as those employed to herd animals and stock traders as well as butchers may lose their livelihood (Windsor and Wood 1998). In the case that extra labour or time is needed to take care of sick animals, other activities (both social and economic) have to be abandoned while at the same time seeking extra financial resources to meet the cost of treatment. Often, women who take care of the sick animals as well as the family may be required to work for extremely long hours (Twinamasiko 2002).

Social effects can be regarded as intangible effects as they are difficult to quantify (Putt et al. 1988). It is generally acceptable to just state that such effects exist. Using contingent valuation methods, however, it is possible to put a value to such effects. The value of controlling the disease can be considered to be the sum of the value of reducing the biological effects as well as the value of social effects. Normally the benefits of control calculated this way should be higher than those calculated in the traditional way (Rheingans et al. 2004) although Wanyoike (2009) showed them to be lower.

Generally, the literature shows that CBPP has high biological, economical and social impact, but these impacts could still be underestimated due to data limitations, particularly on fertility and trade, as well as lack of quantification of social effects.

Control of CBPP

The strategies in CBPP control and eradication 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 sociocultural and trade practices (Mariner et al. 2006a; Tambi et al. 2006). In the context of developing countries, compensation for stamping out is unaffordable and most governments cannot logistically police often very long national borders. 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 may favour the creation of chronic carriers (Provost et al. 1987). Research on antimicrobial treatment was, however, initiated following new evidence from various studies that antibiotic treatment may be beneficial (FAO 2004; Mariner et al. 2006). Control by vaccination, therefore, remains the most feasible option for CBPP.

Current status of CBPP vaccination, successes and challenges

The current CBPP vaccine (strain T144) is effective when administered as part of a well conducted vaccination campaign in which high levels of coverage (in excess of 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 USD worth of mortality for every USD 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 (89%) in number of outbreaks following vaccination of cattle during a 10 year period immediately after a major outbreak in Kenya. In a similar period in Uganda, Twinamasiko (2002) observed a reduction in number of outbreaks and slaughter positives and attributed the reduction to repeated vaccination. 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). Windsor and Wood (1998) attributed the disappearance of CBPP in Africa in the first half of the 20th Century to vaccination.

Macro level benefits of controlling infectious diseases have been discussed by McLeod and Leslie (2000). The benefits mentioned, which also apply to CBPP, are increased value of off-take, diversity of market opportunities, increased national livestock capacity and export opportunities. Over a ten year period, Bbalo (1991) also demonstrated positive changes in herd value, milk production, draught power and off-take following CBPP control.

Vaccination policies

It is also possible that the existing policies (who delivers the vaccine, how vaccine is delivered, subsidies etc.), which are either inappropriate or are not being executed adequately (Thomson 2004; Le Gall 2009) contribute to vaccination failure. These policies need to be evaluated. In cases where disruption and stress occur due to the need to collect animals at a central point, vaccination on-farm may be more appropriate. To involve more female cattle owners there may be a need to pack fewer dosage packages (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.

In some countries, costs for CBPP vaccination have been partially recovered from the cattle owners (Twinamasiko 2002; Njau and Kitalyi 2007). It has been argued that full scale cost recovery or privatization of vaccination against CBPP may lead to further reductions in vaccination coverage (Roeder 1998; Twinamasiko 2002). McLeod and Wilsmore (2002) stated that livestock owners would prefer to pay for vaccination in an epidemic situation rather than for preventive vaccination against absent disease. In Senegal and Guinea, CBPP vaccination is conducted by private vaccinators with the national animal health authority playing a regulatory and supervisory role. This may be more cost effective and may help in raising vaccination coverage (Thomson 2005). McLeod and Rushton (2007) have suggested that payment at point of delivery is a way to effect cost sharing in government vaccination programs. However, Twinamasiko (2002) has indicated that there can be problems if the vaccine is not of the best quality.

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; McLeod and Rushton 2007; Wanyoike 2009). Farmers may also resist vaccination at certain times of the year when the body condition of the animals is not good (Wanyoike 1999, 2009).

With CBPP vaccination, seroconversion has been shown not to be associated with protection and is further complicated by the fact that initial seroconversion is only up to 60% rising to 80% only after the second vaccination (Yaya et al. 1999; Wesonga and Thiaucourt 2000). Bi-annual, rather than annual vaccination is, therefore more appropriate, but much harder to achieve. However, this implies that a thorough investigation of the existing vaccination policy is required.

Technology adoption

Technology is often perceived as a pathway out of poverty. For example, an ex post study on groundnut technology adoption in Uganda demonstrated that adoption of improved groundnut varieties significantly increased household crop income by USD 130–254 and reduced the poverty incidence, measured by the headcount index, by 7–9% (Kassie et al. 2011). What exactly determines adoption of a technology, however, remains unclear (Besley and Case 2013). Owing to the complexity of the subject of technology adoption, many studies on this subject have been carried out, but no single study has been able to cover all its aspects. Among the empirical methods used to measure trends in technology adoption include time series, which observe only an aggregate measure of adoption, such as the percentage of farmers employing the new technology at each date; cross sectional studies which provide only a snapshot of adoption at that point in time; and panel (data) analysis studies detailing farm and farmer characteristics and the adoption choices made at each point in time (Besley and Case 2013). The foregoing statistical methods use aggregate data overlooking the drivers that influence technology adoption by individuals, which are equally important. Work done on individuals such as understanding the factors that influence user acceptance, adoption, and usage of emerging information technologies in the workplace (Venkatesh et al. 2000), may help explain technology adoption by individuals rather than aggregate groups.

More crop than livestock technology studies have been conducted and some lessons from crop studies could be applied in livestock technology adoption studies. Crop and/ or livestock technology can alleviate poverty because it can cause an increase in productivity gains and lower the cost of production per unit, which in turn results in raised incomes of producers. Indirect benefits from technology adoption when the demand is high in an environment of increased productivity include reduction in prices, and an enhanced demand in production labour and increased employment and wages. The poor benefit from selling their labour and reduced food prices because they are net food buyers (Kassie et al. 2011). Benefits of households from technology adoption vary by context and the specific technology. An example of contextual variation is demonstrated by evidence from numerous studies on adoption of high yield varieties (HYV) of rice in Asia, which show that households have benefitted from adoption, whereas the relatively fewer studies on rice and maize HYV adoption in Africa are not able to demonstrate benefits clearly (ibid). Benefits from adoption of legume technologies are not as widely documented as those of grains (ibid).

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 ten livestock management practices disseminated to farmers were adopted (Musaba 2010). Castration and vaccination were the most adopted. Dehorning, feeding cut 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 farther 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 on the adoption of feed conservation technologies by smallholder dairy farmers in Kenya revealed that the adoption of tube silage, silo and box baling technologies was low (Njeri et al. 2013). Socio-economic factors such as the level of education of respondents and the source of labour, whereby those more educated and those using hired rather than family labour, had a positive and significant relationship with the adoption of tube silage and silo technology. Farm size and the level of income had a positive and significant relationship with adoption of tube silage and box baling technologies respectively. Odds ratio/ binary logistic regression revealed that seeking information from the internet influenced the odds of adoption of tube silage technology positively with the likelihood of those seeking information from the internet being significantly more likely to adopt the technology than those who did not (Njeri et al. 2013).

In a study recording cattle farmers' perception of the impact of East Coast Fever (ECF) immunizations in ECF-endemic areas of southern Zambia and determining the major factors influencing that perception, results showed that the number of calves immunized was strongly associated with the farmer's perception of the benefits of immunization and that there was no association between the number of calves immunized and the number of veterinary assistants or transport situation in any district (Fandamu et al. 2006). Another study to analyse the impacts of a vaccination program for ECF in the Maasai ecosystem of southwestern Kenya and northeastern Tanzania revealed that immunization reduced calf mortality rates from 20–2 percent (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). According to Homewood et al. (2006) vaccinated cattle that had an ear tag to indicate that they had been vaccinated, fetched prices of up to 50% higher than unvaccinated ones. When the vaccine was provided on a commercial basis, poorer livestock keeping households vaccinated a smaller proportion of their calves and immature animals (30–34%) than wealthier households (up to 90%). Thus, among those who vaccinated, the extent to which they were able to take advantage of this technological advance was strongly determined by wealth, both in terms of herd size, but most importantly in terms of access to alternative and secure forms of income. Access to the benefits of vaccination was deemed difficult for two reasons: First, the cost of vaccination exceeded the means of the poor pastoralist households and may have represented a difficult choice for households of even medium wealth. The absolute cost of an individual vaccine (USD 7 a dose), meant vaccinating one calf costs well over a week's income for a poor pastoralist household. Second, the vaccine was provided in 'straws', each of which was diluted in the field to 32–35 doses, which were then required to be administered right away. In this extensive pastoralist system, with isolated homesteads scattered over a wide area, poor transport and communications, and erratic veterinary attendance, only large scale operators can gather the necessary numbers of calves for vaccination at one place and time. It is difficult for smaller producers to coordinate enough individual herd owners with a few calves each to achieve this, rendering the overall cost higher and the feasibility of adoption lower (Homewood et al. 2006).

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 such as pastoralism, agropastoralism, employment, tourism and their varying combinations and cross-investments (between livestock production, cultivation, trade, business etc.); 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 with farmers located farther away from the extension offices being less likely to adopt improved technologies ; credit worthiness; market (Homewood et al. 2006; Heffernan et al. 2008; Musaba 2010; Heffernan et al. 2011; 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 studies should, therefore, identify specific drivers and focus on them. Further, in order to increase adoption of improved technologies, efforts should be made to enhance farmers' access to these factors e.g. education or literacy programs, to off-farm income generating activities and training (Musaba 2010).

Gender and technology adoption

Most gender based norms in most cultures are unfavourable to women situating them in disadvantageous positions in relation to men. Sex and gender, therefore, exert their influence on technology adoption. 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 women and men. Gender, therefore, matters in technology adoption because gender affects farmers' access to labour, land and other inputs and it may affect 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. Summarizing gender roles of households by comparing male and female farmers or male and female headed households is not sufficient because different household systems are embedded in agriculture and non-agriculture economies and interactions within these economies determine technology adoption and impacts (Doss 2001).

Hoping that women understand and will want to embrace a technology is not a guarantee that they will have the opportunity to do so. Although empirical evidence shows that women in some countries access more health services than men (Bertakis et al. 2000), women's overall underutilization of health services is documented in developing countries e.g. in India where more women than men report illness, but hospital research shows that more men get treated and in Thailand where men are six times more likely to seek treatment for Malaria than women (Singh et al. 2009).

Among the drivers of technology adoption include patterns of labour allocation, access to land, inputs, distribution of benefits, men and women's 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). Access to land and security of tenure will also affect decisions regarding the adoption of technology and these vary by gender. For example farmers will adopt a technology according to how they perceive their future tenure and the decision to adopt will shrink if probability of losing the land is high just like women who access land through marriage when they think that their marriage is precarious.

Inputs include seeds, fertilizer, extension services and credit (Doss 2001). Women have less access to inputs than men for various reasons. For example, in Zimbabwe, the government issued loans to small scale farmers who demonstrated that they produced surplus maize for the market leaving out women who produced mainly for subsistence (Rohrbach 1989). Wealth, like access to resources is gendered and a gender wealth gap, in terms of asset accumulation exists whereby, generally, men tend to have more than women (Antonopoulos and Floro 2005). Wealth is related to power—economic and political—and the gender wealth gap translates into a gap in access and utilization of this power (Deere and Doss 2006). Women's asset ownership could lead to their empowerment and wellbeing, both of which are drivers of technology adoption.

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). The utility of the output, whether for sale immediately post-harvest or for home consumption is another driver of technology adoption. If for sale, high yielding seeds will be adopted, but for home consumption, consideration will be for the ease of storage, processing and for taste rather than, say, productivity. The person in the household who makes the decision to produce and what to do with the product most likely decides what technology to adopt. Decision-making can be cooperative bargaining (collective) or non-cooperative bargaining. In the former decision-making model, household members are assumed to have different preferences, but resources are pooled and individuals bargain over how to allocate them. In the non-cooperative bargaining model, resources within the household are not pooled and individuals make separate decisions on the resources that they own (Doss 2001).

Owing to the fact that women have different preferences than, or face different constraints from, men, women may not adopt a new technology that is popular with men. It is, therefore, important to establish women's and men's potential preferences and constraints to adopting a technology ex ante (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 technology adoption appears to depend upon access to resources, rather than gender, but men appear to have greater access to resources than women (Doss and Morris 2001).

Gender and vaccine adoption

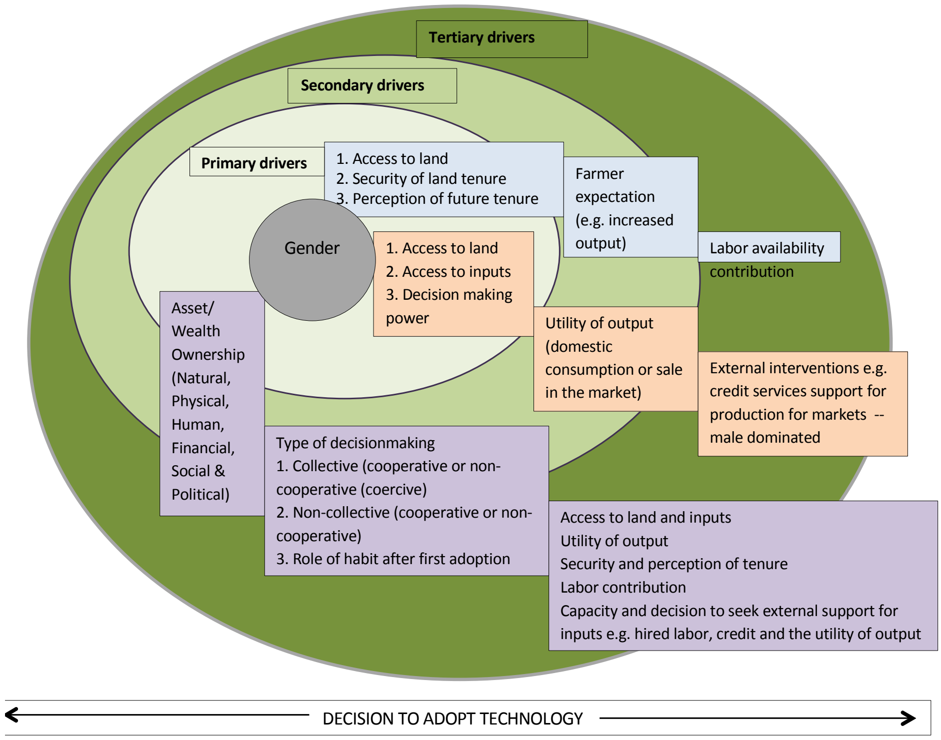
Most studies on vaccine adoption are gender blind. Of the few that have gender considerations, more have been conducted in the field of human than animal health. Studies on human vaccine adoption demonstrate significant or remarkable gender differences, whereas those on animal vaccine adoption indicate that gender has no significant effect. For example, in a study aimed to identify barriers and motivators to future HIV vaccine acceptability among low socio-economic, 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, whereas men were concerned that the vaccine would weaken the immune system or would affect their HIV test results (Kakinami et al. 2008). Among the motivators for women included the ability to conceive a child without worrying about contracting HIV and support from their spouse or partner for being vaccinated. Motivators for men included feeling safer with sex partners and social influence from friends to get vaccinated. Family support for HIV immunization was a motivator for both men and women (Kakinami et al. 2008). Gender-specific interventions may increase vaccine acceptability among men and women at elevated risk for

HIV infection. Among women, interventions need to focus on addressing barriers due to gendered power dynamics in relationships and discrimination in health care. 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 of 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 sociocultural 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. The studies may, however, 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).

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



Source: Authors.

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. In Figure 1, primary drivers of technology adoption have been grouped into three broad categories for ease of explanation. 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 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 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. For 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. For 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.

Wealth/ assets are gendered in that men tend to have more assets than women because of cultural practices that tend to favour men in terms of asset acquisition from inheritance and historical marginalization of women giving men an asset 'head-start.' 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 they are and to act as they do. 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 (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 power than women.

Drivers of vaccine adoption

In addition to the gender-associated drivers of technology adoption presented in the previous section, other drivers of vaccine adoption, some of them less obviously gender-associated, 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. The driver categories are, of course, not discreet, but have been discussed separately for ease of presentation. The studies from which this discussion draws are gender blind, but gender issues, drawn from 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), which have been labelled by the authors as the 3As.

Accessibility

An assessment of the delivery of veterinary services to the poor in Kenya by Heffernan and Misturelli (2000) revealed that access to veterinary services, rather than affordability, appears to be the primary constraint to veterinary technology adoption. Indeed, households living in close proximity to donor or 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 treatments. 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. forthcoming). 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 associated with these. Owing to established gender differences in access, therefore, 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 because of 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. New vaccine prices are unlikely to fall to levels comparable to the original six Expanded Program on Immunization (EPI)[3] vaccines.

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 due 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.

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 latter enhancing acceptability and the former 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 perceive 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). The study on HIV adoption demonstrated a difference between women and men, in terms of influence of their knowledge on the vaccine. Men's adoption was deterred by inadequate knowledge, whereas inadequate knowledge was not raised as a deterrent for women.

This review further identifies another form of acceptability, the acceptability of the woman adopting the vaccine by her partner, which was brought up by only women. This appears to be a driver of vaccine adoption for women and not men.

Political drivers

Decisions to introduce new vaccines are not merely economic, but are influenced by procurement financing and economic constraints. Brooks et al. (1999) have identified six themes related to this argument: 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,

3. The World Health Organization (WHO) initiated the Expanded Program on Immunization (EPI) in May 1974 with the objective to vaccinate children throughout the world. Ten years later, in 1984, the WHO established a standardized vaccination schedule for the original EPI vaccines: Bacillus Calmette-Guérin (BCG), diphtheria-tetanus-pertussis (DPT), oral polio, and measles.

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 programs on the policy agenda.

Varying perceptions of 'affordability' by policy makers lead to inconsistent policy positions because of the varying economic development status of consumer countries. In developed countries, for example, expensive vaccines may be considered to be of good value if seen as an investment against future disease. Polio eradication, for example, requires a huge financial investment, which is considered to be worthwhile to the industrialized world because of the huge benefits its eradication will bring (Brooks et al. 1999). For low income countries, the cost for vaccination although considerably lower than that experienced in developed countries due to subsidies from external sources, may hinder adoption of new vaccines, which may be perceived to be of less importance than addressing current, and hence more pressing, disease problems. The fact that policies on vaccines are supply-driven and not demand-sensitive was demonstrated by the finding that past vaccine policy decisions were made by international and regional experts and donors, and that few countries have a clearly enunciated policy on the introduction of new vaccines into national immunization programs (NIPs). International agencies emphasize international actions in promoting new vaccine introduction and identify local advocates to make the case. Past willingness to pay for vaccines has declined and the point of decision has shifted to the country level. Increased responsibilities for funding, decision-making and integrating new vaccines are now being put on countries, requiring that international agencies become more demand sensitive.

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 programs at the country level to wait and see how policy and strategy develops in relation to new vaccines before including them in NIPs. For the six EPI vaccines, questions on vaccine dosage, timing, cold chains and so on have already been solved.

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.

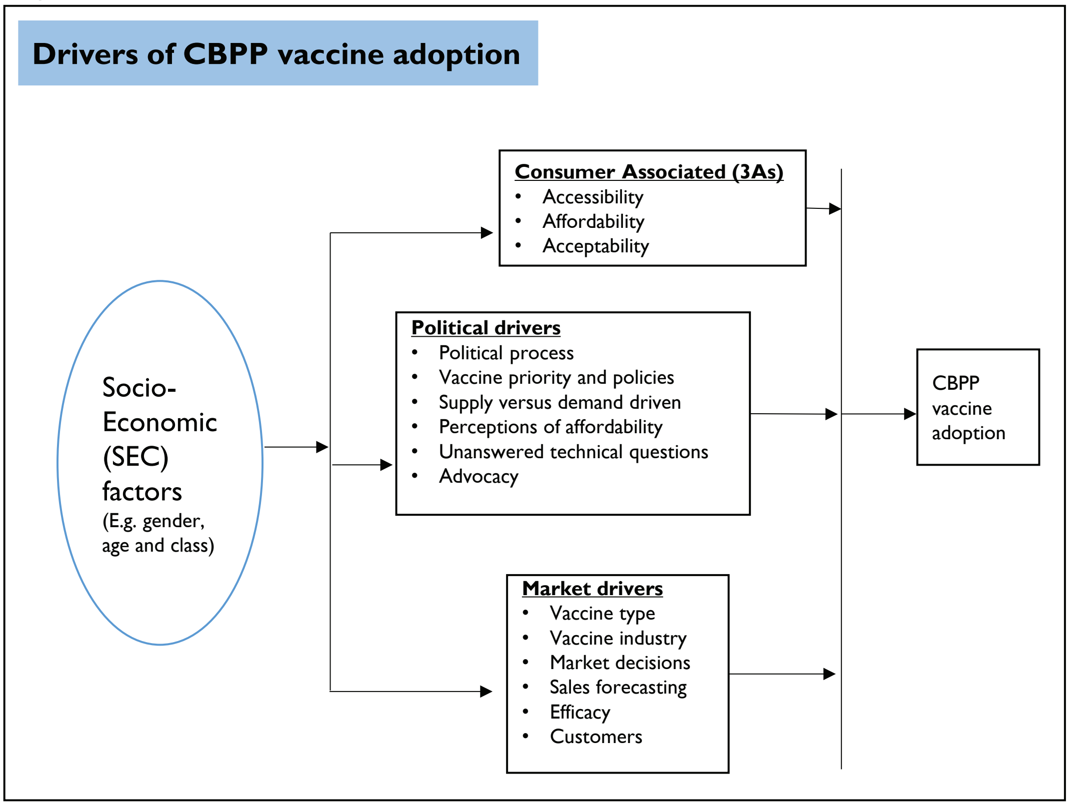
Market-based drivers/vaccine customers

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 marketed 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. Each of these has a number of subcomponent 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 (Figure 2).

Figure 2. Schematic representation of the causal relations among socio-economic factors and drivers of vaccine adoption.



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 socio-economic-status neutral, for example the political process that is associated with excessive delays prior to introduction of an existing vaccine in a new market.

Promising interventions to enhance vaccine adoption

Pull (predictable demand) and push (targeting) interventions

According to Lieu et al. (2005) vaccines are among the most cost–effective interventions in health care, but economic factors may interfere with their optimal development and delivery in both industrialized and developing countries. For the industrialized countries, increasing the financing for vaccines via the public and private systems will enable the best use of available vaccines. For developing countries, innovative and promising approaches will include pull mechanisms to establish predictable demand and push mechanisms such as targeted development programs. Partnerships between philanthropy and public resources have made progress in addressing gaps in vaccine financing and development for developing countries, but much remains to be done.

Potentially lowering the costs—and hence prices—of the most promising vaccines in terms of their potential to lower human and livestock [sic] mortality in developing countries constitute examples of pull mechanisms. Rotavirus, pneumococcal disease, malaria, and HIV vaccines are considered most promising human vaccines in the industrialized and low income countries (Lieu et al. 2005). More specifically, the Global Alliance for Vaccines and Immunizations (GAVI)[4] and its Accelerated Development and Introduction Plan (ADIP) teams are looking at a guaranteed advance-purchase contract to reduce the risks associated with unpredictable demand. The proposed contracts would specify a purchase price, although not a fixed quantity. GAVI hopes that this innovative procurement strategy will speed the development and adoption of rotavirus vaccine as well as forms of pneumococcal conjugate and meningococcal vaccines tailored for the needs of poor countries (Lieu et al. 2005).

Until recently, less effort was invested in immunizations against livestock than human diseases. In 2005, the not-for-profit Global Alliance for Livestock Veterinary medicines (GALVmed) was established and registered as charity in Edinburgh, Scotland. GALVmed is an alliance of public, private and government partners that protects livestock in order to save human lives by making livestock vaccines, medicines and diagnostics available and affordable to millions of people in developing countries for whom livestock is a lifeline (Onehealthglobal 2014). Among the plans by GALVmed include the following: One; in collaboration with Arecor, a Cambridge based liquid biologicals company, to (i) explore the potential formulation of a liquid vaccine against East Coast Fever (ECF) that will not require to be stored in liquid nitrogen until needed (ii) and investigate the possibility of a liquid formulation of peste de petits ruminants (PPR) that is cheaper to produce than the current freeze-dried one that requires expensive equipment (GALVmed 2014a). GALVmed prioritized 13 diseases, which were considered to be most relevant to poverty reduction in Africa and Asia. They include sheep and goat pox, Rift Valley fever (RVF), porcine cysticercosis, Peste des petits ruminants (PPR), Newcastle disease, haemorrhagic septicaemia, East Coast fever, contagious caprine pleuropneumonia (CCPP), contagious bovine pleuropneumonia (CBPP), classical swine fever, avian influenza, animal African trypanosomosis and African swine fever. In addition to addressing specific diseases, GALVmed is

4. The GAVI Alliance is a public-private global health partnership committed to saving children's lives and protecting people's health by increasing access to immunization in poor countries (https://www.google.co.ke/#q=what+is+the+GAVI+alliance).

also involved in the following activities: Advocacy, communication and resource mobilization; building partners' capacity to enhance sustainability; enabling partner innovation and creating a more enabling policy and institutional environment (GALVmed 2014b). Through its Vaccines for the Control of Neglected Animal Diseases in Africa (VACNADA) project, GALVmed supports sustainable improvements to the quality and quantity of vaccines produced by laboratories in eight Africa countries—Botswana, Cameroon, Democratic Republic of Congo (DRC), Ethiopia, Ghana, Kenya, Mali and Senegal. Inputs included capacity building through staff development, market intelligence and upgrading of laboratory equipment, facilities and processes. VACNADA focused on vaccines for four diseases, namely, Newcastle disease, contagious bovine pleuropneumonia (CBPP), contagious caprine pleuropneumonia (CCPP) and peste des petits ruminants (PPR) (GALVmed 2010).

Not all targeted vaccine interventions will be adopted. Vaccine adoption can be shrouded in mystery especially if its long term effects are unknown. For example, it remains debatable how effective the Canadian government funded vaccination program against human papilloma virus (HPV) will be because it focuses on girls between the ages of 9–13 and there is very little research evidence on its effectiveness and long-term consequences on girls of that age. Moreover, if the effect of the vaccination is to reduce the use of pap tests among young women, other strains of HPV, which can lead to cervical cancer could go undetected. Under the best of circumstances there will be a reduction in the incidence of cervical cancer and genital warts among Canadian women with no serious side effects attributable to the vaccine. Some researchers suggest that more would be accomplished if the USD 300 million in federal funds had been allocated to increasing access to pap tests (Renee and MacAdam 2007).

Justification of support through convincing measurement of benefits

Economic factors, including financing, play a key role in the development and use of vaccines throughout the world. To ensure that emerging vaccines are appropriately valued, economic analyses should include measures of health benefit that give credit for preventing morbidity, such as Quality-Adjusted Life Years (QALYs)[5] or Disability-Adjusted Life Year (DALYs)[6] (Lieu et al. 2005).

Investing in lasting advocacy strategies

The theory of prevalence elasticity of disease states that the demand for preventative care (e.g. vaccination) against a disease increases with the prevalence of that disease (Cox 2012). This means that the more a vaccine is adopted, the lower the prevalence of the disease being targeted with the vaccine, and hence, the lower the demand, eventually. The low demand in vaccination causes a decline in immunizations, which can eventually result in a resurgence of a disease.

Consumers of vaccines respond to vaccination if they perceive a risk of disease. If they do not perceive it, they will not vaccinate. Media can exacerbate this nonresponse to vaccination, or initiate a rejection of vaccination by issuing anti-vaccination messages, which are often not grounded in sound science. For example, conspiracy theories that claimed that the avian flu threat was 'manufactured' by vaccine suppliers and their allied players that followed the 2009 H1N1 epidemic threat and [unidentified] 'expert' anti-vaccination testimonials have caused much damage to vaccine technology adoption and sustenance of use (Angelmar and Morgan 2012, 42). Media too can promote response to vaccination through convincing campaigns such as the 'Kick polio out of place X, e.g. Kenya and Sudan', initiated in the 1990s and still going on. Media can also bring prominent public figures, who have been affected by the disease to tell of their lost opportunities from missing vaccination as was the case in Kenya's 2013/14 campaign for vaccination against polio.

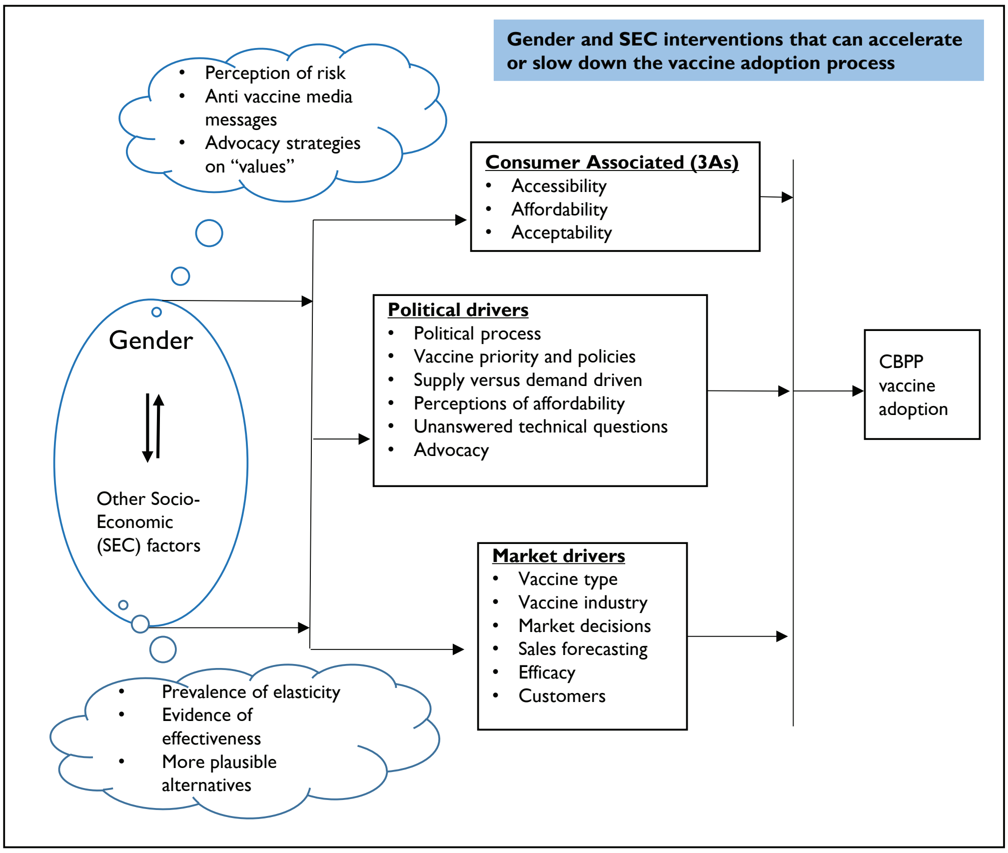
5. The quality-adjusted life year (QALY) is a measure of disease burden, including both the quality and the quantity of life lived (https://www.google.co.ke/#q=what+is+the+qaly+measurement).

6. The disability-adjusted life year (DALY) is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death (https://www.google.co.ke/#q=what+is+the+daly+measurement).

Combating anti-vaccination information with education and evidence-based communication has been found to be ineffective and advocacy strategies such as emphasizing simple bottom-line statements (Reyna 2012), stressing the obligation to act as a moral member of society (Caplan 2011) and including emotionally compelling content (Bean 2011) by, for example, having a parent who lost a child to a preventable disease through vaccination tell his/her story (Parikh 2008). Credible advocates, such as credible medical and marketing practitioners and other credible and knowledgeable persons should be involved in various strategies including online discussion forums (Nicholson and Leask 2012).

Interventions can accelerate or decelerate the rate of vaccine adoption. Like the drivers, some interventions are gender specific and should be implemented in a way that targets the most appropriate gender (Figure 3). Gender associated interventions include influencing the perception of risk, combating anti-vaccine media messages and developing advocacy strategies on values. Less gender associated interventions include education on the prevalence of elasticity, provision of evidence on effectiveness and demonstration of the vaccine as the most plausible approach to the control of the disease among options with varying plausibility.

Figure 3. A conceptual representation of the gender- and other socio-economic associated interventions (in think bubbles) that can influence, by accelerating or decelerating, the rate of CBPP vaccine technology adoption.



Although gender is a socio-economic issue, it is important to pay special attention to it during socio-economic analysis because it is probably the most pervasive variable ever used to define differences between women and men and to justify, sustain and reinforce inequalities between women and men with resultant subjugation of women. In addition, men and women perceive risk differently e.g. a sick cow to a man may represent a shortage of money due to expenditure on treatment and inability to sell it, whereas to a woman, it may represent hunger owing to the drop in milk yield.

CBPP vaccine technology adoption can be motivated in both women and men by occurrence of frequent outbreaks and less adverse post vaccination side effects. Among women, vaccine adoption can be motivated by the anticipation of increased household food security due to enhanced milk production associated with absence of disease and motivation stories/testimonies on improved child-health associated with absence/eradication of disease. Among men, vaccine adoption can be motivated by the anticipation of increased household wealth owing to increased annual sales of livestock associated with absence of disease and motivation stories/testimonies on improved wealth associated with absence/eradication of disease.

Among the barriers to the adoption of CBPP vaccination for women include their inability to access extension information on the disease, its control and benefits of its control and when their decision-making power and ability to negotiate over what to do with cattle and their products within the household is very weak. Barriers of adoption by men include national livestock movement and trade bans imposed on healthy cattle owing to disease outbreaks in a different geographical location.

Regarding media messages, women and men have access to different media and even within the same media category, e.g. radio and television, they access information at different times and channels because they have different interests and women, given their triple roles of production, reproduction and community work, can only view television at specific times. Men and women also have different values and are likely to respond to the same strategies and advocates of strategies differently.

Educating beneficiaries on the concept of prevalence of elasticity, providing evidence on effectiveness and information on alternatives to vaccination can sway different socio-economic groups of people differently. Socio-economic groups are, however, gendered and men and women may sometimes respond differently to these factors. The boundary between the gender and socio-economic factors and interventions associated with them are porous and should be described as such.

Innovative strategies, such as delivering livestock vaccines with children vaccines should be explored. The strategy of combining livestock (especially rinderpest) and human (EPI) vaccination interventions in southern Sudan cattle camps by operation lifeline Sudan (OLS) in the 1990s and early 2000s may have contributed to the eradication of rinderpest from Sudan. A word of caution however, is that negative publicity of one of the combination vaccines might to affect delivery of the other negatively.

Conclusions and recommendations

Vaccine technology adoption issues are complex due to the plethora of drivers that influence the adoption positively and negatively. These drivers carry different weights and change with the context, including the type of vaccine, the community and period in time. The question on what drivers influence the adoption the CBPP vaccine, how they influence it, and what interventions can enable drivers that influence adoption positively and disable those that influence adoption negatively has been investigated in this study.

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 3A consumer based drivers (accessibility, affordability and acceptability), political and market based drivers. The framework also recommends four broad interventions that could be implemented to enhance adoption of the CBPP vaccine technology. They include the following:

i. The predictable demand intervention whereby the cost, and hence the price, of the potentially promising vaccine is lowered—through a combination of use of cheap but effective antigens during vaccine development and government and philanthropic subsidies, so that advanced vaccine purchase contracts that can cater for unpredictable demand can be made for the targeted vaccine. GALVmed's role in this intervention continues to be crucial and offers promise for development of locally made affordable and efficacious vaccines.

ii. 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) the disability-adjusted life years (DALYs). This could be achieved through economic modelling.

iii. Investing in lasting advocacy strategies using media and other methods. While using these strategies, practitioners need to pay attention to the likely gendered perceptions of risk and the values projected in the advocacy messages. Extent of knowledge, too, can be gendered requiring different modes of explanation of concepts, such as the prevalence of elasticity, to women and men. Because women from pastoral communities are unlikely to be educated, the concept can be demonstrated using theatre, whereas brochures and pamphlets may suffice for men and women with some education. 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.

iv. 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 the 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.

In sum, the CBPP vaccine adoption can be catalysed through one or a combination of up to four strategies: reduction in prices especially in times of enhanced and unpredicted demand; a convincing evidence based demonstration of benefits of vaccination over its alternatives; gender sensitive advocacy strategies and messages; and using innovative ways likely to enhance adoption.

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