

**POTENTIAL DEMAND ESTIMATION OF EAST COAST
FEVER VACCINES IN MAKUYU DIVISION, KENYA:
AN APPLICATION OF CONTINGENT VALUATION
AND CONJOINT ANALYSIS**

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A Thesis Submitted in Fulfillment of the
Requirements for the Master of Science Degree in
Agricultural Economics of Egerton University

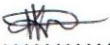
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DECLARATION

I declare that this Thesis is my original work and to the best of my knowledge has not been presented for any degree at any other university.

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Date..... 03/10/2002

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I declare that this work has been done under my supervision and is being submitted with my approval.

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ABSTRACT

East Coast fever (ECF) is considered the most important livestock disease in Eastern Africa and makes producers unable to realize the potential benefit from the sub-sector. Use of vaccines could effectively control the disease. Given the anticipated benefits of ECF vaccines, this study has assessed their potential demand among farmers from Makuyu Division in Central Province of Kenya. This was achieved through estimation of willingness and ability to pay (WATP) and analysis of farmer preferences. The Contingent Valuation (CV) method and double-bounded logit model were employed to elicit and model WATP, while conjoint analysis was used in decomposing farmer preferences regarding the vaccine to purchase. The estimated WATP for sub-unit was slightly higher than that of the other vaccine, infection and treatment method (ITM). Price was identified as a factor statistically influencing demand for the vaccines at 95% confidence level. The contribution of vaccine-attributes to purchase decision in order of decreasing importance were; effectiveness, frequency of administration, reactors and price, hence the need to give priority to non-price factors when designing an ECF vaccine.

DEDICATION

With love and admiration,
I dedicate this thesis to my parents,

Mr. Solomon Ngugi Ruoro

and

Phyllis Ngugi

“To God be the glory great things he has done”

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LIST OF SYMBOLS AND ABBREVIATIONS

ACA-	Adaptive Conjoint Analysis
AGREF-	Agricultural Research Foundation
BHV1-	Bovine Herpes Virus type 1
Cdf-	cumulative distribution function
C.I-	Confidence interval
CV-	Contingent Valuation
Db-	Double-bounded
ECF-	East Coast fever
ECFiM-	East Coast fever immunisation Method
FAO-	Food and Agriculture Organisation
GOK-	Government Of Kenya
hh-	household
IBAR-	Inter-African Bureau of Animal resources
IFAD-	International Fund for Agriculture and Development
ILRI-	International Livestock Research Institute
ITM-	Infection and Treatment Method
KARI-	Kenya Agricultural Research Institute
KShs.-	Kenya Shillings
LSD-	Least Significance Difference
Max-	Maximum
Min-	Minimum
No.-	Number
OAU-	Organization of African Unity

R^2 – Coefficient of determination

Sb-Single-bounded

Std. Dev- Standard deviation

WATP- Willingness and Ability To Pay

WTP-Willingness to pay

CHAPTER 1

INTRODUCTION

1.1 Background

In recent years, there has been a steady increase in research on both theoretical and applied problems related to adoption of new farming technologies in developing countries. This is attributed to the fact that a majority of the population in these countries relies on agricultural production and new technology potentially offers an opportunity to increase that production substantially. There is a high potential for improving livestock production in terms of increasing production efficiencies given that developing countries have nearly two thirds of the world's livestock but produce only a quarter to a third of the world's meat and a fifth of its milk (ILRI, 1999). There is a great opportunity in terms of increasing demand considering that, worldwide, demand for livestock is expected to rise faster than that for cereal grains over the next two decades, with demand for milk and meat predicted to rise by 170 and 260 percent, respectively (ILRI, *op.cit*). With such high anticipated increases in demand, there is need to lay emphasis on improving livestock productivity. Improved productivity will, in turn contribute positively to the economic development of livestock keeping countries.

The livestock sector plays a key role in Kenya. On the average, it contributes about 10% of the country's Gross Domestic Product and employs over 50% of the nation's agricultural labour force (Morzaria, 1999). The country has an estimated 13.5 million cattle of which 3.2 million head are exotic dairy and beef found in both large and small-scale holdings mostly concentrated in the high and medium potential agricultural zones. The remaining 10.3 million head are indigenous zebu cattle kept in the arid and semi-arid areas, which form approximately 80% of the country's land area (*ibid*). Smallholders

dominate in livestock production. They produce over 80% of all the milk and 70% of beef and other meat (*ibid*). Hence, for small-scale farmers in Kenya, livestock production in general, and the dairy industry in particular, is a very important generator of income.

The industry is, however, beset with numerous constraints. These include inadequate water and animal feeds (*fodder and pasture*), high cost of concentrates, poor marketing information, diminishing land resources for livestock due to increasing population pressure, diseases requiring control and treatment, poor animal husbandry practices and infrastructure, and inadequate credit facilities for dairy farmers. While many of these constraints can be addressed through interventions by the government or other agents, the disease constraint is more difficult to address, especially considering the research required for new drugs and vaccines. In Kenya, the most important cattle disease in terms of the detrimental effects realized is East Coast fever (ECF). The continuous exposure of livestock to this disease generates considerable physical losses (mortality, reduced productivity), leads to high control costs and limits widespread adoption of higher producing exotic breeds in endemic areas. This disease is likewise the most important one in eight other countries in Eastern, Central and Southern Africa (ILRI, 1999). In Africa, the disease threatens about 28 million cattle (*ibid*). Loss of cattle through ECF is particularly devastating for smallholder farmers for whom cattle represent a major proportion of family-wealth and nutrition.

ECF is a lymphoproliferative disease caused by a protozoan parasite, *Theileria parva*. Taurine cattle (*Bos taurus*) breeds and crosses of taurine cattle with the indigenous (*Bos indicus*) breeds, which are referred to collectively as grade cattle, are especially susceptible to ECF. Grade cattle are more productive in terms of meat and milk than the

indigenous breeds. Infected animals usually succumb to the disease unless treated soon after clinical signs appear, and those that recover from the disease show substantial losses in milk yield and live weight gain (Nyangito *et al*, 1994). The symptoms of ECF include: swelling of lymph nodes, continuous high fever, diarrhoea, laboured breathing and lung oedema. Due to its high mortality and morbidity rates and the high costs of chemotherapeutic drugs, ECF is of major economic importance (Mukhebi *et al*, 1992).

East Coast fever is transmitted by the three-host tick *Rhipicephalus appendiculatus*. Tick and tick-borne diseases are the principal constraints to further development and intensification of livestock production systems in Africa. Existing technologies of curbing tick and tick-borne diseases include tick control with acaricides, minimizing exposure to ticks through grazing management practices, therapeutic treatment with drugs, and enhancing herd population immunity through vaccination. The control of ECF through acaricide application has been successful but it is becoming increasingly unacceptable for several reasons including environmental pollution, contamination of livestock food products, high costs and the risk of developing pest resistance.

A research programme under the auspices of Food and Agriculture Organisation of the United Nations (FAO) was initiated 24 years ago, the principal aim of which was to develop a vaccine against ECF. This contributed to the development of the only effective method available of immunisation against ECF, the "Infection and Treatment" Method (ITM). The method requires that the animal be injected with a live *Theileria parva* sporozoite stablate and injected intramuscularly with a therapeutic dose of long acting oxytetracycline (TLA) immediately after (Mbogo and Kariuki 1995). The resulting immune response generally protects animals against the disease for life. In Kenya, ITM

trials have been carried out in a number of locations including Embu, Kakamega, Kiambu, Kilifi, Kisii, Kwale, Meru, Nakuru, Nyandarua and Trans-Nzoia Districts. The main objective of ECF research and these field trials has been to produce a vaccine that is affordable, safe, effective, easily manageable and acceptable to the end user (Morzaria, 1999). In Kenya, only one company, Coopers, has been licensed to market ITM vaccine and this has been limited to the Coast Province. Last year, 2001, it was announced that the vaccine would be licensed for use in the rest of the country.

The International Livestock Research Institute (ILRI) is in the process of developing an improved sub-unit vaccine against ECF. The vaccine is still in the early phases of development. It is not expected to be commercially available before the year 2010. The justification for its development has been provided by the need to overcome the various drawbacks associated with ITM. The ITM, in addition to being strain-specific, requires monitoring and a stringent cold chain, uses tetracycline, and is associated with complexity of administration, adverse reactions and significant possibility of disease transmission. Further, the vaccine is packaged in vials containing 20 doses, which must all be used once the vial is removed from liquid nitrogen. Given this type of packaging, it is clear that a smallholder farmer with 1-3 animals might not find this method economically justifiable, as immunising only three animals would imply a loss of seventeen doses. However, unlike the improved sub-unit vaccine, which is envisaged to require repeated administration annually, ITM is injected once and the immunity lasts for life.

As the sub-unit vaccine is being developed, ILRI with funding from IFAD is evaluating the vaccine's eventual impact on smallholder dairy systems in Eastern Africa¹. Both the ITM and the sub-unit vaccines have not been introduced in the Central Highlands. Information on the *ex-ante* impact of the two vaccines is needed to generate support for promoting the transfer and adoption of these technologies as well as identifying the necessary measures to optimize their impact. To ensure sound impact there will need to be sufficient demand for the vaccines. Effective demand will determine the commercial viability of the technologies and hence sustainability in their delivery. Commercial viability is more so important in this case considering the private nature of the technologies. The individual producer captures nearly all of the benefits from ECF immunisation – the benefits don't spill over to other members of the community unlike, say, a case of quarantine where others would stand to benefit. Moreover, with the trend toward liberalization, the government is withdrawing from provision of animal health services and products, leaving this function to the private sector. Establishing the commercial viability of the vaccines is therefore essential.

The supply of a technology may be constrained by factors such as high costs of machinery, raw materials, direct labour, transportation of materials, overheads and poor infrastructure. In addition, delivery may be constrained by difficulties in dissemination, especially in the case of knowledge-based technologies whereby the know-how has to be inculcated to the relevant parties to facilitate technology adoption. For instance, one of the reasons to which low ITM utilisation is attributed is the fact that the method differs from standard immunisation procedures and requires some cumbersome additional training for field veterinarians (AGREF, 1997).

¹ IFAD Technical Assistance grant No. 376 "Enhancing the impact of immunization against East Coast fever with an improved subunit vaccine on the smallholder dairy sector in Eastern Africa. The grant funded the author's thesis research.

The demand for a technology is influenced by several factors, including level of income, own price, price of related technologies, tastes and preferences. For determining vaccine preferences, factors considered are among others: effectiveness, price, frequency of administration and safety or side effects resulting from immunization. Variations in such factors would determine the appropriateness of vaccines from the farmer's perspective.

1.2 Problem Statement

Farmers in areas where ECF is endemic or sometimes a threat to livestock are not enjoying full benefits from livestock enterprise due to the deleterious effects associated with the disease. They may be interested in using the sub-unit vaccine being developed for controlling the disease. However, farmers' willingness and ability to pay for this vaccine and the socio-economic factors that will determine the adoption of this new technology are not yet clear, as no study of this nature has ever been conducted in the area. Yet, this information is essential in the vaccine's design and in deciding how to best target the eventual introduction of the vaccine. Similar issues are also relevant to the existing live vaccine, which has not yet been introduced in the study area. Subsequently, it is not clear how to target adoption in the study area nor is it clear, either, on how the sub-unit vaccine should be designed to meet farmers needs as expressed by their preferences. Also, it is not known whether there would be sufficient demand to support sustained supply and delivery of the vaccines by private sector.

1.3 Objectives

- 1) To estimate farmers' willingness and ability to pay, and hence demand for ECF vaccines.

- 2) To identify the socio-economic factors that determines farmers' willingness and ability to pay for ECF vaccines and consequently, adoption of the technologies.
- 3) To assess the attributes of the ECF vaccines influencing farmers' preferences regarding vaccination against ECF.

1.4 Hypotheses

- 1) The mean willingness and ability to pay for ITM is not significantly different from that for a sub-unit vaccine.
- 2) The willingness and ability to pay for ECF vaccines can be predicted by the factors; age, education, income, cattle herd size, knowledge of ECF and household size.
- 3) Non-price vaccine attributes influence farmers' decision on ECF vaccine to purchase more significantly than does the price.

1.5 Justification

The vaccines' demand estimates from the study are essential, as they form the basis for designing appropriate strategies for introducing the technologies in the study area. The analysis of vaccine attributes enable their ranking in order of importance from the farmer's perspective. This information is necessary for designing vaccines that meet consumer needs, which would thereby ensure sufficiently high demand and sustainability of vaccine delivery.

This study provides information needed by various stakeholders. The research managers at Kenya Agricultural Research Institute (KARI) and ILRI would be interested in the findings to guide them especially in designing the sub-unit vaccine under development.

The donors, who are supporting the development of the vaccines, would be interested in knowing how willing the farmers are to adopt the new technology and consequently to improve their welfare by lowering the disease prevalence. They would also be interested in a sustainable technology, and demand is an essential component for inferring sustainability. Private-sector actors who will be involved in the delivery of the vaccines would be interested in the findings as the demand estimates would guide them in fixing prices of the technologies in such a way that they would sell and at the same time make profit. Policy-makers, especially those in the Ministry of Agriculture, would be interested in the findings to guide them in deciding on how much of subsidy, if any, they should allocate to the delivery of the technologies to make them affordable by farmers.

1.6 Definition of terms

- ECFiM is the commercial name for infection and treatment method (ITM) used in Kenya.
- ECF vaccine is used in the hypothetical scenario (in the questionnaire) to refer to the improved sub-unit vaccine being developed by ILRI.
- Cold chain is whereby the vaccine (ECFiM) has to be kept chilled in liquid nitrogen constantly from manufacturing to when it is administered to the animal. This is done to maintain the live vaccine's viability.
- Willingness To Pay (WTP) refers to the amount the respondent would be willing to pay for a particular good or service- in this study, the vaccine.
- Willingness and Ability To Pay (WATP) refers to the maximum amount the respondent in addition to willingness to pay, has also the ability to do so. WTP is a necessary but not a sufficient condition for WATP.

- Non-giffen goods are those whose quantity demanded is negatively correlated to price changes.

CHAPTER 2

LITERATURE REVIEW

In this chapter, previously done researches relevant to this study are reviewed. It reveals the extent to which related studies have been done. This gives an indication of the gap being filled by this study. The first section highlights issues related to evaluation of demand. The second section highlights those studies that had been conducted with the aim of estimating the WTP. The section mentions among others the findings as well as the methodologies employed in undertaking them. Some of the studies employed single-bounded while others used double-bounded models in the modelling of WTP. The third section looks at livestock-related studies employing conjoint analysis, the technique used in analysis of farmer preferences in our study.

2.1 Evaluation of demand

To make the best decisions about provision of animal health services it is necessary that policy makers be able to determine the demand for the services. Assessment of demand is, for instance, very important in designing cost recovery measures. This would reveal areas that require intervention, say, in terms of subsidy. In the past, demand has been evaluated along two perspectives (Mackenzie 1992). One is non-market related and the other is market-related. Contingent valuation (CV), that makes use of hypothetical market, is the principal method for evaluating demand for non-market goods and services. The market-related goods and services are evaluated by making observations on prices and quantity bought in the market. A good that satisfies needs in the society would normally have high demand. Society's need may be identified through market research whereby consumer preferences are assessed. In other words, effective market research is essential in the design, manufacturing and sale of successful products. It

identifies the need and wants of target markets, ensuring that, products will sell because they meet the needs of buyers.

2.1 Willingness to pay literature

Several studies have been conducted with the aim of estimating willingness to pay for goods and services. A method commonly used in eliciting WTP for a good or service is contingent valuation. The method measures the total value of goods and services, that is, direct use value and passive use. It is used in ascertaining the value of a service which has no market value, or for which the market value does not reflect the true value. Whilst it originated in the industrialised world, Whittington (1998) argues that the method is well suited for use in developing countries. Response rates are typically very high in such countries, and respondents are generally receptive to listening and giving considered answers to questions posed. Because survey costs are considerably lower in developing than in developed countries (*ibid*), larger sample sizes and more elaborate experimental designs are possible.

The only currently available vaccine against ECF is ITM. Two studies have been conducted to determine the willingness to pay, and consequently, the adoption of ITM by Kenyan farmers, one at Kilifi in 1997 (Research International, 1997) and the other at Kiambu in 1998 (Ndua *et al*, 2001). The data used in the Kilifi study were collected from 220 farmers. The study objective at Kilifi was to estimate the likely adoption of ITM under a full cost recovery situation because in the past, it has been provided on a partial cost recovery basis. A price of KShs. 350.00 per dose of ITM vaccine was found to be the one most farmers would be willing to pay. This was at variance with a proposed commercial price for the vaccine of KShs. 1,030.00.

The Kiambu study (ibid) used a sample of 80 respondents selected randomly among those (230 farmers) whose cattle had been immunized with ITM during trials. The results showed existence of two categories of farmers as far as their WTP for the ITM was concerned. The groups expressed KShs. 500 and KShs. 1000 respectively as their WTP for the vaccine. The study revealed that the price the farmers in Kiambu would consider as expensive was that above KSh.1000. The study also revealed that ITM had been commercialised at the Coast Province at a price of KShs.800. However, the price being charged by private veterinarians that were delivering the vaccine was KShs. 1500. This was an indication of an overcharge as the price being charged was higher than that recommended. If the recommended price, KShs.800, were charged, and that there was enough supply for the vaccine, probably the adoption of the technology would have been higher as more farmers would afford it, based on the law of demand². Else, if the farmers adopting the technology were many, and hence high demand, it would be an indication that the farmers were actually willing and able to pay for the vaccine at a higher price than the commercial set one.

Chilonda (1999) used the contingent valuation method to elicit information about willingness to pay for ECF immunisation in Zambia. He used a single-bounded logit model in the modelling of WTP. He reported one of the factors favouring willingness to pay for ECF immunisation as farmer's previous experience with ECF vaccination. While this may be true in the Zambian context, the results may not apply in the Kenyan study site because farmers in this area have had no experience with ECF immunisation as the vaccines have not been made available to them. On this note, it may be suggested that the Chilonda study should probably have used a demand curve approach to infer the WTP rather than use CV since the vaccine was already in the market. Other variables included

² The law of demand postulates an inverse relationship between quantity demanded and price.

in Chilonda's study are: experience in cattle production, knowledge of ECF as a cattle disease, level of income of the farmer, distance from a livestock assistant, and the cattle herd size. The study did not include labour availability or rather household size as a factor in the analysis of willingness to pay. A vaccine is labour saving, especially when the frequency of administration is low, as opposed to acaricide use that is rather labour-intensive considering the customary weekly application. The factor is hence likely to be an influencing factor for WATP.

Swallow *et al* (1994) in a study conducted in Ethiopia, applied the contingent valuation method to determine the maximum amount of money and/or labour that households are willing to contribute towards a trypanosomiasis control programme. The study employed the open-ended method in eliciting the maximum amounts of labour and money that the respondents were willing to contribute. They acknowledged that though the method results in data that are easy to analyse, it raises some concern due to large numbers of non-responses and protest zero responses. The factors affecting willingness to contribute money or labour were tested with multiple linear regressions. Gender, cattle herd size and participation of the household in the guarding of technological inputs were found to be related to the willingness to contribute money. They concluded that contingent valuation, when integrated into a participatory research approach, could generate practical results for evaluating the prospects for local participation in the provision of local public goods. However, the CV is equally applicable when dealing with private goods (Whittington, 1998).

Swallow *et al* (1995) conducted a study at Southwest Ethiopia to assess farmers' perceptions of the public and private benefits of pour-on products against tsetse flies and

identify the household-level factors affecting their demand. The study employed a probit model to quantify the effects of different variables. The study established that proportions of cows and oxen in the household herd, distance to the treatment centre, and seasonal factors were significant determinants of demand for the products. To measure demand, the study used a binary variable: did the household take animals for treatment the month before they were interviewed (yes/no)? Unlike many studies on demand estimation as shown by the literature review in this section, the study was not designed for eliciting information on WTP given a stated price, rather it was on if the action was taken or not that is, whether the animal was treated or not. A proportion of 66% of the households interviewed had taken their animals for treatment during the month. The farmers who did not take their animals for treatment gave various reasons. Such reasons included: technology being too expensive, farmers having fewer problems with tsetse and ticks, and lack of labour or cash on the treatment date. The single-bounded approach was successful in identifying factors influencing demand but could not estimate the monetary amount farmers were willing to pay for the technology.

To estimate farmers' demand for water, a natural resource, a contingent valuation study was carried out in Newala, Tanzania (USAID, 1998). Specifically, the study aimed at determining whether households served by the Kitangari water scheme were willing to contribute to the operation and maintenance costs of their water system so that it could be kept running, the amount they could afford to pay and the type of cost recovery they would prefer. The bidding game approach of eliciting WTP was used in the study. By the time of undertaking the study, the government provided water inconsistently due to lack of enough funds to finance maintenance and operational costs. The study was to establish if households were willing to pay for themselves and hence get water regularly rather

than get it free but irregularly. Though the households were willing to contribute substantially, the amount could not cover the operational and maintenance costs of the water system. Albeit willing to pay less, the study advocated for full cost recovery strategy facilitated by improvement in the performance of the water system thereby saving labour resources that would subsequently be employed in economic development.

Demand has been estimated using Contingent valuation method also in human health related studies. Cropper *et al* (2000) employed the method in their study aimed at measuring the monetary value of preventing malaria in Tembien, Ethiopia. They estimated the WTP for two techniques of preventing malaria, a malaria vaccine and use of bednets. The dependent variable in their study was not discrete (yes/no) but continuous, the number of vaccines purchased. The demand for prevention methods was established as price inelastic. For a successful market penetration for the two technologies, they recommended subsidization. However, subsidies have become rare due to financial limitations. A consumer-oriented approach to development of products is hence being advocated. This approach will ensure that products readily sell in the market and that cost recovery would be possible.

Hanemann *et al* (1991) conducted a survey focusing on WTP for protecting wildlife and wetlands habitat in the California San Joaquin Valley. A combination of mail and telephone media was used to collect data for the study. A double-bounded dichotomous choice approach was used in the elicitation of WTP. This is whereby two bids are presented to the respondent the second being dependent on the response to the initial one and he is asked if he/she would be willing to pay at the suggested price. This method has the advantage of yielding estimates with higher precision than does the single-bounded

approach where only one bid is presented. The Hanemann study collected the response to the initial bid using a mail-out questionnaire and that for follow-up bid by a telephone interview that came later. For the wetlands maintenance, the study used five bid sets of prices. Initial costs used were \$40, 50, 65, 80 and 110. When the initial response was a “no,” the follow-up costs were \$25, 25, 30, 40 and 55 respectively. When the initial response was a “yes,” the follow-up costs were \$80, 110, 125, 125 and 170 respectively. The estimation of the WTP was done using both single and double-bounded logit models. As opposed to iterative bidding, the dichotomous choice approach is associated with less cost to the respondent and the interviewer especially in terms of less interview time and mental effort. Comparing the double and single-bounded model, they acknowledged an improvement in statistical efficiency when the technique of elicitation is double-bounded. They therefore supported the asking of a second dichotomous choice question as opposed to only one.

Carson *et al* (1994) conducted a study in Australia aimed at estimating the economic benefits of preserving the Kakadu conservation zone. He described a hypothetical scenario whereby the payment vehicle was a reduction in annual take-home pay of the respondents. The study employed the double-bounded discrete choice method to elicit the WTP. The initial costs were A\$5, 20, 50, and 100. The follow-up costs when the initial response was a “no” were A\$2, 5, 20 and 50. But when the response on the first price was a “yes” the follow-up costs were, A\$ 20, 50, 100, and 250. The results showed that 47% of the respondents answered yes to both responses while 40% gave a no response to both payment questions. Approximately 8 and 5 percent of the respondents fell in the (“yes”, “no”) and (“no”, “yes”) categories respectively. The study estimated the WTP using both the Turnbull nonparametric (covariates excluded) approach and a parametric

(covariates included) approach based on Weibull distribution. The study was in favour of the parametric approach as the Turnbull nonparametric approach does not give point estimates. However, they acknowledged a drawback with the parametric approach that some statistics estimated, such as the mean, are quite sensitive to the distribution assumed. The authors acknowledged that assuming different distributions from the Weibull, such as the lognormal or Log-logistic, would result to the same median value though different mean estimate.

In another related study, Carson *et al* (1992) conducted a survey in America to measure the loss of passive use values arising from injuries to natural resources caused by the Exxon Valdez oil spill. The respondents were asked how they would vote on a plan to prevent another oil spill similar in magnitude to the Exxon Valdez spill. The study had four bid sets. The study used \$10, 30, 60, and 120 as the initial costs, \$5, 10, 30, and 60 as the follow-up costs when the first response was a “no”, and 30, 60, 120 and 250 when it was a “yes”. Twenty-seven percent of the respondent provided two positive responses, 39% gave two negative responses while 25 and 9 percent provided (“yes”, “no”) and (“no”, “yes”) response respectively.

2.2 Preferences analysis literature

Analysis of preferences is important especially in understanding how people make their choices and hence decisions. This information is relevant to policy makers in formulating appropriate strategies to achieve specified goals. In marketing research, analysis of preferences does reveal how consumers make their purchase decisions regarding the good or service to purchase. This is achieved by disclosing the order of importance of various attributes of a good or service from consumer’s point of view. Some techniques

used in preference analysis are conjoint analysis and ordered probit model. The techniques enable managers understand what is valued most in a good or service by consumers and hence how they make decisions regarding their purchase. This information is necessary in designing products that meet consumer preferences and hence readily sell in the market. Our study used conjoint analysis in decomposition of preferences. Conjoint analysis has been used in addressing several problems as revealed by the proceeding highlighted studies.

Randolph and Ndung'u (2000) used conjoint analysis to describe how smallholder dairy farmers in Kenya make their choices of livestock health services. The study explored the role of transaction costs in delivery of services to farmers. Their study considered six attributes, and established their order of importance as: promptness of service, professionalism, bundled services, reputation, distance and lastly price. The study, however, was not planned to determine the proportion of variation in consumer preferences that is explained by changes in the attribute levels.

Other studies using conjoint analysis related to livestock have been conducted in developed country contexts, and two of the three, have been used to evaluate disease risk factors, rather than consumer issues. Van Schaik *et al* (1998) used adaptive conjoint analysis³ (ACA) to determine the perception of farmers, veterinarians and artificial insemination technicians of the importance of risk factors for the introduction of Bovine Herpes Virus type 1 (BHV1) to dairy farmers in Netherlands, whereby they considered 18 attributes and established direct animal contact as the most important risk factor. ACA is a computer driven method of eliciting respondents' preferences. As opposed to use of

³ It has not been possible to apply adaptive conjoint analysis in developing countries. The respondent uses a computer-based software, which is often not suited to a developing country context.

paper questionnaires or sets of attributes, say represented on cards, ACA is preferred for the reasons that: first, respondents can work with a large number of factors in a relatively short period of time. Second, ACA customizes the interview so that each respondent is asked in detail only about those factors of greatest relevance for him or her. Third, answers from each participant can be checked for consistency and excluded from further analysis when they are inconsistent. Lastly, after completion of the interview, the estimated preferences of the respondent are directly available for discussion or analysis. For the case at hand, not only was access to computers very limited (though palmtops could thereafter be used with farmers being assisted by enumerators) compared to the large number of farmers interviewed but also majority of the smallholder farmers were computer illiterate, so it would not be feasible to consider applying.

Horst *et al* (1996) applied conjoint analysis in their study to elicit expert opinions on risk factors concerning the introduction of a virus in Netherlands. The study considered seven risk factors, each with two levels, present or not present. The risk factors considered were import of livestock, import of animal products, feeding of import swill, tourists, returning livestock trucks, wildlife and currents. To elicit subjective knowledge of people involved in disease prevention and eradication, the study used a computerized questionnaire experiment whereby the interview was computer driven. In other word, the study used ACA. Import of livestock, swill and returning trucks were evaluated as the major risk factors. This study did not address the issue of WTP for a programme that could prevent the entry of the virus.

Ouden *et al* (1996) used conjoint analysis to evaluate pig welfare perceptions of both consumer-related respondents and pig welfare experts in the Netherlands. They used

ordinary least-squares (OLS) regression analysis to decompose the respondents' overall judgments on the set of pig welfare stages. They showed that the farm stages of farrowing and fattening were considered most important with respect to pig welfare.

2.3 Summary of literature review

From the review of literature on WTP, it can be inferred that previous studies have tended to concentrate in estimation of only the willingness to pay. Our study is unique in that in addition to WTP, it captures also the ability to pay, as indicated in the hypothetical scenarios presented to the respondents for valuation. There was emphasis that the farmer would give an affirmative answer to the proposed bids if only he was willing and able to buy at the suggested bids. From previous studies, as revealed by this chapter, the estimated willingness to pay for ITM is lower than the expected commercial price. There is no previously done study that has estimated the WATP for the Sub-unit vaccine. As regards the methods of estimating WTP, the studies portray some benefits, among them statistical efficiency and hence precision, that arise from using double-bounded model as opposed to single-bounded one. The studies therefore tend to advocate for the double-bounded method. On the other hand, studies on preference analysis are an indication that conjoint analysis is increasingly being employed in the livestock sector. Though not widely used in Africa, the technique has been extensively used in the rest of the world.

CHAPTER 3

THEORETICAL FRAMEWORK

This chapter presents the theory guiding this study. The first section presents the theory of demand and links it to utility theory. The two form the underlying theory in this study. The signs and magnitude of relevant coefficients imposed by theory and their implications are discussed. Consumers' objectives and constraints in making their purchase decision are also highlighted. The section gives an overview of the available approaches for assessing WATP and shows the justification for selecting the approach used in this study.

3.1 Theory of demand

According to demand theory, consumer demand as measured by the quantity of a good or service purchased or consumed is a function of both the average level and the distribution of relative prices faced, real income and a set of consumer characteristics (Sadoulet *et al* 1995). Consumer characteristics refer for example, to age, education, professional status, type of the household to which one belongs and the geographical environment, for instance, either urban or rural. Consumer characteristics indicate tastes and preferences of the individual.

In estimating a demand function, theory imposes restrictions on the signs of parameters. The coefficient of price of a non-giffen good is expected to have a negative sign. This reflects the law of demand that postulates an inverse relationship between quantities demanded and own-price. The coefficient of income, on the other hand, is expected to have a positive sign for the reason that, except for inferior goods, income and quantity demanded are positively related (Koutsoyiannis, 1988). Since money is normally scarce, that is, a consumer's budget is constrained, a rise in price would not necessitate the

consumer to purchase the status quo amount, that is, the amount he could have bought if the price did not go up. Rather, through the income and substitution effects, he would purchase less. The quantity demanded and prices of non-giffen goods are inversely related. When the demand function is linear, the coefficients of price and income are components of their respective elasticities (Koutsoyiannis 1988).

Given that each consumer has a budget constraint, he is confronted with the problem of choice (Tomek *et al* 1981). He therefore has to choose among alternatives the specific goods and services that best satisfy him and that he can afford to buy given his limited income. The satisfaction is the utility he derives from the goods and services. The consumer's goal is hence to maximize utility given his budget constraint. Given the consumer's exogenous budget, outlay or total expenditure x , that is to be spent within a given period on some or all of n commodities, his budget constraint may be expressed as:

$$x \geq \sum_{i=1}^n p_i q_i \quad (1)$$

where p_i and q_i are respectively price and quantity of good i .

Consequently, the utility maximization goal of the consumer may be expressed as:

$$\text{Maximize } v(q) \text{ subject to } \sum p_k q_k = x \quad (2)$$

where v is the transformation relating quantity bought to utility

k -subscript signifies the number of commodities

p , q and x are as earlier defined

Due to existence of budget constraint confronting the consumer owing to his limited income, among the available bundles of commodities, a rational consumer would give preference or have higher demand for those that yield him high utility. He would be willing to spend more to acquire such goods than on those that give him less utility. In other words, a good or service associated with highest willingness to pay would consequently be the one that yield highest utility to the consumer and vice versa. Subsequently, a high willingness and ability to pay indicates high utility derived from the commodity and hence such a good would be given preference implying its high demand. Logically, a good that satisfies one most is also highly valued. The value of a good would be expressed through WATP.

Generally, there are two approaches to assessing demand or rather the willingness and ability to pay. The first is the demand curve approach. This entails making observations on prices and quantities in a market. From data collected, one then estimate the demand curves. Using the demand curves, one can then infer the willingness and ability to pay for the products of concern. The approach may involve going to an actual market place, collecting data on quantities bought and the respective prices, and then developing a locus of points representing quantity bought per specific price. From such a plot, one can then infer the consumer's demand for the good or service at each price. In a fully private market, the prevailing market price reflects the product's value to the user. However, where the goods or services are either free of charge or subsidized, the market does not reflect the user's true valuation of the product. The demand curve approach is not applicable in this study for the reason that the products (vaccines) have not been made available in the study area (Makuyu) and therefore the product's actual market prices and quantities consumed do not exist.

The second approach to assessing WATP directly getting information from respondent is the CV method. This approach uses responses to some questions posed to consumers to infer preferences and willingness to pay for a hypothetical product or service. The method can be used for private goods as well as public goods (Whittington, 1998). The assessment of WTP through CV has a sound theoretical basis in welfare economics (Mitchell and Carson, 1989) whereby goods provided free or at subsidized rate, and hence do not reflect the actual market price, are valued using the method. According to the theory, if demand for a good or a service exists this must be reflected by willingness and ability to pay for it. A high willingness and ability to pay for a good is logically a proxy for its high demand. The CV method enables monetary valuation of both market and non-market products. Thus, the value placed by a customer on a good or service can be expressed as willingness to pay to obtain it or willingness to accept compensation for its loss. CV has the advantage over the pre-mentioned demand curve approach of assessing the willingness to pay, by being able to estimate total economic value. Since the products under consideration in this study have not been introduced in the market in the study site, the contingent valuation is appropriate for this context. Again, CV results in collection of data that can directly be analysed using conceptual models. The technique in general has another advantage in that hypothetical markets can be designed for use in wide variety of valuation methods.

Despite the advantages associated with the CV methods, it has some disadvantages due the fact that it uses hypothetical rather than actual markets. These includes, less reliability of the technique when used to value alternatives that lie beyond the experience of the

subjects, it is not easy to validate the generated findings and lastly the method normally provides opportunities and incentives for respondents to behave strategically. Strategic bias is minimised in our study by employing closed-ended approach in elicitation of WATP rather than the open-ended. Use of vaccines is not beyond experience (though for ECF may be relatively new) and therefore the issue of reliability may not be a major problem.

In addition to CV method, there are others used in valuing non-market goods. These are inferential techniques and cost of the least-cost alternative (Randall, 1981). Inferential techniques include Travel-cost, Land-value and lastly use of labour-market observations to estimate the value of human health and safety. The inferential techniques use market-generated data pertaining to some marketed good in an attempt to infer the value of the non-market good. In the travel cost method for instance, the value of amenities provided by outdoor recreation sites may be inferred from the cost of travel and subsistence purchased by people visiting the sites. Land-value method assumes that certain natural resource and environmental amenities are enjoyed in a complementary manner with residential land. For instance, the value on a unit improvement in air quality may be estimated by comparing purchase price of residential land in the two regions, of course taking into consideration the variation in other factors characterising the regions. Labour-market observations normally use present value of expected earnings foregone due to injury or premature death. The least-cost alternative is not an inferential technique. It uses the cost of a substitute of the non-market good to infer demand for a non-market item.

Preferences analysis is based on the new economics theory that asserts that consumers derive utility from the attributes of goods and services and not necessary the quantities consumed. The utility realized is neither conflicting nor disjoint from demand. For instance, an increase in utility would automatically correspond to higher demand and vice versa.

3.2 Summary

This chapter has presented the theoretical framework that guides this study. The theory of demand has been presented and the linkage between it and utility theory explained. The objective of the consumer in making purchase decision is explained. Lastly, various approaches normally employed in demand estimation are discussed and a justification given for adopting the one used in this study. For valuing market goods, demand curve approach is discussed. On the other hand, methods used in valuation of non-market goods are highlighted including; inferential techniques including, travel-cost, land-value and labour-market observations; contingent valuation techniques and lastly the cost of the least-cost alternative. Lastly, the relationship between utility derived from product's attributes (as would be estimated by conjoint analysis) and demand is briefly explained as asserted by the new economics theory.

CHAPTER 4

METHODOLOGY

This chapter describes the methodology employed in this work. The study was part of an IFAD funded project undertaken by ILRI. The chapter starts with a description of the overall project and then narrows the focus to this study. It describes the site where data were collected and how the area was selected and then proceeds with a description of sampling techniques, data collection methods and procedures, data type, model specification, data analysis techniques and, lastly, the scope and limitations.

4.1 The ECF vaccine impact assessment project

This study was conducted as part of an IFAD-supported project for enhancing the impact of immunisation against East Coast fever on the smallholder dairy sector in Eastern Africa. The project had four major objectives. One was to confirm the efficacy of the ECF sub-unit vaccine under development. Second was to evaluate the mechanisms for optimal delivery, adoption and impact of the sub-unit vaccine. Third was to determine the impact of the ECF vaccines on a series of productivity and economic indicators in smallholder dairy systems. The final objective was to evaluate the benefits of reduced risk of ECF to livestock keepers and consumers of livestock products gained through the use of vaccines. The project conducted field studies in four different sites in Kenya namely: Makuyu, Kiambaa, Kakamega and Uasin Gishu. This study focuses on the first site, Makuyu.

4.2 Study area

4.2.1 Location and size

Makuyu Division is the study area. It is in Kenya, Central Province and Maragua District. Maragua is a new District that recently (1997) split from Muranga District in which Makuyu was formerly located. Since the data for the newly defined district are not available, the location of Muranga District in Kenya is shown by Figure 1. Makuyu Division covers an area of 203 square kilometers (Ministry of Finance and Planning, 2001). It has three locations, namely Kamahuha, Kambiti and Makuyu, and 13 sub-locations.

4.2.2 Topography and climate

The Division lies at an altitude of about 914 metres. The terrain is relatively flat. The area is generally arid and semi-arid. It receives an average rainfall of less than 800mm annually. There are two rainy seasons. The long rains fall in the months of March, April and May. April records the highest amount. Short rains fall in the month of October and November. The average maximum annual temperature is 28°C while the minimum is 16°C.

4.2.3 Physical infrastructure

Makuyu Division has low coverage of road network. The Thika-Sagana road is the only tarmacked road that passes through the division. The rest are earth roads, which are rendered impassable during the rainy season. This creates a problem in terms of transportation of people, raw materials to market and other processing points as well as inputs to farms. In addition to the Thika-Sagana road, a railway line traverses the Division. This is mainly used by National Cereals and Produce Board (NCPB) to

transport grains. The line is also used to transport bulky agricultural inputs such as fertilizers.

As regards water supply systems, since the area is characterized by low rainfall, rainwater availability is not consistent. The natural supply is augmented by water from self-help projects.

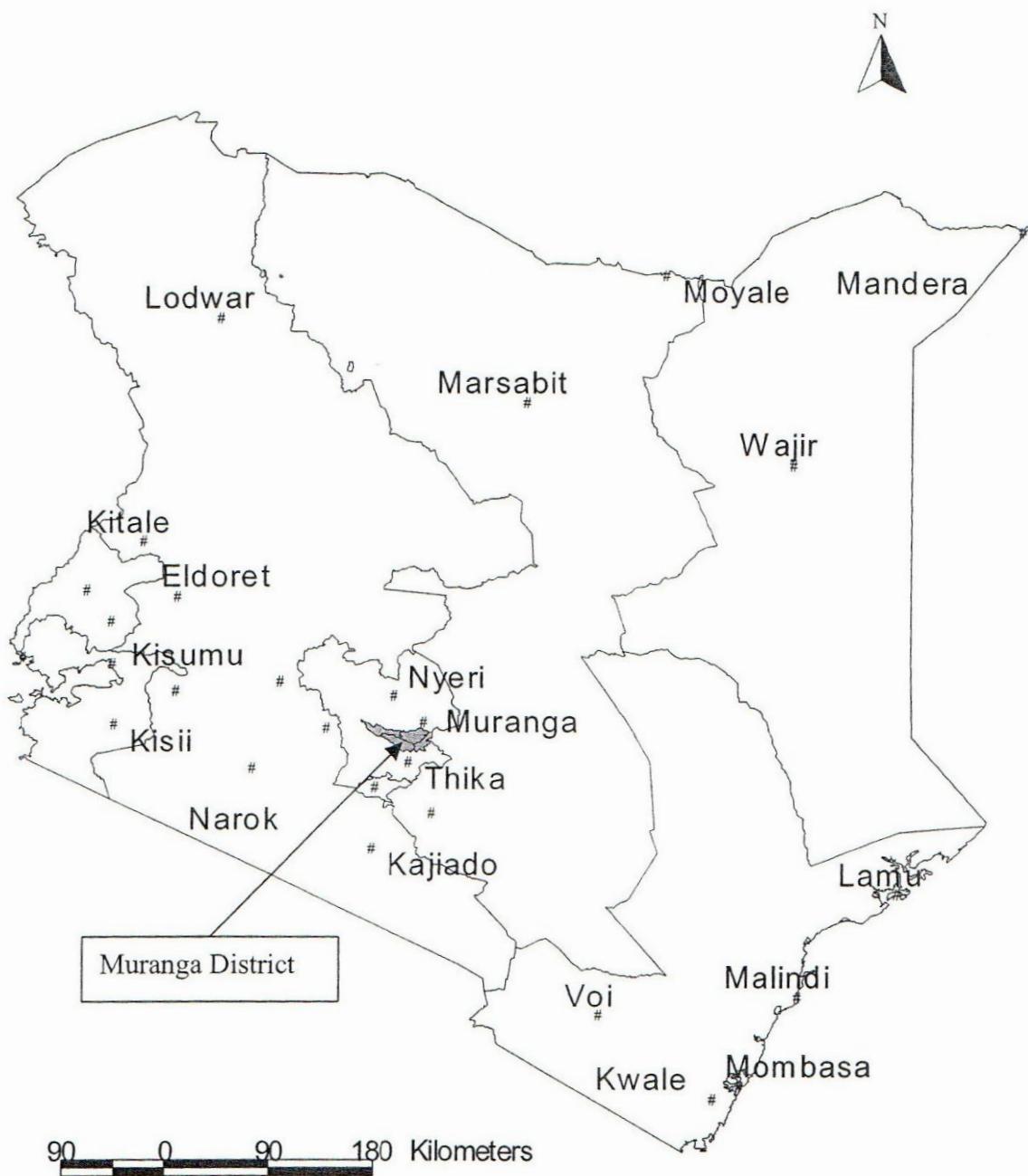
4.2.4 Human population

In 1999, Makuyu Division had a human population density of 287 (Ministry of Finance and Planning, 2001). The population of males was about 28.5 thousands and this was only about a thousand less than that of females. The total number of households in the Division was 13.9 thousand (*ibid*).

4.2.5 Agricultural systems

Coffee is the major cash crop grown by small-scale farmers in the area. Other common crops are French beans, maize, sweet and Irish potatoes, beans, peas, bananas, cassava, tomatoes and other vegetables. Farmers mainly practice mixed farming. By diversifying, they are able to reduce risk against income generation. Again, crops benefit from manure yielded from animals.

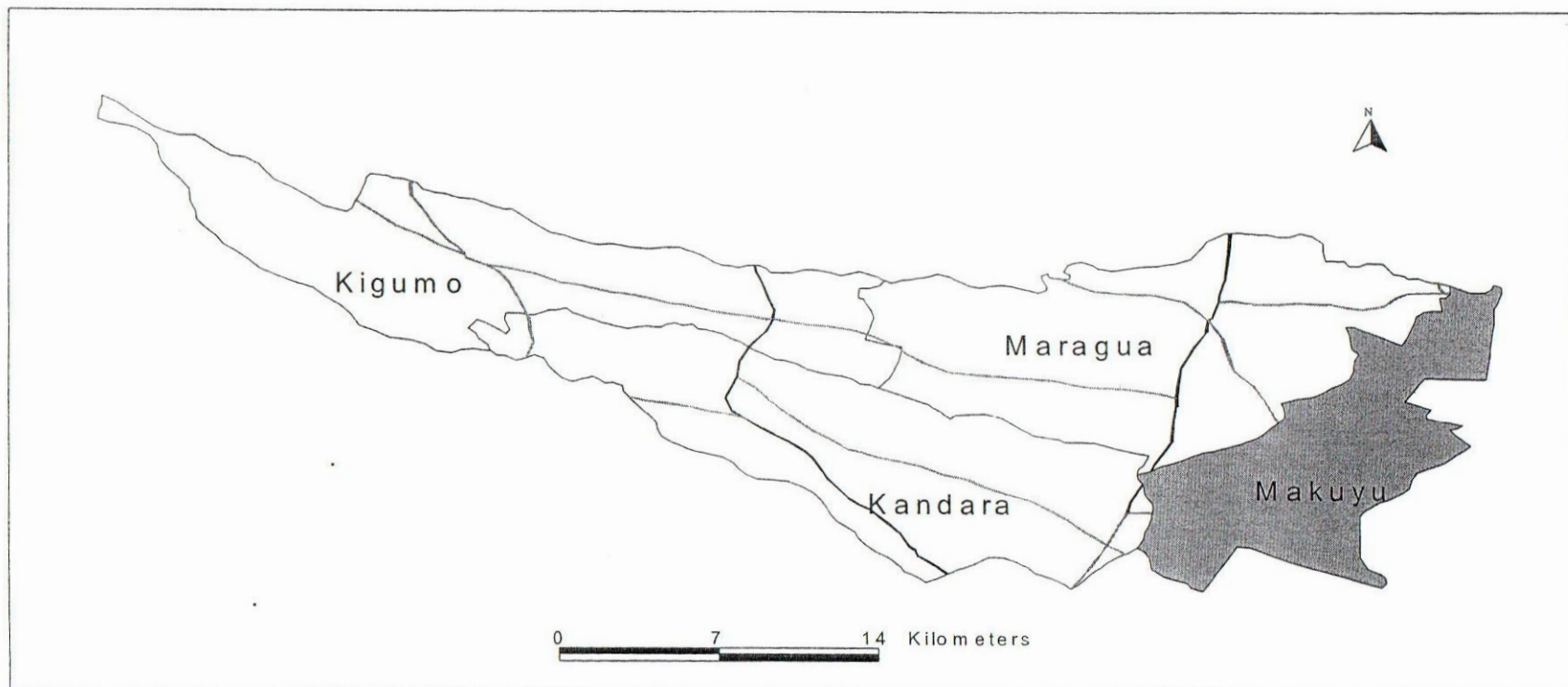
As regards livestock farming, a mixture of exotic, crosses and indigenous breeds of cattle are found in this Division. Farmers also keep sheep, goats, rabbits, poultry and a few have donkeys. The region is a marginal area for dairy; it is an area of expansion (of smallholder dairy) as intensification rises in the high potential areas. The area is characterised by high mortality from ECF, variable tick control and vector challenge. The area is endemically unstable for ECF.



Key: # is town centre

Source: ILRI Geographic information systems section

Figure1: Map of Kenya showing the location of Muranga District



Source: ILRI Geographic information systems section

Figure 2: Muranga District showing location of Makuyu Division

4.3 Sampling procedures

4.3.1 Selection of the area

The area was selected through a purposive sampling procedure. ILRI personnel had previously conducted research aimed at assessing tick prevalence in the area. Part of the findings from this project was to be used in comparing with results from the previous research. This is important for validating the results.

4.3.2 Sampling of the households

A list of all the sub-locations in the Division was obtained from the Division's Office. There were 13 sub-locations in the area. A simple random sampling procedure was employed to select 5 sub-locations from the 13. The selected sub-locations were: Gakungu, Gathungururu, Kaharati, Makuyu and Sabasaba. A sampling frame of all the livestock-keeping households in each of the five sub-locations was developed. This was done with the help of chiefs and village elders. For all the five sub-locations, the sampling frame had a total of 1869 farmers. From this, a total of 250 households were randomly selected for interview.

4.4 Data: Instruments, collection and management

4.4.1 Questionnaire development

The questionnaire used in collection of data for this study was developed by personnel at ILRI.

It consisted of four major sections:

- a) Characterization of production and management systems. This section was for collecting information regarding household members, farm resource base, farm enterprises, farm connections including group membership and market information, farm income and decision making, goals, objectives, and innovations, livestock diseases and management, farmers opinions, preferences and priorities.
- b) The contingent valuation. This section described a hypothetical product, either, ITM or sub-unit vaccine, and its means of delivery. The section was meant to collect information on WATP for the ECF vaccines.
- c) Conjoint analysis. This section had cards representing different vaccines based on variations in attribute levels. Data on farmers' preferences were collected by ranking the cards.
- d) Farmers' perception regarding ECF disease. This section collected information on how farmers perceived ECF risk and how they managed it.

The full questionnaire used in data collection is shown in appendix 3.

4.4.2 Recruitment and training of enumerators

The positions of enumerators were advertised with a minimum academic qualification of a four-year of secondary education with mean grade of C. They were to be fluent in the local language, Kikuyu, and have a farming background. A total of 15 were short-listed based on their qualifications. They were invited for oral interview and eight of them selected. The eight were trained at KARI Muguga. The focus of training was on establishing a good rapport with

farmers during the interview, translation of questions written in English to Kikuyu, and on accuracy in recording information collected.

4.4.3 Data type

Data used in this study for analysis consisted of primary data collected through the survey conducted at Makuyu Division in Central Province of Kenya in December 2000 and January 2001. Both social and economic data were collected.

4.4.4 Data collection and mode of administration

The collection of data was performed using questionnaires that were administered to farmers by enumerators. The data were collected mostly by interview. However, some information in the questionnaire, especially that related to farm structures, was collected by direct observation.

4.4.4.1 Elicitation of WATP

In this study, a survey-based method, contingent valuation, was used to elicit WATP. The method is frequently used for placing monetary values on goods and services not bought and sold in the market place. In the past, the method has mainly been used in the valuation of non-marketed resources such as recreation, wildlife and environmental quality. For instance, a CV study on a natural resource such as water, would provide information necessary in making appropriate decisions regarding: site selection (a village showing higher WTP is likely to be given preference rather than that with low WTP), choice of service level, tariff design and benefit estimation for cost-benefit analysis. Such a study also provides a means of communicating with users (USAID, 1988)- it enables better understanding of the problems and needs of customers and solicits their input in fashioning the solution, hence promoting a participatory approach to problem solving. From the policy point of view, a crucial issue is how much a service or a good is worth to the users. A measure of user's valuation can provide

important clues to designing cost recovery measures or deciding whether the institution concerned, say, the government, should provide these services at all. If a product is valued highly by the users, then there is no rationale for subsidization or for other government intervention in its provision.

The contingent valuation method is consistent with the consumer sovereignty assumption that asserts that the consumer is a better judge of what gives him utility than anyone else.

Generally, contingent valuation data collection would include or comprise (Moran, 1999):

- (i) An introduction for setting the general context of the problem.
- (i) A description of the good or service being valued.
- (ii) The institutional structure within which the good or service is to be provided.
- (iii) The manner in which the good will be paid for.
- (iv) A set of follow-up questions to ascertain why the respondents answered the way they did.
- (v) Information on respondent's characteristics for statistical analysis.
- (vi) A method by which the survey elicits the respondents' preferences about the good or service.

There are various methods by which a survey may elicit the respondent's WATP for a good or service. The most often used are: -

- (a) The Open-ended approach in which the respondent is asked the maximum amount he would pay for the service or good rather than go without it. With this approach, there is a tendency for respondents sometimes to give very high and unrealistic figures for WATP and at times, they may express it as zero or answer with protest just to put off the interviewer if they are not interested in the interview. This is a disadvantage associated with this approach.

- (b) Payment cards approach where the respondent is shown a card that depicts a variety of payments and asked which he would pay. With this approach, if in any case a different card with other sets of payments is shown to the respondent, he may give a different WATP. The responses are hence usually not credible due to this sort of inconsistency.
- (c) Bidding games where the respondent is asked if he would pay a given amount: a “no” response is subsequently followed by a lower amount and a “yes” response is followed by a higher amount until the true value seems to have been identified. This was the traditional way of eliciting the willingness to pay. This approach has the disadvantage that once the respondents note the pattern of the questioning, they tend to give strategic answers. To eliminate this strategic bias, use of discrete choice kind of questions has been recommended.
- (d) Dichotomous choice payments where the respondent is given a single payment and answers with a yes or a no. The yes-no answers are then used along with the required payment to estimate a discrete model from which the expected WTP is then calculated. This method of eliciting WTP has the advantage of considerably reducing strategic responses. Strategic bias arises when a respondent attempts to influence the results of a WTP survey by answering in such a way as to serve his own interest rather than reveal his true valuation of the good or service. For instance, a respondent might give a very high amount if he felt that by so doing, he would influence the decision on whether to provide the commodity or not and that once made available the provider would not be able to collect the charges. Alternatively, by strategic answering, the respondent might give a very low amount of WTP if he felt that the answer would lower the amount he would be charged once the good or service is provided. The dichotomous choice approach was employed in this study. However, instead of using a single-bounded design (i.e, only a single bid is presented), the double-bounded design (i.e,

two bid values are tested –an initial one and a follow-up one) was adopted as it improves statistical efficiency.

For the double-bounded design, similar to the single-bounded one, the respondent does not determine the first bid. It is externally determined and therefore termed *exogenous*. However, the second bid is *endogenous* as it is determined on the basis of the respondent's response to the first bid. In other words, the level of the second bid is contingent upon the response to the first bid. If the response to the first (exogenous) bid is affirmative, then the second bid is higher than the first. If the response is negative, then the bid is some amount lower than the initial. The double-bounded contingent valuation method was first proposed by Hanemann and Carson in 1985 (Hanemann *et al*, 1991). In 1986 (*ibid*), Carson, Hanemann and Mitchell used it for the first time in determining demand for public goods.

A double-bounded model was used in this study to estimate WATP for two “hypothetical” ECF vaccines:

- a) The infection and treatment method (ITM) of immunisation (the existing vaccine that is hypothetical since it is yet to be made available in the survey sites).
- b) A sub-unit vaccine currently under development at ILRI.

Asking the same farmer about WATP for both vaccines would likely confuse the farmer. Again, this is likely entice strategic responses whereby farmers would answer with the intention as to influence a policy decision, hence not revealing their true WATP. To avoid this, 50% of the farmers sampled were asked about WATP for ITM and the other 50% about the sub-unit vaccine. The procedure involved the enumerator carefully explaining the hypothetical scenario including what the properties of the vaccine would be. Once the enumerator confirmed that the respondent had understood the scenario, he then asked if the farmer would be willing to buy the

complete vaccine service (the product and its administration by a vet) at a given price. If the farmer was not willing to pay the initial price, then the enumerator would propose a predetermined lower price and re-ask the question. If the farmer was willing to pay the initial price, then the enumerator re-asked the question with a pre-determined higher price. Some questions were asked to those farmers who were not willing to pay at both of the proposed levels to understand better why they were not interested in the vaccination and thereby enable the testing of protest behaviour.

In this study, initial prices for ITM were KShs.250, 500, 1000, 1700 and 3000 and follow-up prices were KShs. 125, 250, 500, 850, and 1500 if the initial response was a "no", and KShs. 300, 625, 1250, 2125 and 3750 if the initial response was a "yes". The first bid vector for the sub-unit vaccine was KShs. 100, 150, 400, 1000 and 3000. If the first response was a "no", the follow-up prices were KShs. 50, 75, 200, 500 and 1500, but if it was affirmative, the bid vector was KShs. 125, 200, 500, 1250 and 3750. The corresponding price if the initial response was a "no" was half (50% less) that for initial price and a quarter (25% higher) if the first response was a yes. The prices were based on those offered at the Kenyan Coast – where ITM has already been commercially introduced.

4.4.4.2 Eliciting farmer preferences regarding ECF vaccines

Unlike in elicitation of WATP where the scenario presented for ITM was different from that of the sub-unit vaccine, in the elicitation of farmer preferences, the vaccine attributes considered were generic to both vaccines. In determining farmer preferences regarding the vaccine to purchase, conjoint analysis was employed. Conjoint analysis is a market research tool for developing effective product design. It is a multivariate technique used specifically to describe respondents' preferences for attributes of products or services. It is based on a simple premise

that consumers evaluate the value or utility of a product, a service or an idea (real or hypothetical) by combining the separate amounts of utility provided by each attribute and that a product can be 'decomposed' into a set of attributes. In other words, consumers make their consumption decisions based on a joint comparison of a product's attributes. Conjoint analysis assumes that a consumer assigns a utility value to each level of each attribute, and makes his or her final decision based on the total of utility values across attributes for a given product. Conjoint analysis is unique among multivariate methods in that the researcher first constructs a set of real or hypothetical products or services by combining the selected levels of each attribute. These hypothetical products are then presented to respondents who provide their overall evaluations. Because the researcher constructs the hypothetical products or services in a specific manner, the importance of each attribute and its levels can be determined from the respondent's rankings across products. This is achieved by decomposing the overall preference by conjoint analysis.

Conjoint analysis is also called trade-off analysis. This is due to the fact that in making a judgment on a hypothetical product, respondents must consider both the good and bad characteristics of the product to form a preference. Respondents must weigh all attributes simultaneously in making their judgments. The methodology is based on a decompositional approach in which the respondents react to a set of profile descriptions to rank in order of preference the profiles representing a number of different combinations of attribute levels of a selected set of product attributes. The number of combinations and their content are selected in such a way to permit the statistical decomposition and quantification of each attribute level's contribution to the consumer's ranking decision. An advantage of the technique is that it can be used to evaluate hypothetical as well as existing products and so is often used to evaluate new

commercial products before they are put on the market, or even before they are developed (Randolph and Ndung'u 2000).

The evaluation of the products involves presenting stimuli to the respondent for rating or ranking. The most widely used methods of presenting stimuli are: trade-off, pair wise comparison and full profile. The tradeoff method compares two attributes at a time until all combinations of levels are compared and hence ranked. This method is considered simple as only two attributes are considered at a time. It avoids information overload if the attributes are few. Nevertheless, when they are many, the respondents make a lot of comparisons and therefore tend to be fatigued.

Unlike the trade-off method where pairs being compared are attributes, in pair-wise comparison, profiles⁴ are compared. However, the profiles involved contain only a few attributes as opposed to full profile method that, as we shall see below, contains all attributes under consideration. Mostly, with this method, respondents assign scores to the profiles to show the strength of preference among profiles. Ranking is rarely used in this case.

The last method, full profile, involves the ranking or rating of profiles where each consists of a combination of all the attributes to be considered. This method has the advantage that if the attribute levels are many, it can allow for their reduction by use of fractional factorial designs. In addition, though order effects may characterize the data if the attributes are not rotated in the profiles, the method more closely represents how respondents make decisions in real life situations. In this study, this method was employed. Four vaccine attributes (effectiveness,

⁴ A profile is a set of levels of more than one attribute, representing a particular good or service, which is presented to the respondent for valuation. Different profiles are obtained by varying levels of different attributes.

frequency, safety and price) were considered. Each had two attribute levels, apart from price, which had three.

The attributes and their levels are shown in Table 1.

Table 1: Vaccine attributes

Attribute	Attribute levels
Effectiveness	Very effective -95% versus moderately effective-75%
Frequency	Once for life versus annual boosters
Safety	No reactors versus reactors (5%)
Price	KShs. 600, 1200 and 1800

The first attribute, effectiveness, refers to the protection to be provided by the vaccine once the animal has been immunized. Moderately effective (75%) level means that if animals are exposed to ECF challenge, then 75 out of 100 may be expected not to get ECF. On the other hand, very effective (95%) level means that 95 out of 100 animals subsequently exposed to ECF challenge may be expected not to get ECF.

Frequency refers to the rate of vaccine administration that is recommended to maintain optimal protection. As regards frequency, once for life refers to a vaccination that is performed one time and provides life-long protection. On the other hand, annual refers to a frequency whereby the immunization would be repeated annually after initial vaccination.

Safety refers to the side effects associated with the vaccine. In other words, it is the risk of reactors to the vaccination and the associated need to monitor. No reactors mean that the vaccination has no side effects and hence no post –vaccination monitoring by a vet is required.

Risk of reactors on the other hand means that the vaccination is associated with risk of side effects soon after vaccine administration, for instance, ECF may occur after immunizing the animal with the live vaccine. The proportion, 5 percent, implies that 5 out of 100 cattle immunized are expected to have side effects. Due to risk of side effects, post-vaccination monitoring by a vet is required.

Price refers to the monetary value to be paid by the farmer for the full cost of immunization. The cost includes that of the vaccine, the administration and follow-up monitoring, if required. Three different amounts to be paid for the full cost of immunization are represented by the three levels of price.

Given the levels of attributes, there were 24 possible combinations. However, by applying the fractional factorial design method, it was possible to draw an orthogonal subset of 8 different combinations sufficient to estimate the desired parameters (see equation 15). The orthogonal set is drawn on the basis of the transitivity axiom commonly assumed in preference ranking. Hence, the farmers were required to rank only the eight profiles (represented on separate cards) shown in Table 2.

Data collection for conjoint analysis involved the respondents ranking in order of preference the eight profiles consisting of vaccine attributes. By strong ordering, it was possible then to elicit farmer's preferences regarding the hypothetical vaccines. By the axiom of rationality, in presence of strong ordering, a rational decision maker must choose the most preferred element of the attainable set- in this case the eight profiles. Hence, in the conjoint analysis, rank order data were used. The eight profiles are represented in Table 2 while details of cards used in the field to collect data are shown in appendix 6.

Table 2: Conjoint profiles used in data collection.

Card number	Effectiveness	Safety	Price (KShs)	Frequency of administration
1	Moderately	No side effects	1200	Annual
2	Moderately	Risk of reactors	1800	Annual
3	Moderately	No side effects	600	Once for life
4	Very	Risk of reactors	1200	Once for life
5	Very	Risk of reactors	600	Annual
6	Very	No side effects	1800	Annual
7	Very	No side effects	600	Once for life
8	Moderately	Risk of reactors	600	Annual

4.5 Data analysis techniques

In this study, data analysis involved

- 1) Descriptive analysis- this was done to summarize the variables used in this study and to identify the interrelationships among them. It entailed computation of measures of central tendency, in this case the arithmetic mean, and of dispersion- standard deviation and range (maximum and minimum). STATA and Excel were the main softwares used in descriptive analysis.
- 2) Conjoint analysis using SPSS software. This involved decomposition of preferences to estimate the utility scores attached by farmers to various vaccine attributes. A plan file was generated by using the “orthogonal” command in SPSS. It consisted of a set of 8

full concepts ranked in terms of preferences by farmers. A continuous model was adopted for the price attribute. A discrete model was assumed for each of the other three attributes namely: effectiveness, frequency and safety. The data file contained the ranks in sequence order-the first column indicating the card number of the most preferred card and the last, (column eight) representing the least preferred card number...

- 3) Cluster analysis using SPSS software. This is a technique for segmenting observations into homogenous groups, given data on a variety of characteristics for the objects. It enables segmentation of objects so that those within each group are similar to one another on the basis of the considered characteristics. In our study, the basis for clustering is the utility attached by the farmers to each of the four vaccine attributes. The aim is to identify existing natural groups of farmers based on their preferences regarding the vaccine to purchase. Related to cluster analysis, the social economic characteristics of the respondents were assessed to identify those that mark each of the clusters.
- 4) Econometric analysis in which a double-bounded logit model was estimated using GAUSS software. It entailed both nonparametric as well as parametric estimation of WATP. In parametric estimation of WATP, the coefficients of explanatory variables were estimated to develop a model that can be used to predict WATP given socio-economic characteristics. Other models employed for analyzing the discrete choice data are: single-bounded logit and single, double and bivariate probit. The results estimated by these models are presented in appendix 2 for the sake of readers who might be interested. The double-bounded models are preferred for they yield estimated that are more precise.

Data management and analysis were mainly done using Access, Excel, STATA, SPSS and GAUSS softwares.

4.5.1 Estimation of WATP

The ultimate objective of CV analysis in our study is to obtain a reasonable estimate of willingness and ability to pay, and hence the effective demand, for the good or service in question. Also of use would be information as to what socio-economic or other factors affect respondents' WATP. Studies in willingness to pay usually entail undertaking of household surveys whereby a series of structured questions are asked to a household member. The questions are pre-designed in a manner geared to determine the maximum amount of money a household is willing to pay for a good or service and the decision to pay is made based on utility derived from consumption of such good or service. The utility function reflects the way in which the good or service in question, together with other factors such as income, contributes to the utility, of the respondent. Individuals are expected to maximize their utility. An individual utility function may be represented as:

$$U=f(y,z,e) \tag{3}$$

where:

U represents individual's utility

y represents the individual's income

z represents all other factors to be considered that have an effect on the individual's utility

e represents the random component of the utility function

From equation 3, the probability that the respondent will respond yes and hence be willing to pay, is the probability that his utility with the proposed change is greater than that without the change, represented by the equation:

$$P_{yj} = P\{u_{ji}(y_j - c, z_j, e_{ji}) > u_{jo}(y_j, z_j, e_{jo})\} \quad (4)$$

where: P_{yj} is the probability that the j^{th} respondent will answer “yes” to an offered price of c

u_{jo} is the respondent's total utility in the status quo

u_{ji} is the utility with the change

y_j is the income

z_j is a vector of respondent's characteristics and other variables

e_{ji} and e_{jo} are random components with and without change, respectively.

When a continuous variable is used to measure WTP, i.e. with open-ended responses, ordinary least squares models can be used to explain the variation in the dependent variable. However, for discrete choice responses, different models are required based on the probability that a respondent will answer, “Yes” to the valuation question. Appropriate models are the logit and the probit models. Both are non-linear and use the principle of maximum likelihood to estimate parameters. The logit follows a cumulative logistic distribution while the probit follows the cumulative normal distribution. A logit has a slightly flatter tail than a probit function (Mukras, 1993). The logit model is normally commonly used since it is easier to use from computational point of view (ibid). Variants of logit model include the single-bounded and the double-bounded logit models while those for the probit model include single-bounded, double-bounded and bivariate probit models. With the single-bounded models, the respondent is presented with only

one bid on which he is meant to give information on if he would be willing and able to pay or not. On the other hand, with the double-bounded models, two bids are presented. The double-bounded models are preferred for the estimates are associated with improvement in statistical efficiency (Hanemann *et al* 1991, Carson *et al* 1997)

In this study, the double-bounded logit model will be employed in the analysis of the discrete responses. This is an appropriate model in the analysis of contingent valuation survey data with follow-ups as it takes into consideration the two responses simultaneously. In the study, each respondent was presented with two bids. The level of the second bid was higher than the initial one if the first response was positive and lower if it was negative. The second bid plays the role of placing an upper and a lower bound on the respondent's unobserved true willingness to pay or it raises the lower bound or lowers the upper bound (Hanemann *et al* 1991). The method hence obtains more information about where respondent's willingness and ability to pay amounts lie than does the simple binary discrete choice approach. The double-bounded dichotomous choice contingent valuation gives four possible outcomes namely; YY, YN, NY and NN, where a Y represents an affirmative answer and an N a negative one. As expressed earlier (Equation 4), an affirmative answer would result if the utility yielded by the farmer were higher as a result of adopting the vaccine than without it, of course taking into consideration the amount he/she would part with (bid value) to have the vaccine. If we represent the set of bids applicable to the i^{th} respondent as β_i for the initial bid, β_i^l for the lower bid and β_i^u for the upper one, the relationship between the bids may be expressed as;

$$\beta_i^u > \beta_i \text{ for YY and YN.}$$

$$\beta_i^l < \beta_i \text{ for NY and NN.}$$

If we then represent the likelihoods of the respective outcomes as π^{yy} , π^{yn} , π^{ny} , and π^{nn} , they (likelihoods) may be expressed as below.

$$\begin{aligned}\pi^{yy}(\beta_i, \beta_i^u) &= \Pr \{ \beta_i \leq \max \text{ WATP and } \beta_i^u \leq \max \text{ WATP} \} \\ &= \Pr \{ \beta_i^u \leq \max \text{ WATP} \} \\ &= 1 - G(\beta_i^u; \theta)\end{aligned}\tag{5}$$

$$\begin{aligned}\pi^{yn}(\beta_i, \beta_i^u) &= \Pr \{ \beta_i \leq \max \text{ WATP} < \beta_i^u \} \\ &= G(\beta_i^u; \theta) - G(\beta_i; \theta)\end{aligned}\tag{6}$$

$$\begin{aligned}\pi^{ny}(\beta_i, \beta_i^l) &= \Pr \{ \beta_i > \max \text{ WATP} \geq \beta_i^l \} \\ &= G(\beta_i; \theta) - G(\beta_i^l; \theta)\end{aligned}\tag{7}$$

$$\begin{aligned}\pi^{nn}(\beta_i, \beta_i^l) &= \Pr \{ \beta_i > \max \text{ WATP and } \beta_i^l > \max \text{ WATP} \} \\ &= \Pr \{ \beta_i^l > \max \text{ WATP} \} \\ &= G(\beta_i^l; \theta)\end{aligned}\tag{8}$$

where

$G(\bullet; \theta)$ is some statistical distribution function with parameter vector θ . It is the cumulative distribution function of the respondent's true maximum willingness and ability to pay. In our study, $G(\bullet; \theta)$ is either:

a) the log-logistic cumulative distribution function expressed as

$$G(\beta) = [1 + e^{a+b(\ln \beta)}]^{-1} \quad (9)$$

where $\theta \equiv (a, b)$

b) Logistic cumulative distribution function

$$G(\beta) = [1 + e^{a+b(\beta)}]^{-1} \quad (10)$$

The double-bounded approach likelihood function may then be expressed as:

$$\ln L^D(\theta) = \sum_{i=1}^N \left\{ I(\beta^u) I(\beta^l) \ln \pi^{yy}(\beta, \beta^u) + I(\beta) (1 - I(\beta^u)) \ln \pi^{ym}(\beta, \beta^u) + \right. \\ \left. (1 - I(\beta)) (I(\beta^l)) \ln \pi^{ny}(\beta, \beta^l) + (1 - I(\beta)) (1 - I(\beta^l)) \ln \pi^{nm}(\beta, \beta^l) \right\} \quad (11)$$

$I(\bullet)$ is an indicator function that assumes the value of one when the response is affirmative and a zero when it is negative.

With the double-bounded model, the maximum likelihood estimator, $\hat{\theta}^D$ is obtained by solving the equation (Hanemann *et al*, 1991):

$$\frac{\delta \ln L^D \left(\hat{\theta}^D \right)}{\delta \theta} = 0 \quad (12)$$

In this study, WATP was estimated using the double-bounded logit model. Both parametric and nonparametric estimations were done. Parametric estimation entailed incorporation of household characteristics in addition to bid in the model while nonparametric used only the bids. The model used the discrete choice dichotomous choice data collected by presenting a scenario for hypothetical ECF vaccines to the farmers and then asking them whether they would be willing and able to pay at stated bids. The regressors, in addition to bid values (for parametric estimation), included certain household characteristics.

The WATP estimating function with covariates may be specified as:

$$WATP = f(E, A, B, I, H, C, K) \tag{13}$$

where:

E = level of Education of family head

A = age of household head

B = bid value

I = income of the farmer

H = household size

C = cattle herd size

K = knowledge of ECF as a cattle disease

4.5.2 Estimating farmer differential preferences

In forming preferences, the respondent compares various profiles each comprising a given set of attribute levels. The preference hence depends on the attribute levels and consequently, in terms of a basic dependence model, conjoint analysis can be expressed as:

$$Y_i = \sum \beta_i X_i \quad (14)$$

Where:

Y_i represents overall preference

β_i represents the estimated part-worth⁵ for the i^{th} attribute.

X_i represents the i^{th} attribute

In addition to estimating the part-worths, a model of this nature would enable the testing of the significance of the estimates as the output has t-statistics for comparison with critical values. The output also includes a value of R^2 that indicates the proportion of preferences explained by the defined set of attributes. It should be clear that the study used only 4 attributes hence excluding others for instance packaging, colour, size and so on. One should therefore be cautious in interpreting the value of coefficient of determination. The preference model is founded on three axioms: comparison⁶, transitivity⁷, and nonsatiation⁸.

In the decomposition of preferences into part-worths, either of two compositional rules may be assumed. In deciding on the rule to adopt, the researcher should put into consideration how the attributes relate to one another in the respondent's decision-making process. The first is the iterative rule. This assumes that individuals add up the part-worths to get the overall preference.

⁵ Part-worths are computed utility values that respondents attach to attribute levels.

⁶ Axiom of comparison- this is also called complete-ordering axiom. It assumes that, given A and B bundles of commodities, the consumer must be able to compare them and state unequivocally that he either: prefers A to B, B to A, or he is indifferent between the two. The axiom guarantees two-term consistency.

⁷ Axiom of transitivity- this axiom involves three-term comparison. Given three bundles of commodities, A, B and C, according to the axiom, if the consumer prefers A to B and B to C, he must also prefer A to C. Likewise, if he is indifferent between A and B and between B and C, the ambivalence also exists between A and C. Further, if he is indifferent between A and B, but prefers B to C, he must also prefer A to C. Lastly, if he is indifferent between B and C but prefers A to B, he must also prefer A to C.

It allows for situations whereby some combinations of attribute levels may give more than or less than their sum. The rule may synonymously be stated as, “the whole is greater or less than the sum of its parts”.

The second rule is the additive compositional rule. It asserts that the overall or total part-worth score that indicates the preference is equal to the summation of individual attribute’s part-worths. This rule applies in many situations and is the one commonly used. It is simple in terms of the number of evaluations and estimation procedure involved. The additive rule is assumed in this study.

Part-worth values were estimated using linear regression analysis, since the assumption adopted is that the preference model is additive and that there are no interaction effects. Incorporating the specific variables of interest in this study into equation 14, the conjoint analysis preference model may be specified as:

$$R_{ij} = \alpha_0 + \alpha_1 E_j + \alpha_2 F_j + \alpha_3 S_j + \alpha_4 P_j + e_{ij} \quad (15)$$

Where; R_{ij} =overall preference (rank) for a given combination j of the attributes: effectiveness, frequency, safety and price for the i^{th} individual

E, F, S and P represents effectiveness, frequency, safety and price respectively.

α_0 is the overall mean preference rank

$\alpha_1 \dots \alpha_4$ are part-worth estimates associated with the respective factors

e_{ij} is the error term

⁸ Axiom of non-satiation- it assumes that more is preferred than less. It hence implies that the consumer is not oversupplied with any good or service.

4.6 Expected results

In the modelling of WATP, the expected coefficient signs are shown in Table 3.

Table 3: Expected signs of socio-economic variables

Variable	Sign
Age of household head	-
Level of education	+
Income level	+
Cattle herd size	+
Knowledge of ECF as a disease	+
Household size	-

Age of the household is expected to be negatively related to the WATP. This is due to the fact that younger people are generally risk takers compared to older people. The young would be expected to readily adopt the vaccines, caring less of the side effects, say in case of ITM, and the loss they are likely to suffer if, as a result of immunization, the animal incidentally dies. They are usually eager and willing to try new technologies. Education level is expected to be positively related to WATP. Ambitious farmers with more educated farmers have a better understanding of the benefits of adopting the vaccines. WATP for ECF immunisations is positively related to the level of income of smallholder farmers since level of income of the farmer determines his ability to pay for the vaccines. Farmers with large herds of cattle generally have higher incomes and therefore the herd size is expected to be positively associated to WATP. Again, as the herd-size increases so does the probability of experiencing ECF in the cattle herd and therefore the demand for prophylactic services is likely to increase. Knowledge of ECF as a cattle disease is expected to be positively associated with WATP because those with such knowledge are assumed to understand the dangers of the disease and therefore be

willing to prevent the disease by buying the vaccines. The higher the number of household members, the lower the WATP. This is because with large households, normally labour would be available to spray the animals with acaricides. However, this may only apply where family members work on-farm.

For the conjoint analysis, the expected coefficient signs are shown in Table 4:

Table 4: Expected signs of attributes’ coefficients

Attribute	Sign
Effectiveness	+
Frequency	-
Safety	-
Price	-

These are the expected signs because rational farmers are expected to prefer a vaccine that would be very effective, administered once and the immunity lasts for life, has no side effects and has lowest price.

4.7 Scope and limitations

The study estimated the WATP for both ITM and the sub-unit vaccine. The two differed slightly. It was not possible, however, albeit being one of the hypotheses, to test whether they were statistically different. This is for the reason that the estimated WATP value is a solution to an equation that has no statistical properties. The estimate per vaccine is a single point estimate and hence not possible to test the difference across the full samples.

4.8 Summary

This chapter has presented and discussed the procedures, survey instruments, methods and techniques used to generate and process the data. The models have been specified and the expected signs coefficients discussed. The chapter has discussed the survey technique, CV, and

further, various methods of eliciting WATP have been presented and a justification given for selecting the one used in this study, the double-bounded dichotomous choice method. The methods of eliciting consumer preferences have been highlighted. The analytical techniques, double-bounded logit for estimating WATP, conjoint analysis for decomposing farmer preferences and cluster analysis for identifying existing natural groups of farmers, have been discussed. The chapter has also highlighted the scope and limitations of the study. The results obtained are presented and discussed in the next chapter.

CHAPTER 5

RESULTS AND DISCUSSION

In this chapter, the results are presented and discussed. They were obtained by use of a double-bounded CV model and conjoint analysis. The chapter has two major sections. The first presents and discusses results on WATP, and the second, on farmer preferences. As noted earlier in the literature review section, farmers in the Coast Province of Kenya, where ITM has been introduced previously, have shown a high willingness to pay for it. However, in our study area, neither of the two vaccines, ITM nor a sub-unit vaccine, have been made available to farmers. As cited previously, WATP for these vaccines have not been established. This first section of the chapter analyses the WATP for the two vaccines. It begins by describing the socio-economic characteristics of the interviewed farmers, first those who were asked about ITM and secondly those for a sub-unit vaccine.

The second sub-section presents the specific results related to WATP. It starts with a presentation and discussion of farmers' responses to the various bid prices. The section then discusses the 'not willing to pay' responses. The double-bounded logit nonparametric and the parametric estimates of WATP for the vaccines are then presented, respectively. This is followed by a discussion of the factors influencing WATP. It ends by presenting the mean WATP estimate of each of the two vaccines, and this was a single value GAUSS software estimate, in relation to the distribution of the bids.

In section 5.2, the results from the conjoint analysis are presented, analysed and discussed. The results are first tabulated and explained, including their interpretation and implications. Next, the trade-off between the price and the other attributes is discussed. It entails the computation of the monetary amounts that are equivalent to a change in the level of one of the vaccine's other

attributes to make the farmer indifferent in both situations. This is followed by an analysis aimed at testing the significance of the vaccine attributes and to quantify the proportion of variations in the farmer preferences that is explained by changes in the attributes under consideration. The chapter ends by establishing possible groupings of the farmers on the basis of commonalities in their preference structures using cluster analysis. The socio-economic factors characterising each cluster are also assessed.

5.1 Farmers willingness and ability to pay for ECF vaccines

5.1.1 Farmer characteristics

A total of 234 respondents' data were used in the estimation of WATP and consequently the potential demand for ECF vaccines. They included 119 for ITM and 115 for a sub-unit vaccine. This number was arrived at after dropping cases with missing values of socio-economic characteristics considered in the analysis later in the chapter. The number dropped was 31 for ITM and 35 for the sub-unit vaccine.

Table 5:Socio-economic characteristics per vaccine's respondents

VARIABLE	ITM (n=119)				Sub-unit vaccine (n=115)			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev	Min	Max
Cattle herd size (No.)	2.6	2.0	1	14	2.6	2.1	1	20
Household members (No.)	6.1	2.5	1	12	5.6	2.1	1	12
Age of household head (yrs)	52.4	11.9	25	85	51.8	12.8	26	96
Education of hh head (level)	2.4	1.1	0	5	2.3	1.0	0	4
Income (KShs./Year) ¹	55977	157071	0	236236	44853	122320	0	1077600
Knowledge of ECF (Y/N)	.9	.3	0	1	1	.2	0	1

Source: Own computation.

¹Data collected did not capture all sources of income. For instance income from sale of livestock (apart from cattle) was excluded and this could give rise to zero income, or more likely could be that farmers did not report accurately.

Table 5 presents the socio-economic characteristics of the cases used in our analysis. The variables are used in the parametric estimation of WATP. The cattle herd size was the sum of the grade, crosses and zebu cattle owned by the household. Income comprised totals from the sale of crops, milk, cattle and off-farm cash income. The education level of the household head was categorized and coded such that the values 0, 1, 2, 3, 4 and 5, represented the levels, no formal education, adult literacy education, primary (1-8), secondary (1-6), diploma or certificate and university, respectively.

A farmer was considered as having knowledge of ECF if he either stated ECF as one of the three important diseases in the area, that at least one of his cows had died of ECF, that the disease is one of those caused by ticks or lastly, if he explicitly acknowledged having knowledge of ECF. In the analysis, knowledge of ECF was represented by one and zero otherwise. To reveal possible bias in sampling procedure, a t-test was conducted to compare variation among respective variables in Table 5 for ITM and sub-unit vaccine respondents. At 95% confidence level, the differences were not statistically significant for any of the variables apart from knowledge. Since most of the means (apart from the one variable) for the two subgroups were equal, there was no evidence that the sampling procedure was biased.

Among the 119 respondents interviewed for ITM, 8.4% of the respondents had no formal education, 1.7% had adult literacy education, 50.4% had primary education, 26.1% had secondary education, 10.9% had diploma or certificate and, lastly, 2.5% had university education. The results show the highest proportion being of farmers with primary education.

On the other hand, of the 115 cases interviewed for sub-unit vaccine, 7.0% had no formal education, 1.7% had adult literacy education, 53.9% had primary education, 26.1% had secondary education, and 11.3% had diploma or certificate level education. None of the respondents had university education. As in the case of ITM, the majority of respondents had primary school education.

The mean age of the ITM respondents (52 years) indicates that most household heads were elderly. The mean level of education was primary school. The age and level of education show that the sample was a representative of the population in Central Highlands and likewise in Kenya whereby on the average, people of age-cohort 50-54 years have primary school level of education (Ministry of Finance and Planning 2001). The mean of knowledge of ITM respondents was lower than for sub-unit farmers though close to one reflecting the high level of awareness of ECF. On average, each household had six members. Mean income of ITM respondents was slightly higher than for sub-unit respondents and was not significant. The distribution of income is shown by a Lorenz curve, Figure3. A Lorenz curve is a curvature showing distribution of income in relation to population. As is common in developing countries, Figure 3 shows a high income disparity- more than 90 percent of the respondents possessed less than 50 percent of the total income. The existence of some farmers with zero income may be attributed to omission of earnings from enterprises not included in the questionnaire used in data collection for instance that from sale of sheep, goats and poultry; only sale of cattle was included among revenues from livestock sales. Else the farmers might have misreported their income.

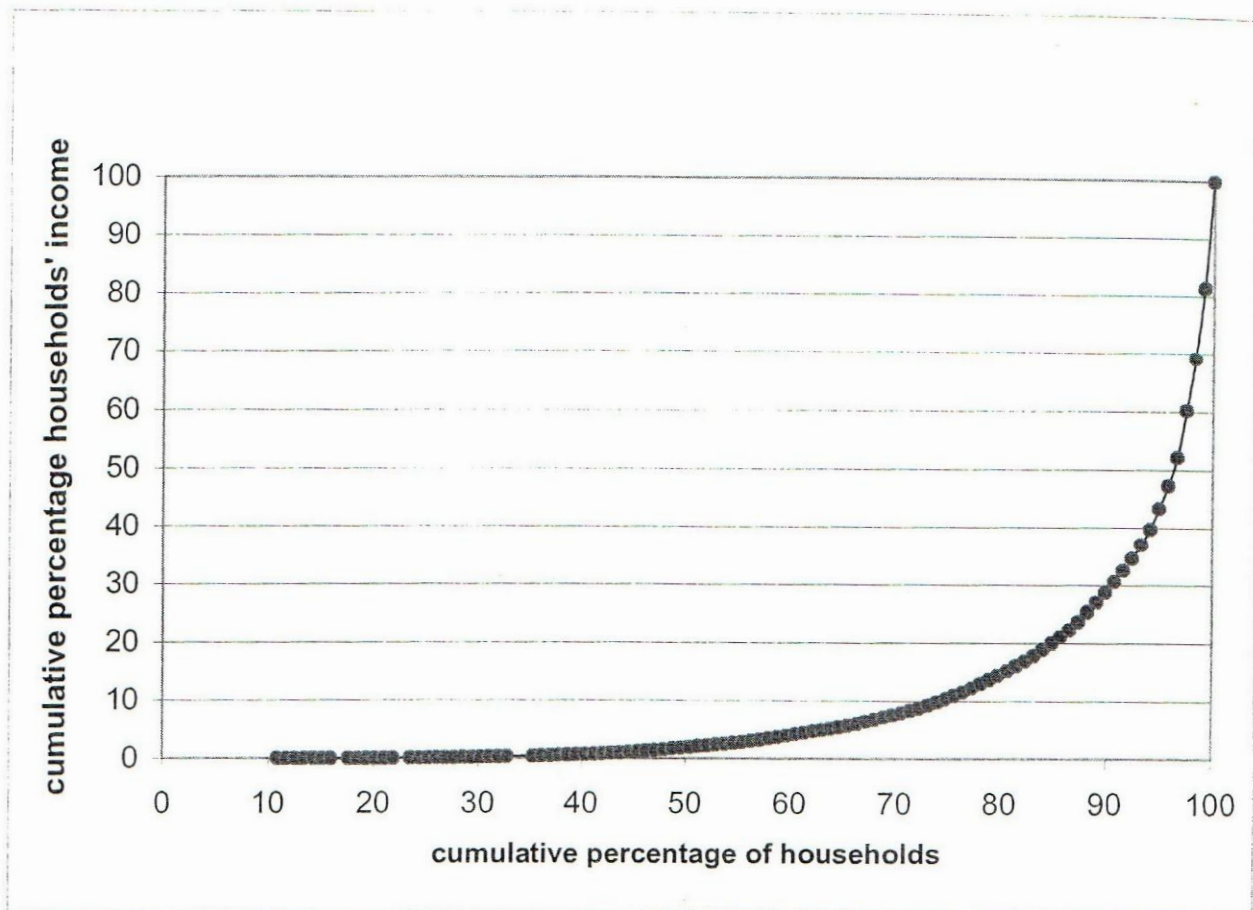


Figure 3: Lorenz curve for ITM households' income

Figure 4 presents the income distribution for members interviewed for the sub-unit vaccine. Similar to ITM, the income distribution was highly skewed; there were farmers with zero income (since not all sources of income were considered as noted earlier and again could be misreporting error) and at the same time there was an exceptional farmer with an income of more than a million but with the majority having low income. The standard deviation of income was much greater than double the mean due to high range of income.

As with the ITM, more than 90 percent of households possessed less than 50 percent of the total income. The skewness in income again is an indication that the sample was a representative of a third world context.

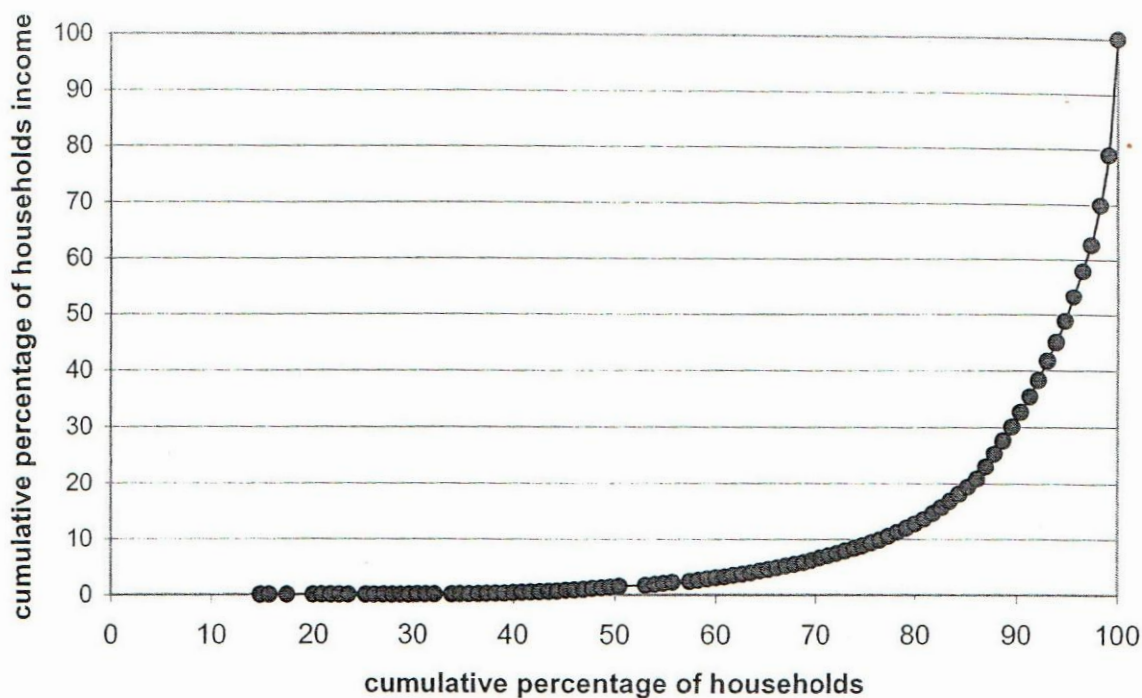


Figure 4: Lorenz curve for sub-unit vaccine households' income

5.1.2 Willingness and ability to pay analysis

5.1.2.1 Response to respective bids

Table 6 summarizes the responses regarding the willingness and ability to pay for the ITM vaccine.

Table 6: ITM vaccine Responses

Bid sets (KShs.)	YES-YES		YES-NO		NO-YES		NO-NO		TOTAL	
Initial (upper/lower)										
	No.	%	No.	%	No.	%	No.	%	No.	%
250(300/125)	9	64.3	1	7.1	2	14.3	2	14.3	14	100
500(625/250)	15	62.5	3	12.5	4	16.7	2	8.3	24	100
1000(1250/500)	22	52.4	3	7.1	9	21.4	8	19.0	42	100
1700(2125/850)	8	32	6	24	4	16	7	28	25	100
3000(3750/1500)	1	7.1	0	0	5	35.7	8	57.1	14	100
Total	55	46.2	13	10.9	24	20.2	27	22.7	119	100

Source: Own computation from survey data

Note:

- ❖ Initial refers to the initial bid, the first bid that was presented to the respondent.
- ❖ Upper refers to the upper bid, the bid presented to the respondent when the response to the initial bid was affirmative.
- ❖ Lower refers to the lower bid, the bid presented to the respondent when the response to the initial bid was negative.

The first column represents the bid sets. These were the five different bid sets presented to farmers. The other columns contain the number and respective proportion of respondents by type of response combination. “Yes-yes” (YY) represents an affirmative answer to both the first and the second bid. It means that a farmer is willing and able to pay at both bids. On the other hand, a “no-no” (NN) represents a negative answer to both bids. It implies that the farmer has no willingness and ability to pay for the vaccine at both the initial and the second lower bid. “Yes-no” (YN) represents an affirmative answer to the first bid and a negative one to the second higher bid. A “no-yes” (NY) represents a negative answer to the initial bid and an affirmative one to the second lower one. Each farmer was asked only one of the five bid sets at random but with proportionally greater probability of being asked one of the middle bid sets.

The results in Table 6 show that the YY category has the largest proportion of observations for each of the bid sets apart from the highest. Considering the four possible responses for all the five bid sets, the smallest fraction, 10.9 %, fell in the YN class. The fraction of farmers whose WATP was bounded by two bids was 31.1 percent. A proportion of 77.3% of the respondents gave a positive response to at least one bid. This is an indication of the high demand for the ITM vaccines at the stated price amongst the farmers. Alternatively, this can be an evidence of bias when presenting a farmer with the contingent situation. Since the study area, Makuyu, is characterized by high mortality from ECF, the farmers may be desperately in need of any vaccine against the disease. To press for its supply, some of them might have responded strategically by expressing higher than their true willingness to pay. However, this possibility is minimal considering the method of eliciting WATP employed in this study, the dichotomous choice as opposed to a bidding game.

Taking the proportion of respondents giving positive response to at least one bid as a proxy for quantity of ITM vaccines purchased at the bid price, a pseudo demand curve may be developed as shown by Figure 5:

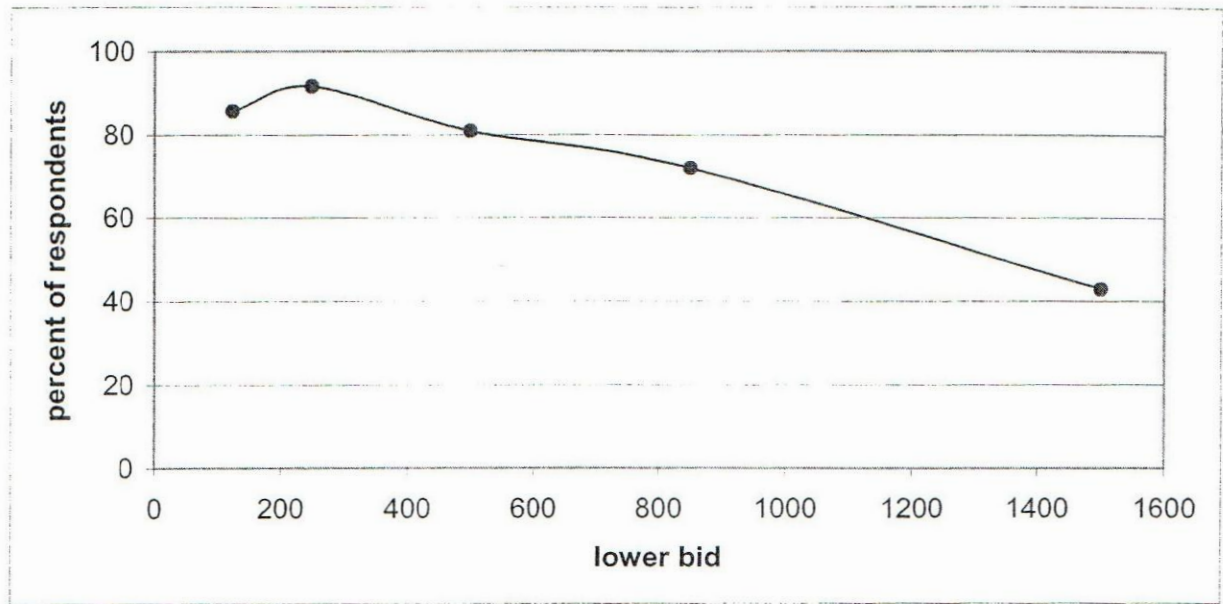


Figure 5: Household Pseudo demand curve for ITM vaccine

This pseudo demand curve represents the share of respondents presented with each respective bid set who were willing and able to pay for the vaccine at least at the lower bid. As would be expected for a demand curve, it generally has a negative slope. The lower the price the higher the proportion of farmers who express their willingness to buy the vaccine at the price. At a low price of KShs.250, a very high proportion, more than 90% of the respondents confronted with the second bid set are able and willing to pay. On the other hand, at a high Price of KShs.1500, only about 43% of the respondents confronted with the highest bid set are willing and able to pay for ITM vaccine.

Table 7: Sub-unit vaccine responses

Bid sets (KShs.)	YES-YES		YES-NO		NO-YES		NO-NO		TOTAL	
Initial (upper/lower)										
	No.	%	No.	%	No.	%	No.	%	No.	%
100(125/50)	10	71.4	2	14.3	1	7.1	1	7.1	14	100
150(200/75)	18	78.3	4	17.4	0	0	1	4.3	23	100
400(500/200)	28	66.7	2	4.8	9	21.4	3	7.1	42	100
1000(1250/500)	11	52.4	3	14.3	4	19.0	3	14.3	21	100
3000(3750/1500)	3	20	2	13.3	4	26.7	6	40	15	100
Total	70	60.9	13	11.3	18	15.7	14	12.2	115	100

Source: Own computation from survey data

Note:

- ❖ Initial refers to the initial bid, the first bid that was presented to the respondent.
- ❖ Upper refers to the upper bid, the bid presented to the respondent when the response to the initial bid was affirmative.
- ❖ Lower refers to the lower bid, the bid presented to the respondent when the response to the initial bid was negative.

Similar to the ITM experiment, Table 7 shows that, apart from the highest price set, the percentage of respondents per vaccine is greatest in the YY response category. With the sub-unit vaccine, the majority of the respondents (60.9%) were willing to pay for the vaccine at both the initial and the upper bids. A proportion of 27 percent had their responses bounded by the two administered bids. Just like the ITM, the smallest proportion, 11.3%, fell in the YN category.

The positive response to both the first and the second bids by the majority of the respondents is an indication of the high demand for a sub-unit vaccine at the stated prices. It was only a small fraction (12.2%) that responded negatively to both the first and the second bids. In other words, 87.8% of the observations had a positive response to at least one bid of the sub-unit vaccine

Taking the proportion of respondents giving a positive response to at least one bid as a proxy for the quantity of sub-unit vaccines purchased at that price, a pseudo demand curve may be again developed as shown by Figure 6: The Figure shows the proportion of respondents whose WATP was at least the lower bid per set. The pseudo demand curve, again, has its normal shape in general of sloping downward to the right. The percentage of respondents willing and able to pay for a sub-unit vaccine is less with the higher bid than with the lower. This buttresses the economic theory that the higher the bid, the lower the demand for a non-giffen good.

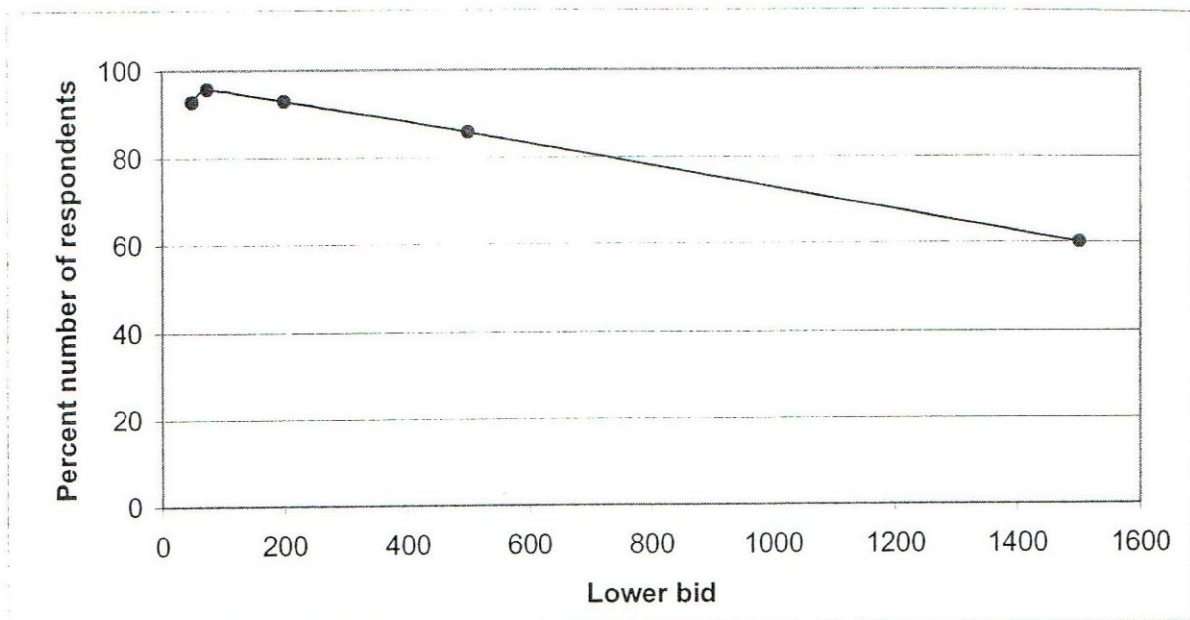


Figure 6: Households pseudo demand curve for sub-unit vaccine

5.1.2.2 Comparison of pseudo demand curves for both ITM and sub-unit

Having developed pseudo demand curves for both ITM and sub-unit, there is need to explore further and establish the vaccine with higher demand as portrayed by the farmers' responses. This would give an indication of the preferred choice by farmers between the two vaccines. For ease in comparison, the two pseudo demand curves were plotted on one sheet. Figure 7 shows the two curves.

It is tempting by observation from the graph to infer that the level of demand for sub-unit vaccine is higher than that of ITM at respective prices. However, by considering the proportions willing to pay at least at the lower bids (KShs. 500 and 1500), that are common with both vaccines, and conducting a t-test to test the difference between the two population proportions from the two independent samples (that for ITM and that for sub-unit), the difference was found to not be statistically different from zero at .05 level.

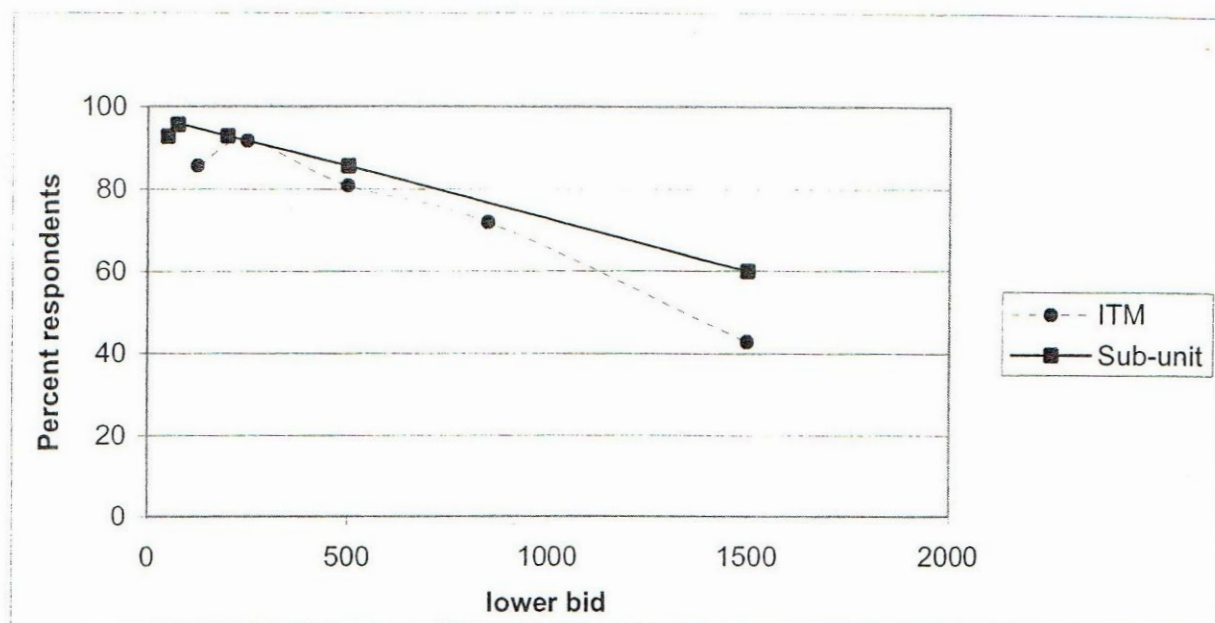


Figure 7: Positive response to at least lower bid per set

The computed t- statistic was -0.355 . Farmers therefore seem to be merely interested in any ECF vaccine that would be available. The properties of the vaccine, side effects and frequency of administration, that came out as the main differences between the two vaccines in the hypothetical scenarios do not seem to influence the farmers WATP.

5.1.2.3 Reasons for not being willing to pay at both bids

The respondents who gave negative answers to both the first and second bids were asked to give the reason. This would help in detecting protest behaviour. Of the 27 farmers (23% the ITM sample) that would not pay for an ITM vaccine at both bid prices, 26% admitted that they could afford to pay. Though able to pay, they were not willing due to various reasons. A proportion of 12% did not think that their cattle were in danger of getting ECF, 9% did not want to take the risk of their cattle getting sick from the shot and lastly, 6% did not find it worth paying if the vaccine could not guarantee 100% protection against ECF. The

remaining 74% could not afford to pay but would be interested in buying the ITM if it was much cheaper.

Of the 14 farmers (12% of the sub-unit sample) who showed negative willingness to pay for a sub-unit vaccine at both bids, 12% had the ability to pay yet were not willing. Half of these 12% did not want to buy a vaccine requiring annual administration. The other half were not willing to pay for the sub-unit vaccine if the shot could not guarantee 100% that their cattle would not get ECF. The remaining, 88% of the 14 farmers could not afford to pay though they would be interested if the vaccine was much cheaper than the prices cited.

5.1.2.4 Non-parametric estimates of WATP

The WATP was estimated with and without covariates; that is, parametric and non-parametric estimation respectively. The estimation was done assuming each of two conditions, restricted and unrestricted. The restricted condition assumes that WATP can take any value between zero and positive infinity, that is, $0 < \text{WATP} < \infty$. The unrestricted condition assumes on the other hand that the estimate can take any value between negative infinity and positive infinity, that is, $-\infty < \text{WATP} < \infty$, such an assumption would cater for situations where a respondent would be willing to part with money so as not to get the product being valued (a scenario of negative WATP). For cases of goods, such scenarios are rare since rational decision makers are better-off with the goods than without. Table 8 presents estimates of WATP obtained from double-bounded logit model without incorporating covariates.

Table 8: Non-parametric Double-bounded logit WATP estimates

Assumed condition	Item	Sub-unit	ITM
Restricted		KShs.	KShs.
	Mean	1469	1430
	C.I. 99%	1030-2298	1097-1954
	95%	1094-2066	1185-1785
	90%	1142-1937	1217-1697
Unrestricted			
	Mean	1355	1332
	C.I. 99%	926-2177	959-1741
	95%	996-1866	1061-1646
	90%	1056-1778	1096-1588

Source : Own computation

The first column shows the two different conditions being assumed. The second column represents what is being estimated, the mean and the confidence intervals. The third column presents the double-bounded logit estimates for sub-unit vaccine and the last one those for ITM. The results show the WATP for subunit vaccine being relatively higher irrespective of the condition assumed, restricted or unrestricted. The estimates of ITM have higher precision than that of subunit as indicated by compactness of the confidence intervals. As mentioned earlier, covariates were not included in estimating these results.

5.1.2.5 Parametric estimates of WATP

The WATP was estimated incorporating covariates in the double-bounded logit model under two different assumptions, restricted and unrestricted. Table 9 presents the estimates.

Table 9: Mean WATP estimates and confidence intervals

Assumed condition	Item	Sub-unit	ITM
Restricted		KShs.	KShs.
	Mean	1409	1407
	C.I. 99%	920-2175	1067-1952
	95%	1060-1909	1155-1732
	90%	1118-1801	1191-1673
Unrestricted			
	Mean	1379	1313
	C.I. 99%	958-2064	996-1711
	95%	1047-1779	1055-1621
	90%	1099-1723	1102-1556

Source : Own computation

The first column shows the two different conditions being assumed. The second column represents what is being estimated, the mean and the confidence intervals. The third column presents the double-bounded logit estimates for sub-unit vaccine and the last one those for ITM. The results in Table 9 show that the mean WATP for a sub-unit vaccine is higher than that of the ITM. This is the case regardless of the assumption made; either restricted, or unrestricted condition. The estimates in Table 8 and 9 differ due to effect of incorporating covariates in the estimation of WATP.

Coefficients of the incorporated variables were also estimated while estimating WATP. Again, a double-bounded logit model was used to estimate the valuation parametric function to explain willingness and ability to pay as determined by socio-economic characteristics of the respondents. Unlike the WATP estimates where they differ depending on the condition assumed, (either restricted or unrestricted) the coefficient estimates are the same assuming either state.

Table 10: ITM vaccine’s parameter estimates

Variable	Double-bounded logit estimates	t-statistics
Constant	0.817	0.672
Bid	-0.0016	-6.979*
Household size	0.064	0.768
Herd size	-0.026	-0.257
Age	0.004	0.191
Education	0.271	1.365**
Income	0.0000006	0.517
Knowledge	0.0419	0.065

*Parameter statistically significant at 0.002 level
 **Parameter statistically significant at 0.20 level
 Source: Own computation using survey data

Table 10 presents the parametric estimates of WATP for the ITM. Two factors are found to be significantly influencing the WATP for the ITM. These are bid (at 0.01 level) and education level (at 0.20 level). The two factors also have the expected sign. The higher the

bid value the lower the WATP, and vice versa. Also, the higher the education level the more willing to pay is the farmer and vice versa. Size of the household, knowledge and the cattle herd have the expected signs but in addition to age, are not statistically significant. The three coefficients are therefore not significantly different from zero and the variables hence do not appear to be determining factors of WATP for a sub-unit vaccine.

Table 11: Sub-unit vaccine’s parameter estimates

Variable	Db logit estimate	t- statistics
Constant	2.013	1.094
Bid (KShs.)	-0.0018	-5.589*
Household size (No.)	0.033	0.284
Herd size (No.)	0.009	0.091
Age (years)	-0.027	-1.318***
Education (level)	0.206	0.719
Income (KShs./year)	0.00001	1.834**
Knowledge (y/n)	0.665	0.595

* parameter is significant at 0.01 level
 ** parameter is significant at 0.10 level
 *** parameter is significant at 0.20 level

Source: Own computation

From the results in Table 11, for the sub-unit vaccine, the variables: cattle herd, education level, income and knowledge show the expected positive sign. Additionally, the price and the age exhibit a negative sign as expected. However, contrary to our expectation, the household size shows a positive sign. Nevertheless, the sign is not contentious since the

parameter is not statistically different from zero and hence the factor is not a determinant of WATP.

The coefficients represent the impact of a covariate on the WATP. Three factors are found to be statistically significant. These are bid (0.01 level), age (0.20 level) and income (0.10 level). As would be expected, the higher the bid, the lower the willingness to pay and vice versa. The higher the income, the higher the WATP. Age is negatively correlated to the WATP. Customarily, in economics, age (significant at 80% confidence level) would not be considered since there is tendency to only concentrate on coefficients significant at least at 95% confidence level. However, for the sake of various consumers of the findings, who may choose a lower level of confidence, the factor was considered for discussion to reveal the implication. The coefficient of age is negative probably because the old are normally more risk averse compared to the young and would not normally be willing to test or adopt the new technologies when the outcome is not certain, as there have not been prior experience with the vaccines. A tempting argument regarding income and age is that old people have accumulated wealth and hence their WATP is expected to be higher. Actually, older people generally have more experience and assets, so they tend to generate more income than younger people. This contention, however, is not supported by our results. The cattle herds size, the education level and the knowledge of ECF have the right sign, but are not significant. These coefficients are therefore not significantly different from zero at this level. They are not determinant factors of willingness and ability to pay for the sub-unit vaccine.

5.1.3 Relationship of the mean WATP relative to bid variation

The position of the mean WATP for the vaccines relative to the bid distribution can reveal a possible bias in the data collection procedure or in bid value determination. The plot below shows the location of restricted non-parametric mean estimates for both ITM and sub-unit vaccines. Since situations of negative WATP for goods (possible assuming the unrestricted condition) are rarely encountered in real world situations, we hereby assume the restricted estimates. Again we present the non-parametric estimates as they have a greater difference (39 shillings) between the two vaccines unlike the parametric ones that have a difference of only two shillings and hence is not visible from the graph.

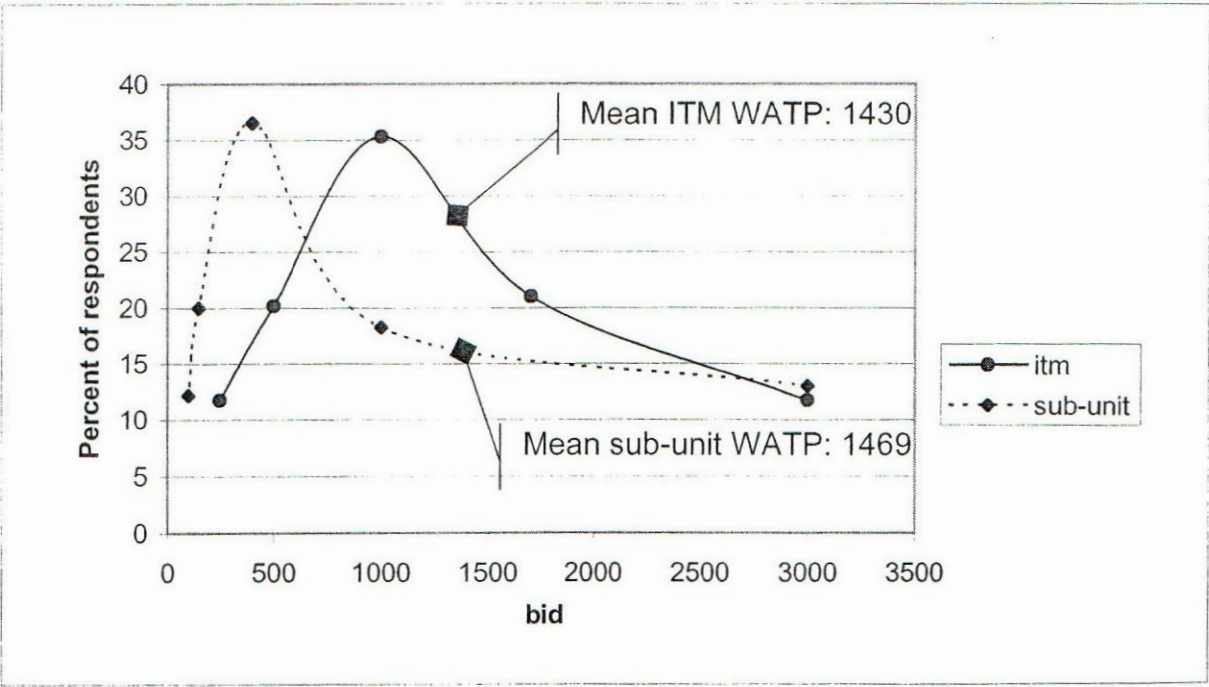


Figure 8: Relationship of WATP relative to bid valuation

The WATP for each vaccine fell to the right of the apex of the respective curve though not at the same level of slope. The estimates do not seem to have been influenced by bid distribution.

5.2 Farmer preferences analysis

5.2.1 Relative importance of vaccine attributes

A conjoint analysis was run on 225 cases. Eight different profiles had been used for ranking. The process involved a strong ordering, i.e, it involved ordering the profiles whereby each occupied a unique position in the preference ranking (first, second, etc.). There was no sharing of positions amongst the profiles. Each of the profiles was composed of four vaccine attributes. In specifying the conjoint model, the attributes of frequency, effectiveness and safety were assumed to follow a discrete relationship. On the other hand, price was assumed to follow a linear relationship. The rankings were decomposed using the SPSS program. The conjoint analysis results for the full sample are presented in Table 12.

In Table 12, the first column shows the four vaccine attributes under consideration. The second shows the relative importance of each of the attributes. The same information (relative importance) is represented by the graph shown in appendix 1. The relative importances are in percentages and represent the proportion of the overall decision in choosing among alternative vaccine products that are attributed to the respective factor, hence indicating each factor's role in decision-making process. The third column presents the utility ranges. This is the difference in utility between the highest and lowest attribute levels. It is from these ranges that the relative importances of attributes are determined. The fourth column has the attribute levels. Price had three levels while each of the other three attributes were represented by two levels. The last column has the utility scores or part-

Table 12: Average conjoint analysis results (n=225)

Attribute	Averaged Importance (%)	Range in utility	Attribute levels	Estimated part- worth
Effectiveness	31.8	2.4	Moderately effective (75%)	2.4 ⁹
			Very effective (95%)	4.8
Frequency	29.6	-2.2	Once in life time	-2.2
			Annual boosters required	-4.4
Price	11.7	-0.4	KShs. 600.00	-0.4
			KShs. 1200.00	-0.8
			KShs. 1800.00	-1.2
Reactors	26.9	-2.1	No reactors	-2.1
			Risk of reactors (5%)	-4.2
Constant	8.0129			
Pearson's R 0.999				
Level of significance 0.0003				

Source: Own computation, conjoint analysis output

⁹ Part-worths are relative measures of utility and so are not associated with any absolute unit of measure.

worths associated with each of the attribute levels. The part-worths express the contribution of the respective attribute levels to the overall preference.

The Pearson's r from the conjoint analysis was 0.999 on the average. This is a high value, close to 100%, and it is an indication that the fit of the additive model to the individual data is good. It can thus be inferred that the farmers were quite capable of a consistent evaluation of the vaccine attributes.

The utility scores exhibit the expected relationships. Utility values associated with effectiveness have a positive sign indicating that a higher level of effectiveness is preferred. On the other hand, the utility scores for frequency, price and reactors have negative signs since lower levels of these factors are preferred. Said differently, higher levels of each of these three factors contribute to disutility.

The estimated average part-worths show that farmers get higher utility from a vaccine that is more effective over the less effective one. A farmer gets a utility of 2.4 from a vaccine that is moderately effective, but gets 4.8 utility from a vaccine that is very effective. A vaccine that is administered once in the animal's lifetime yields the farmer utility of 2.2 points higher than that requiring annual booster. In other words, a vaccine with lower frequency of administration is preferred. Likewise, eliminating the risk of side effects yields the farmer utility of 2.1 on the average and hence it is preferred over that with side effects. An increase in the price of a vaccine by KShs. 600 is associated with a disutility of 0.4. As would be expected with a rational farmer, the utility derived from a higher price is lower than that from a lower price. Simply said, farmers prefer cheap vaccines to the expensive ones.

As already demonstrated above, a price increase is associated with a minor decrease in utility compared to a change in the level of other factors. Hence, raising the price appears to result in only a minor decrease in overall utility.

As mentioned before, four factors are considered: effectiveness, safety, frequency and price. The average importance in Table 12 indicates that effectiveness is the most important factor influencing the choice of ECF vaccine that farmers would buy. Frequency, reactors and price follow in that order. The first three factors (effectiveness, frequency and safety) are the key ones and are almost equally important as shown by the minor difference in their relative importance. The 32% averaged importance of “Effectiveness” is the highest amongst the computed values for the four factors and 12% for the price is the least. The second highest value is 30%, which is the averaged importance associated with the factor “Frequency”. The third highest value of averaged importance concerns the risk of “Reactors” and is 27%. Farmers place less value on possible side effects than they do on effectiveness and on frequency in deciding on the vaccine to purchase. However, the three factors differ little in their level of importance. Their relative importance differences, though statistically significant as tested by a test of Least Significance Differences, do not have major practical significance. The three play a key role in the purchase decision. On the contrary, price seems to be minor in the purchase decision. It accounts for less than half of the averaged importance of any of the other factors. More specifically, its relative importance is less than half that of reactors and slightly greater than a third that of effectiveness. Amongst the four factors under consideration, price is the least important accounting for only 12% of the total on average. This suggests that price is a relatively minor factor in the average preference structure, and has least influence on the overall decision regarding ECF vaccination.

As expected, a vaccine that is very effective, cheap, with no risk of side effects and with less frequency of administration represents the most preferred option among the farmers.

5.2.2 Trade-off between price and other attributes

Many parties involved in the development of a new product are interested in the trade-off between price and other attributes. In our case such information is important to stakeholders in the development of ECF vaccines. They are able to estimate the change in price that should accompany a change in the level of one of the attributes to make the consumer, in this case the farmer, indifferent at both situations. This change, the compensation value, may be computed using the formula below:

$$\text{Compensation value} = \frac{\text{Utility range for the respective factor} \times \text{base price (600)}}{\text{Utility range for the price}} \tag{15}$$

Table 13 shows the price change that would accompany the respective change in attribute level for the farmer to be indifferent in both situations. The computations address any ECF vaccine in general and are not specific to ITM or sub-unit vaccine.

Table 13: Attributes trade-off analysis.

Factors	From	To	Compensation value (KShs.)
Effectiveness	Moderately effective	Very effective	3600
Frequency	Annual	Once in life time	3300
Reactors	Risk of reactors	No reactors	3150

Source: Own computation

The first column represents the three factors of which each is being traded against the price. The second column represents the status quo in the level of attribute. The third column represents an improvement that would make the farmer no different if the change is accompanied by an increase in price by the compensation value shown in the fourth column. From Table 13, it is clear that a farmer would be indifferent if confronted with a vaccine that is very effective and has a price of KShs.3600 higher than that of another vaccine that is moderately effective and has a price of less the pre-mentioned value. In other words, the farmer would be willing to pay KShs. 3600 more for improved effectiveness to 95%. If researchers intend to make the farmer indifferent with both annual and once in lifetime vaccines, a value of KShs.3300 would compensate this difference. Lastly, if they are to be indifferent regarding the side effects, then the price difference should be KShs.3150. The comparison values are extremely high, suggesting it may not be appropriate to extrapolate from the marginal price change values. However, the implication of the high monetary values assigned by farmers to the attributes is clear- the farmers highly value the better quality of the attributes.

5.2.3 Regression analysis for vaccine attributes versus ranks

The SPSS conjoint run command involving the plan and data files for executing the conjoint analysis, does not provide statistical information needed for testing the hypothesis on the significance of the four attributes under consideration in influencing farmer preferences. The output also does not tell us how much of the variation in ranking or farmer preferences, as would be presented by coefficient of determination (R^2), can be attributed to the four vaccine attributes.

Due to these drawbacks, it was found necessary to recreate the SPSS conjoint command results by running a regression with each of the three explanatory variables (effectiveness, frequency and safety) represented as dummy values and price as a continuous variable. Moderate effectiveness, reactors and once for life vaccination each assumed a zero value while very effective, risk of side effects and annual vaccination assumed a value of one, respectively. In order to run the regression, each card was considered as a separate case. Since there was a pool of 225 farmers and each ranked 8 cards, the total cases were the product of the two (8*225).

The following regression equation was estimated:

$RV = 7.156 - 2.4089E + 2.0689R + 0.0007P + 2.22F$	(16)
$s.e(.0809)(.0556)(.0556)(.00006)(.0556)$	$r^2=0.7354$
$t \quad (88.460) \quad (-43.293) \quad (-37.182) \quad (11.801) \quad (-37.182)$	$n=1800$

where RV = rank value

- E = Effectiveness
- R = Reactors
- P = Price
- F =Frequency

Since a lower rank indicates a higher preference and vice versa, as would be expected effectiveness of the vaccine is negatively correlated with the rank value. On the other hand, reactors, price and frequency are positively correlated to the rank value.

All the factors are statistically significant at 1% level of significance of course as would be expected since these were the only attributes the farmers were considering while they ranked

the profiles. The explanatory variables, the four vaccine attributes, explain 73.5% of the variations in the dependent variable, rank value.

A t-test was done to test if the non-price factors were as important as the price in determining the kind of vaccine farmers prefer. The results showed that the mean utility farmers derive from non-price factors is statistically significantly higher than that from price. Each of the three factors; effectiveness, frequency and safety are hence more important to a farmer than the price.

5.2.4 Cluster analysis

The conjoint analysis results discussed above are from the full sample. They therefore represent the findings on the average for the entire group. Sometimes, within a given population or group, there exists sub groups with common features. For our study, since we are analyzing farmer preferences, it would be useful to identify the existing natural groups on the basis of the computed utility values they attach to attributes. A cluster analysis on the sample was used in doing so. Further, since utility is psychological and hence not physically observable, it is also wise to identify the socio-economic characteristics identifying the groups with common preference structure. In so doing, given the socio-economic characteristics of any farmer, it would be possible to predict the cluster he belongs to without necessarily computing his utility values.

The full sample was classified into four segments using the SPSS software. The K-means cluster command was used in the classification. The segments were based on estimated respondent's part-worths for the four vaccine attributes under consideration. The part-worths were clustered to identify commonalities in preference structures. Based on the relative size

of the segments and the number of iterations, four segments were found to be the most appropriate. This segmentation had only three iterations, which was the minimum among other trial segmentations. The trial segmentations were necessary to identify if there existed other more appropriate groupings.

Among the four clusters, one had only a single observation. This was dropped from further analysis, as it was not possible to do multiple comparisons of the means in SPSS with only one respondent in that cluster. The single respondent in this cluster considered frequency as the most important attribute. Effectiveness and reactors tied as the second most important and lastly, price was established as the least important. The member was 62 years old and had primary school level of education. He had knowledge of ECF disease. His income per year was KShs.90000 and had a cattle herd of 3 animals.

The other clusters 1, 2 and 3 constituted 43, 25 and 32 percent of the respondents respectively. Figure 9 presents the three clusters together with utilities each group attach to the attributes on the average. Their socio-economic characteristics were investigated to examine those that distinguish each segment.

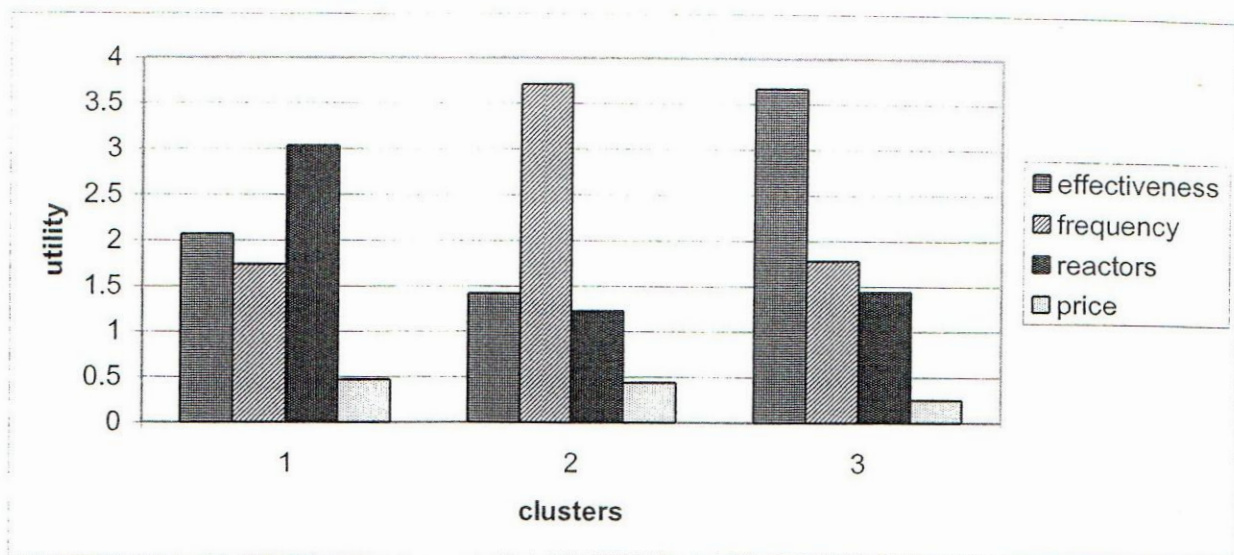


Figure 9: Market segmentation on basis of vaccine attributes

As it is clear from the above graph, the order of importance of attributes per cluster emerges as shown by Figure 10.

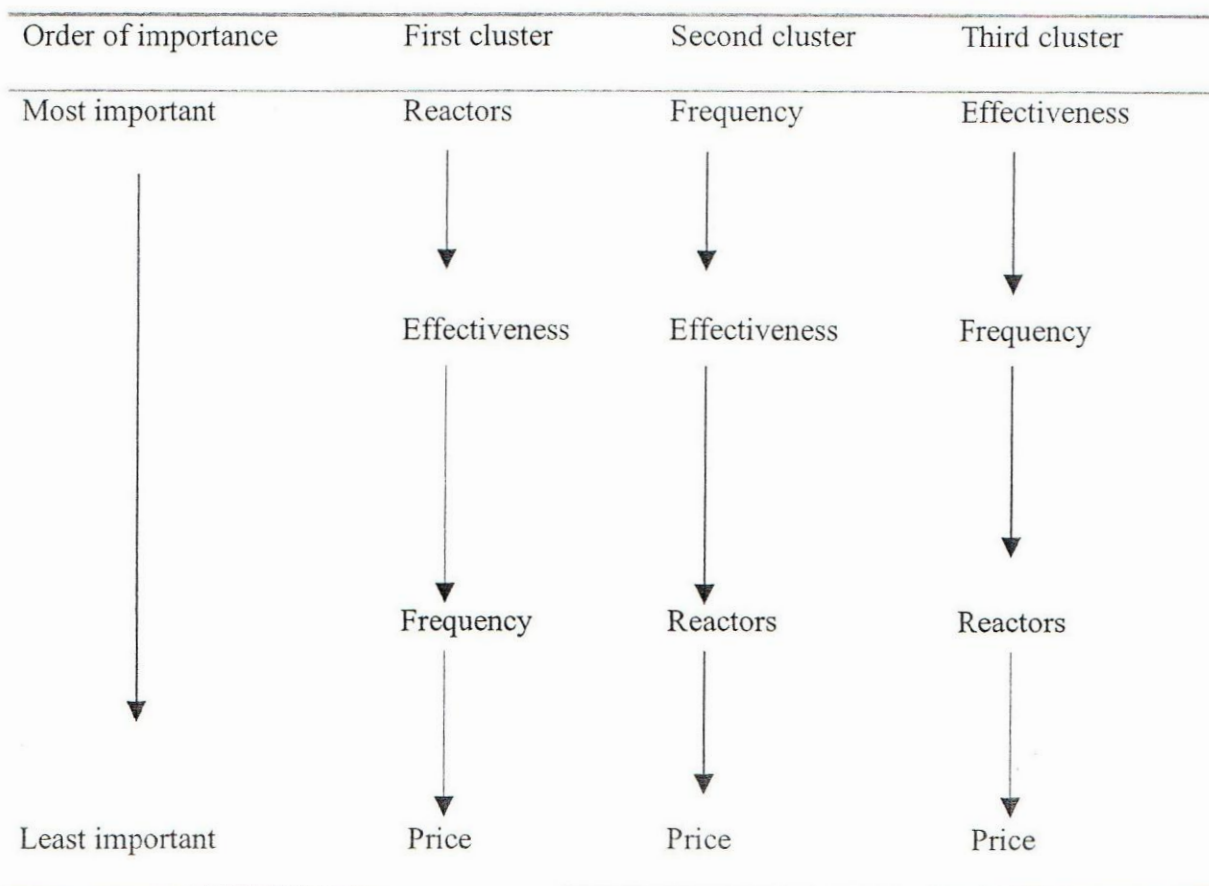


Figure 10: Attributes order of importance

Having established the order of importance in attributes for each of the three clusters, we may henceforth refer the first cluster as the safety cluster, the second cluster as the frequency cluster and the third one as the effectiveness cluster. All the segments regard price as the least important factor. However, as shown by Figure 9, the utility attached to the price differs from one cluster to another. The highest price utility is by cluster one (safety cluster) and the least by cluster three (effectiveness cluster). The safety cluster members are therefore the most price sensitive group and the least is the effectiveness cluster. Table 14 shows the socio-economic characteristics of each cluster.

Table 14: Socio-economic characteristics per cluster

Variables	Cluster 1 “Safety”			Cluster 2 “Frequency”			Cluster 3 “Effectiveness”		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Income (KShs./year)	45737	0	1077600	34376	0	540000	78659	0	1236236
Education (level)	2.3	0	5	2.4	0	4	2.4	0	4
Age (years)	51	25	85	54	32	83	52	27	96
Herd (No.)	2.7	0	20	2.6	1	8	2.5	0	6
Hhmembers (No.)	6	2	12	5.6	1	12	5.9	1	11
Knowledge of ECF (y/n)	1	0	1	0.9	0	1	0.9	0	1

Source: Own computation from survey data

The mean values of the variables per cluster are represented by Figure 11.

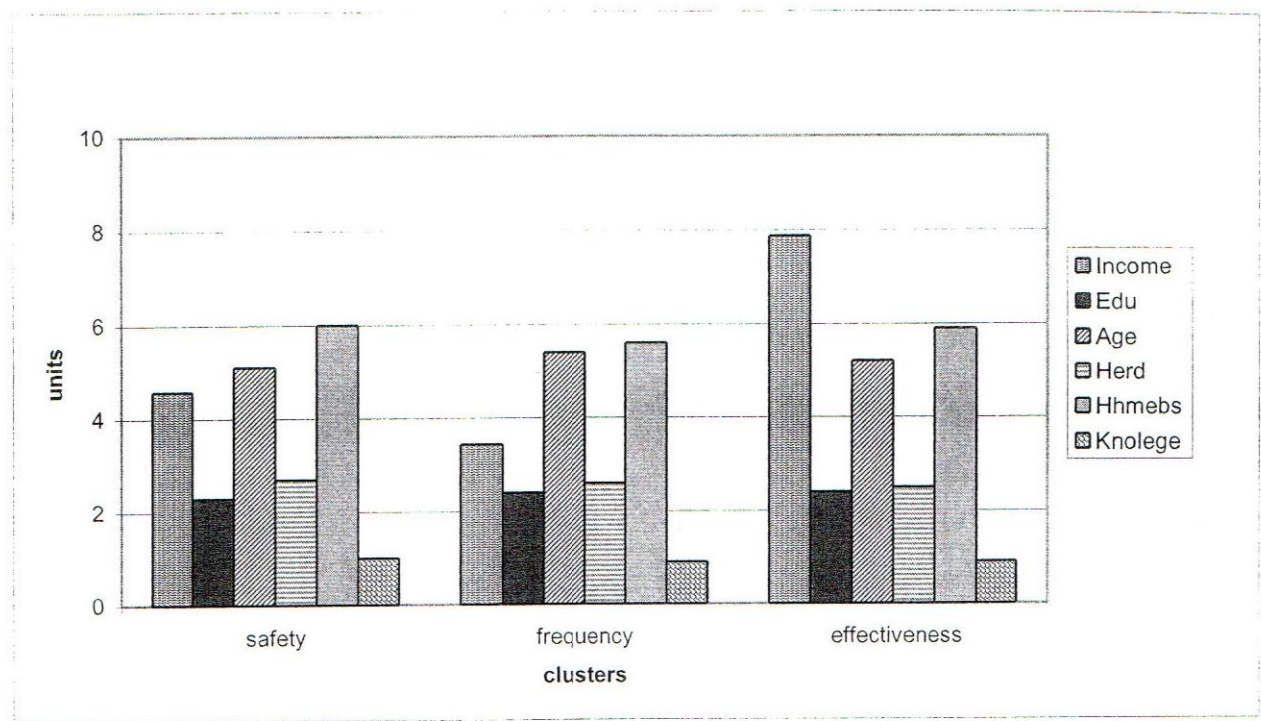


Figure 11: Socio-economic characteristics of each of the clusters

Y-axis scale: Income:- one unit represents KShs. 100,000.00

Age:- one unit represents 10 years.

Other factors:- one unit represents a unit of the respective factor

A test of Least Significance differences was done to test statistically the differences amongst the means of the variables. It was established that there was no statistically significant difference in the means. This is an indication that the factors under consideration do not statistically differentiate the clusters. The clusters therefore, though statistically different based on utility scores members attach to vaccine attributes (apart from that of price between cluster 1 and 2, and 2 and 3 and that of frequency between clusters 1 and 3), are not different on the basis of the socio-economic characteristics under consideration. Statistics from the least significance difference (LSD) test are shown in Table 15.

Table 15: LSD statistics

Variable	Clusters 1 versus 2	Clusters 1 versus 3	Clusters 2 versus 3
	Mean difference	Mean difference	Mean difference
Effectiveness	.647*	-1.602*	-2.249*
Frequency	1.972*	-.039	-1.933*
Reactors	1.803*	1.589*	-.213*
Price	-.052	-.239*	-.187
Income	11361.496	-32921.904	-44283.399
Education	-.076	-.141	-.065
Age	-2.704	-.826	1.878
Cattle herdsize	.125	.239	.114
Household members	.393	.127	-.266
Knowledge of ECF	.030	.086	.055

* Significant at 0.01 level

Source: Own computation.

The emergence of three defined groups of farmers with different and conflicting preferences for the vaccine attributes is an indication that farmers do not perceive the same value on respective vaccine attributes. This has some policy implications. As may be inferred, it is rather impossible to develop a single vaccine that will satisfy all the farmers. Also efforts to improve on one attribute at the expense of the other, except price, may be viewed as detrimental to another segment. For instance, farmers in cluster one consider frequency the most important factor while those in cluster two consider effectiveness. With these diverse groups, probably an appropriate policy would be one that would employ an approach that would aim at satisfying each of the three categories. Such would be the segmentation

approach. This would entail development of different vaccines for the various market segments, but this would not likely be practically feasible in the case of a vaccine. The other alternative to deal with the three groups is to try to satisfy them simultaneously by giving equal priority to all the three factors.

5.3 Summary

This chapter has presented and discussed results on WATP for ITM and sub-unit vaccines as well as those obtained by analysis of farmer preferences. It has been established on basis of income distribution that the samples are representative of that would be expected for a developing country context, a clue that the results may be applicable in other third world countries with similar levels of ECF prevalence. The demand curves for the two vaccines were negatively sloped as would be expected. The WATP for the two vaccines do not differ significantly. The major constraint for the inability to pay for the vaccines was the price as indicated by the fact that majority of respondents who could not pay for the vaccine at both of the presented bids gave the reason that they could not afford it.

The utility farmers derive from different vaccine attributes do differ. Among the considered attributes, variation of vaccine's price would influence farmers' utility least while on the other hand, varying the level of effectiveness would influence the most. On the basis of utility farmers yield from the vaccine attributes, three distinct clusters emerge with each considering a different attribute as most important. However, all the clusters consider price the least important factor.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

This work achieved the objectives set at the beginning of the study. The willingness and ability to pay (WATP) for each of the two vaccines, ITM and sub-unit, was estimated. The socio-economic factors influencing demand for each of the two vaccines were also identified. This encompassed development of a model for predicting individual's WATP given his/her socio-economic characteristics. The study also assessed the attributes that influence the farmer purchase decision for ECF vaccines.

Having analysed the data, presented and discussed the results in the previous chapter, the study culminate in this chapter with conclusions and recommendations. These were based on the results from the conjoint analysis and from the Willingness and Ability To Pay estimates. The conclusions and recommendations are made under the assumption that farmers answered truthfully during the interview, hence data used in the analysis were accurate. Areas for further research are also suggested in this chapter.

6.1 Vaccine's demand

The mean willingness and ability to pay for the ITM when estimated using the double-bounded logit model ranged between KShs. 1313-1430 depending on, first, whether the model assumed is unrestricted or restricted, and secondly, if the estimation was parametric or non-parametric. That for a sub-unit vaccine was estimated more narrowly, 1355-1469. Note that different models gave different estimates of WATP. This is clearly shown in appendix 2 where estimates from other models for analysing dichotomous choice data are presented. This was an indication that the mean monetary valuation is sensitive to the model adopted

and the assumptions made. The demand estimate would form the basis for developing the next strategy to undertake as far as the ITM and the sub-unit vaccines delivery is concerned. For instance, the demand may be compared with the costs of vaccine development. If projected demand is so low that it would not cover costs, then this might argue for subsidization.

Among the socio-economic factors considered in this study, those significantly influencing the demand for ITM are price of the vaccine and the education level of the household head. Lowering the vaccine's price and/or improving the level of education of the household head would therefore boost demand for ITM. High demand would essentially imply a high level of adoption of the ITM and consequently enhanced impact of ITM immunization on smallholder dairy sector.

The variables significantly influencing demand for a sub-unit vaccine are the vaccine's price, age of the household head and income level. The demand for sub-unit vaccine would therefore be enhanced if farmers had higher incomes, prices were lowered or younger farmers were targeted. Income of the farmers may for instance be improved by facilitating proper marketing of their various produce, say by forming cooperative societies, yielding higher proceeds due to eliminated middlemen thereby strengthening the farmer's purchasing power and consequently WATP for the vaccines. This would imply a high level of vaccine adoption and hence enhancements in impact on the smallholder dairy sector of immunization against East Coast fever with the improved sub-unit vaccine.

The models estimated may be used in predicting demand based on the socio-economic factors considered. The results from Makuyu Division may be used in making predictions for

other areas especially those with similar levels of vector challenge and livestock production systems.

6.2 Farmer preferences

From the conjoint analysis, effectiveness of the vaccine emerges the most important factor on average that farmers consider in making the purchase decision of an ECF vaccine. Effectiveness is followed by frequency of vaccine administration, and then risk of side effects and price is the least important. Nevertheless, effectiveness, frequency and safety carry almost equal relative importance. In adopting a consumer-oriented approach, the three attributes should hence be given priority in designing a vaccine that would be readily acceptable by farmers. The order of preference that has been established in this study should form the blue print in designing vaccines that would meet consumer needs or preferences. In particular, the results form the basis for setting priorities in designing the new sub-unit vaccine under development.

The study has established that the non-price attributes of a vaccine are more important factors in determining the vaccine to purchase than the price itself. These factors were effectiveness, frequency of vaccine administration as reactors. It is important to lay emphasis in the factors while designing ECF vaccines.

Three heterogeneous segments were identified based on commonalities in utility structures though did not appear to be tied to differences in socio-economic characteristics. The implication of this is that it is difficult to develop one vaccine that would satisfy all farmers. Therefore, to satisfy them, it may call for development of several vaccines each targeting a specific segment with a common preference structure. Since this is not practically feasible

for a vaccine case, especially due to financial as well as technological constraints, the three factors (effectiveness, frequency and safety) that matter equally most to a farmer should be given relatively equal emphasis in the development of new ECF vaccines.

In conciliation of estimates of WATP and farmer preferences analysis, the results show that the estimated WATP is relatively high compared to bid sets presented, an indication of the high demand for the vaccines. These double-bounded logit model estimates are consistent with the results of conjoint analysis. In the latter, farmers were revealed to regard price least important and hence less sensitive to it than to non-price factors. This insensitivity is confirmed by the estimated high WATP.

6.3 Suggestions for future research

This study estimated WATP using data collected by double-bounded dichotomous choice design. For the cases where both responses to the bid were negative, the farmer was not asked on the amount then he would be willing and able to pay, making it difficult to detect the protest behaviour. On the other hand, those who gave positive response to both bids, the maximum the farmer could pay was not enquired, making it difficult to detect cases where high unrealistic monetary valuations would be given. It would be important to elicit such information given that the maximum and minimum responses would help identify individuals with no positive valuation for the good being presented as well as subjects stating high unrealistic bids. Also, to be able to estimate the income and price elasticities of demand, it would be advisable to ask the respondent the number of animal's he would immunize given the quoted price.

This study was focused to potential demand estimation. It did not consider the cost of developing the vaccines. Research geared to generation of such information would be of importance, as it would enable assessment of cost recovery given the estimated WATP.

Again, in order to maximize adoption of the technologies, it would be appropriate to undertake research aimed at identifying the most cost effective delivery strategy of the vaccines.

Lastly, once the vaccines are introduced in the study area and hence bought by farmers, it would be necessary to carry out some research to assess the actual adoption level. The findings from such research would validate the results of this study. Again, such findings would form the basis for recommending the most appropriate model of estimating the WATP for a technology that has not yet been released in the market.

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APPENDIX 1: Relative importance of vaccine attributes

Figure 12 presents the information contained in Table one. It shows the relative importance of the factors included for the conjoint analysis.

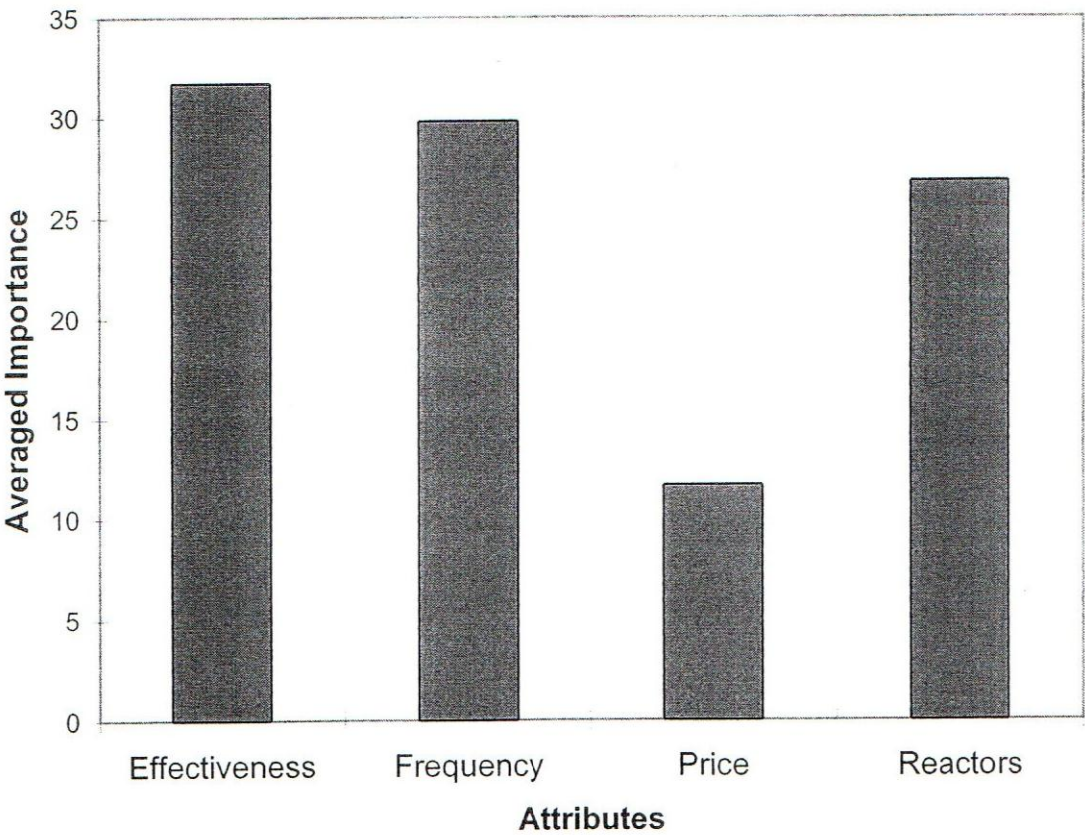


Figure 12: Graph of Averaged Importance Versus Attributes

As the bar graph shows and as noted earlier, the most important factor is effectiveness and the least is price.

APPENDIX 2: Different models' estimates of WATP

A) RESTRICTED WATP

Table 16: Sub-unit vaccine parametric restricted WATP

		Db logit	Sb logit	Db probit	Bivariate	Sb probit
WTP	Mean	1409.00	1927.10	1676.60	2426.60	2115.05
	Median	1388.00	1842.90	1668.35	2352.15	2040.95
	Point	1376.25	1841.95	1670.65	2361.20	2048.80
C.I.	99%	919.50-2175.30	1309.10-3572.40	1341.34-2109.40	1731.25-4106.60	1462.00-3771.05
	95%	1060.00-1908.60	1392.90-2926.95	1424.20-1982.15	1824.45-3467.95	1558.55-3117.90
	90%	1117.60-1800.55	1475.35-2633.70	1463.95-1914.75	1910.20-3182.60	1631.85-2820.30

Source: Own computation

Table 17: ITM vaccine parametric restricted WATP

		Db logit	Sb logit	Db probit	Bivariate	Sb probit
WTP	Mean	1407.80	1805.95	1634.35	2130.95	2150.70
	Median	1391.60	1709.20	1623.50	2042.75	2004.60
	Point	1389.90	1697.45	1624.75	2056.10	2017.95
C.I.	99%	1067.40-1951.60	1223.20-3878.40	1383.95-2004.75	1492.75-4053.55	1425.30-5265.30
	95%	1154.75-1731.55	1319.20-2975.40	1424.85-1906.20	1586.50-3123.25	1523.40-3410.20
	90%	11.91.10-1672.70	1354.60-2562.30	1449.65-1845.00	1645.75-2816.10	1580.65-2973.75

Source: Own computation

B) UNRESTRICTED WATP

Table 18: Subunit vaccine parametric unrestricted WATP

		Db logit	Sb logit	Db probit	Bivariate	Sb probit
WTP	Mean	1378.50	1824.15	1454.70	1992.25	1810.55
	Median	1355.00	1775.80	1451.65	1949.25	1764.20
	Point	1359.65	1770.10	1448.95	1942.25	1758.60
C.I.	99%	958.35-2063.60	1126.25-3063.50	10829.50-860.50	1385.65-3270.40	1214.00-3142.40
	95%	1047.40-1778.80	1307.50-2612.90	1121.20-1761.00	1504.85-2787.20	1331.80-2612.90
	90%	1099.30-1721.95	1381.10-2458.35	1201.55-1710.70	1563.75-2566.45	1388.45-2382.95

Source: Own computation

Table 19: ITM vaccine parametric unrestricted WATP

	Db logit	Sb logit	Db probit	Bivariate	Sb probit
Mean	1313.00	1597.40	1348.55	1593.35	1521.75
Median	1304.00	1503.80	1350.60	1563.30	1488.70
Point	1311.55	1495.60	1347.00	1554.30	1478.50
99%	995.70-1711.40	874.75-3533.40	1031.72-1712.00	1111.90-2520.55	946.70-2695.60
95%	1054.50-1620.60	1082.95-2299.30	1100.70-1580.30	1217.85-2200.45	1080.10-2203.20
90%	1101.80-1555.60	1156.45-2061.60	1146.65-1541.75	1262.25-2023.10	1146.00-1990.15

Source: Own computation

APPENDIX 3: Cross-sectional Survey Questionnaire

(Developed by ILRI Epidemiology and Disease Control Project Team and in Collaboration With KARI)

Questionnaire Identification
(To be filled by supervisor at time of issuing questionnaire to enumerator)

Province _____ (write name)
District _____ “
Division _____ “
Location _____ “
Sub-location _____ “
Village _____ “
Questionnaire Serial Number [/ / / / /]

Reviewed by:

1. Field Supervisor: _____
Date: _____
2. Nairobi team: _____
Date: _____

If sent back for verification/correction:

1. Date sent back to enumerator: _____
2. Date corrected and returned: _____
3. Reviewed again by: _____

ENUMERATOR NAME _____ ENUMERATOR CODE _____

DATE of interview / ____ / ____ /2001

NAME of HOUSEHOLD HEAD _____

RESPONDENT’S NAME _____

GPS LONGITUDE [_____] (DECIMAL DEGREES)

GPS LATITUDE [_____] (DECIMAL DEGREES)

GPS ALTITUDE [_____] (METERS)

SECTION A HOUSEHOLD INVENTORY

A/1 1. How many households are there in the homestead? [] (*Fill in the number*)

2. *If more than one*, are the households separated in terms of labour, resources and management (decisions)? []* (*Fill in Y for yes, N for no*)

** If yes, the remaining questions should be answered with regard to one separate household*

** If no, the remaining questions should be answered with regard to the whole homestead (thus homestead is household)*

A/2 Who is the head of the household? _____ [1]

Who is the farm owner? _____ []*

** Fill the number from the HH table (A/3) later.*

_____ **ASK A/3 FIRST** _____

A/4 Who makes most of the management decisions, concerning livestock? []

Who decides specifically on cattle disease control? _____ []*

Who decides on seeking veterinary assistance? _____ []*

Who does the payments for veterinary services? _____ []*

** Take the number from the HH table.*

The last three questions (in A/4) are critical for the selection of the respondent.

1. If for two of these three questions the same person appears, then he / she should answer the rest of the questions of the questionnaire.
2. If they happen to be three different people, let the one who decides on seeking veterinary assistance be the respondent.
3. Consult with the Field Supervisor in case of unclearities.

A/3 Household members in the last 12 months

Start asking the details of the household head (HHH), followed by wife (ves), children, etc.

No	Name of member	Age in years	Sex (M, F)	Relation-ship to household head	Occupation		No. of months resident on farm	Highest educational level completed	Years of farming experience	Ethnic affiliation	Religion
					main	other					
1			[]	Self	[]	[]		[]		[]	[]
2			[]	[]	[]	[]		[]		[]	[]
3			[]	[]	[]	[]		[]		[]	[]
4			[]	[]	[]	[]		[]		[]	[]
5			[]	[]	[]	[]		[]		[]	[]
6			[]	[]	[]	[]		[]		[]	[]

7			[]	[]	[]	[]		[]		[]	[]
8			[]	[]	[]	[]		[]		[]	[]
9			[]	[]	[]	[]		[]		[]	[]
10			[]	[]	[]	[]		[]		[]	[]
11			[]	[]	[]	[]		[]		[]	[]
12			[]	[]	[]	[]		[]		[]	[]

Relation to HH head

H = Husband
W = Wife
CW = Co-wife
S = Son
D = Daughter

F = Father
M = Mother
E = House help/ farm labourer
HM = Hired manager
O = Other (specify) _____

Ethnicity

1 = Kikuyu
2 = Luhya (specify sub-group _____)
3 = Kalenjin (specify sub-group _____)
Other (specify _____)

Occupation

1 = farmer
2 = civil servant / teacher
3 = student
4 = business person
5 = farm worker
6 = casual labourer
7 = retiree
Other (specify) _____

Educational level

0 = No formal education
1 = Adult literacy education
2 = Primary 1 - 8
3 = Secondary 1 - 6
4 = Diploma or certificate
5 = University

Religion

C= Catholic
P = Protestant (all except for SDA)
S = SDA
M = Muslim
H = Hindu
T = Traditional African faith
O = Other (specify)

SECTION B FARM RESOURCE BASE

B/1 In which year did you start farming on this farm? 19__*

* Refer to Kenyan events calendar if necessary.

B/2 What was the total land size when you started this farm? _____ acres

What is the total land size now? _____ acres

Do you use shambas elsewhere? [] (Fill in Y for yes, N for no

Of all the shambas can you tell us what you grow on them (crops, fodder, etc.)? Is there any fallow land or land for grazing? How much land is for housing, etc.? What is the tenure of each parcel /shamba /plot?

Plot	Acres	Land use	Land tenure
1		[]	[]
2		[]	[]
3		[]	[]
4		[]	[]
5		[]	[]
6		[]	[]
7		[]	[]

Land use

- C = crop cultivation
- AF = animal feed cultivation
- F = fallow land
- G = grazing
- H = housing
- O = other (specify) _____

Land tenure

- O = owned by the HH
- R = rented out
- L = leased or borrowed
- P = public / communal land

If not mentioned in the previous question ask:

Do you use communal or public land for grazing?[] (fill in Y for yes, N for no)

for cropping? [] (fill in Y for yes, N for no)

for fodder? [] (fill in Y for yes, N for no)

Type of roof

1 = thatch
2 = iron sheets
3 = tiles

Which type of roof [_] and walls[_]?

Type of walls

a = mud
b = wood
c = stone / bricks
d = iron sheets

c = stone / bricks
d = iron sheets

d = iron sheets

(Fill in Y for yes, N for no, a number if they have more than one of the item)

ITEM	(Y / N/ #)
Armchair sets	[]
Wheelbarrow	[]
Hand cart	[]
Animal drawn cart	[]
Bicycle	[]
Motor cycle	[]
Tractor	[]
Car/ Pick-up	[]

You can make a note for the items that are no longer functional:_____

SECTION C ENTERPRISES

C/1 Which are the five most important crop / vegetable enterprises that you have? How many acres are there under cultivation for each enterprise? Is it for home consumption or for selling? *Please note that fodder is not taken as a crop.*

Crop enterprise	Total acres under cultivation	Yield *		Price/unit
		For home consumption	For cash	
1.				
2.				
3.				
4.				
5.				

** Fill in the unit as given by the farmer, but make a note of how much it is in kgs. below*

C/2 Which type of livestock do you rear? Do you have zebu cattle? Do you have grade cattle, etc.?

Type of livestock	Total number	Most important reasons for keeping the animals		
		First	Second	Third
0 Zebu cattle		[]	[]	[]
0 Grade cattle		[]	[]	[]
0 Zebu-Grade crosses		[]	[]	[]
0 Goats		[]	[]	[]
0 Sheep		[]	[]	[]
0 Chicken		[]	[]	[]
0 Pigs		[]	[]	[]
0 Rabbits		[]	[]	[]
0 Donkeys		[]	[]	[]
0 Other poultry		[]	[]	[]

C/3 Of the cattle enterprise, what is the herd composition? How many calves, weaners, heifers, etc?

What have been the changes over the last 12 months?

Cattle category		No. of grades today [A]	No. of crosses today [B]	No. of zebus today [C]	No. of new born last 12 months	No. of natural deaths last 12 months	R E A S O N	No. of slaughtered last 12 months	R E A S O N	No. bought last 12 months	R E A S O N	No. sold last 12 months	R E A S O N
[1]	Suckling calves						[,]		[]		[,]		[]
[2]	Weaners						[,]		[,]		[]		[]
[3]	Heifers						[]		[,]		[,]		[]
[4]	Cows						[,]		[,]		[,]		[]
[5]	Bulls						[]		[,]		[,]		[]
Total							[,]		[,]		[,]		[]

Notes for additional reasons:

Reasons for deaths

D = disease

A = age (old)

S = still birth

U = unknown

Other (specify) _____

Reasons for slaughter

D = disease

A = age (old)

M = for meat

I = injury

C = ceremony

Other (specify) _____

Reasons for sales

C = to obtain cash income

P = poor performance

D = disease

Other (specify) _____

Reasons for purchases

R = replacement

M = increase milk prod.

E = expansion

P = social prestige

Other (specify) _____

For those who have zebu or crossbred

C/4 1. Do you wish to (further) upgrade your cattle?

[] (fill in Y

for yes, N for no)

If yes, what is / are the reason(s) why you wish to upgrade your cattle?

1 = For more milk

2 = For larger animals

3 = For prestige

Other (specify) _____

If no, what is / are the reason(s) why you do not wish to upgrade?

1 = animals already have 100% grade

2 = grade animals tend to be susceptible to diseases

3 = I cannot afford to buy one

4 = I cannot feed it enough

5 = I have no interest in the milk

6 = I have no knowledge on how to keep them

7 = they are too labour intensive

Other (specify) _____

For those who chose disease susceptibility (#2), Please state which diseases you fear most with regard to upgrading?

Disease 1 _____ Disease 2 _____ Disease 3 _____

For those who have zebu or crossbreds:

In which ways can one acquire a grade or grade-zebu crossbred animal?

0 purchase

0 AI on zebu

0 using a grade bull on zebu

0 grade animal on credit (e.g. Heifer Project International)

0 Other (specify) _____

For all respondents:

3. Does having grade cattle give more prestige than having crosses or zebu? []

(fill in Y for yes, N for no)

Does keeping grade animals give returns that exceed the costs? [] *(fill in Y*

for yes, N for no)

C/5 Do you have any other enterprises? [] *(fill in Y for yes, N for no)*

If yes, which one(s)?

0 Shop

0 Livestock trading

0 Grain / vegetable trading

0 Building contracting

0 Contracting animal traction

0 Contracting tractor work

0 Fish trading

0 Other (specify) _____

C/6 Which of all your enterprises is the most important one? _____

Why do you consider it to be the most important? _____

SECTION D FARM CONNECTIONS

D/1 To which groups are you or any member of the HH affiliated? What benefits do they receive from them?

0 Self – help group [__, __, __, __] *(fill in the benefits)*

0 Co – operatives [__, __, __, __]

0 Religious groups [__, __, __, __]

0 Other (specify) _____ [__, __, __, __]

Benefits

I = information

A = advice

C = credit

L = loan

Ac = Assets on credit

Other (specify) _____

D/2 Does any one in the household serve as a leader in the community?

0 Church leader

0 Village elder

0 Assistant chief

0 Chief

0 Councillor

0 Chair person of a group (e.g. self help group)

0 Other (specify) _____

D/3 Which services have you used on your farm in the last 12 months?

0 Extension

0 Artificial insemination

0 Veterinary services

0 Other (specify) _____

D/4 What is the distance to the nearest..etc.? Which means of transport do you normally use from your farm to it?

Place	Name of locality	Distance from farm (Kms)	Usual mode of transport
1. Nearest main road (tarmac / all weather)			[]
2. A place where producers can deliver their milk			[]
3. A place where producers can buy fertilisers and animal feeds			[]
4. Your veterinary service provider			[]
5. Your extensionist			[]
6. Nearest self-help			[]

Mode of transport

1 = walk
 2 = bicycle
 3 = motor cycle
 4 = public transport
 5 = own vehicle
 6 = animal traction
 Other: _____

group*			
7. Nearest co-operative society			[]
8. Nearest market/ trading centre			[]
9. Nearest town			[]

* In case the self-help group does not have a fixed residence, put NA in the cells.

D/5 1. How long on average do you milk your cows (lactation period)? _____

How much milk do they on average give in the beginning _____

two months after calving _____.

and at the end of the lactation? _____.

How high on average is the total milk yield of all the cows in the wet season? _____

How high on average is the total milk yield of all the cows in the dry season? _____

Have you sold any milk over the past 12 months? [] (Y for yes, N for no)

If yes: To who did you sell? How much did you sell to each buyer? Do you transport

it yourself?

Customer	How much?		Price/unit	Self transport	Mode of transport	Distance / day	Hours / day
	Quantity	Units / d					
Co-operative (s)		[]			[]		
Trader (s)		[]			[]		
Individual(s)		[]			[]		
Other (specify _____)		[]			[]		

Units

L = litre

FB = fanta bottle

C=cup

TT= treetop

R= beer bottle

2. How much milk on average did the household consume daily during the last 12 months? [. ...] (*Put quantity and unit*)

3. Do you sell other animal products? [] (*Y for yes, N for no*)

If yes, which of the following animal products did you sell over the past 12 months?

(not including live cattle)

0 beef

0 sheep / goats

0 chicken

0 eggs

0 hides or skins

0 manure

0 other (specify) _____

To whom did you sell? 0 neighbours

0 traders

0 co-operatives

0 other (specify) _____

D/6 Which farm inputs did you buy for your farm over the last 12 months?

0 animal feeds

0 fertilizer

0 manure

0 seeds

0 crop pesticides

0 acaricides, from [____,____,____]*

0 drugs, from [____,____,____]

0 machinery (specify) _____

0 tools (specify) _____

0 other: _____

Ac. & drug sources

Ag = Agroveter

V = Veterinarian

N = Neighbour

Ch = Chemist / Pharmacy

GS = General shop

** Fill the sources in order of importance*

Do you find it difficult to buy inputs? [] (Y for yes, N for no)

If yes, which inputs did you find difficult to buy?

1. _____

2. _____

3. _____

Why was it difficult to buy them?

0 they are seldom in stock [__, __, __] (fill in 1, 2 and/or 3 as applicable)

0 distance [__, __, __]

0 too expensive [__, __, __]

0 lack of information on the products [__, __, __]

0 lack of information on where to obtain [__, __, __]

0 other: _____ [__, __, __]

SECTION E FARM ACTIVITIES AND INCOME

E/1 Who in the household is responsible for.(Mention the following activities)?

Who decides on the activity and who carries it out? How much time do you estimate, that it costs?

*After the first questions on land preparation, ask for the crop activities whether there is a difference between who attends to the food crops and who to the cash crops. Crop activities include vegetables. See***

Ask: Is there a difference between who is attending to the food and who to the cash crops?

[] (Y for yes, N for no)

If yes, fill in separately for food and cash crops.

ACTIVITIES:	HH member(s) deciding ♦	HH member(s) carrying out♦
1. Activities related to crops	[]	[]
2. Collecting feed / forage (cut and carry) for cattle	[]	[]
3. Stall feeding of cattle	[]	[]
4. Herding of cattle	[]	[]
5. Cleaning cattle confinements, e.g zero-grazing unit / shed / bomas	[]	[]
6. Milking of cows	[]	[]
7. Delivery of cow milk	[]	[]
8. Spraying / dipping cattle	[]	[]
9. Seeking assistance of veterinary services	[]	[]
10. Seeking advice and / or extension	[]	[]
11. Seeking AI services	[]	[]
12. Activities related to other L/S	[]	[]
13. Domestic activities, such as cooking, cleaning, child care, care for relatives, fetching water for the household, etc.	[]	[]
14. Off farm activities (specify)_____	[]	[]

♦ Identify the one or two most important HH members, who decided about and who performed these tasks for the last 12 months (Use numbers corresponding to the HH members in table A/3)

E/2 Who decides on the..... ?

Decision topic	HH member deciding
1. Sales of cattle	[]
2. Purchases of cattle	[]
3. Sales of other animals	[]
4. Purchases of other animals	[]
5. Sales of crops	[]
6. Sales of vegetables	[]
7. Quantity of milk to sell / quantity for home consumption	[]
8. Purchase of food items for home consumption	[]
9. Purchase of milk for homeconsumption	[]

E/3 Who obtains / pays for.... ? How much is received or paid for.....?

Obtaining does not just mean receiving, it means having decision power over that money.

	HH member(s)	Money involved (Kshs.) *
1. This last month who obtained milk payments and how much was it		
2. This last year who obtained payments of cattle sales and how much was it		
3. This last month who paid for cattle feed / forage		

4. This last year who pays for veterinary services		
5. This last year who pays for AI services		
6. This last year who pays for schoolfees		
7. This last year who obtains off farm income (specify) _____		

* If payments and gains are in kind, translate into Kshs. and make a note. (e.g. one chicken = 200 Kshs, or 300 Kshs.)

SECTION F GOALS, OBJECTIVES AND INNOVATIONS

F/1 There are several goals a farmer can have in farming. *Read goals a. to e. and ask which very important goals are missing. Do not add more than 3 additional goals.)*

Then ask the farmer to rank all the goals. Fill in 1 for the most important , 2 for the second most important, etc.)

Can you please rank the goals according to their importance to you.

- a. Earn as much money as possible

[____]
- b. Enjoy my work

[____]
- c. Pass a viable farm onto my children

[____]
- d. Earn respect for being a good farmer

[____]
- e. The farm must feed us today

[____]
- f. Other (specify) _____

[____]
- g. Other (specify) _____

[____]
- h. Other (specify) _____

[____]

F/2 Farms can do well or poorly due to factors that the farmer has no control over or due to factors that are within his / her control. Of the factors that the farmer has no control over, what are the factors in your situation that benefit your farm and what are the factors that constrain your farm?

The two major opportunities (*no control- benefits*) for your farm? _____

The two major constraints for your farm? _____

Of the factors that the farmer can have control over, what are the factors in your situation that benefit your farm and what are the factors that constrain your farm?

The two major strengths of your farm: _____

The two major weaknesses of your farm: _____

F/3 What do you expect your farm to be like in 5 years time?

☐ It will have remained the same

☐ It will have become larger in scale

☐ It will have become smaller in scale

☐ It will have higher yields per acre

☐ It will have lower yields per acre

☐ I will have sold my farm

☐ I will have moved to another farm

☐ Other (specify) _____

F/4 What innovations do you expect to do in the next 5 years?

☐ I will acquire more land

☐ I will use (more) modern crop varieties

☐ I will upgrade my cattle (further)

☐ I will start (a) new enterprise(s) *Specify:* _____

- 0 I will specialise in one or two enterprises for income generation (market orientation)
- 0 I will buy transport means, so I can market my products (*this does not include replacements*)
- 0 I will buy new tools *Specify:* _____
- 0 I will buy new machinery *Specify:* _____
- 0 I will change to a zero grazing unit
- 0 I will build a new house
- 0 I will build new animal houses
- 0 I will have bought a watertank
- 0 Other (specify) _____

(Innovations are new investments (so not replacements) They can be a change in management strategies, purchase of land, construction of a zero grazing unit, adoption of napier grass, etc.)

F/5 Which innovations did you do over the last 5 years? When and what were the results?

Innovation	When (year)	Outcome (good / bad)	Main reason for outcome
1.		[]	[, ,]
2.		[]	[, ,]
3.		[]	[, ,]
4.		[]	[, ,]
5.		[]	[, ,]
6.		[]	[, ,]
7.		[]	[, ,]
8.		[]	[, ,]

Examples main reason for outcome

- 1 = Increase of yield
- 2 = Increase of yield per acre
- 3 = Increase of income
- 4 = Saving labour
- 5 = Less risk

- 6 = Increasing labour
- 7 = Economical loss
- 8 = Lack of knowledge
- 9 = Prestige
- Other (specify) _____

F/6 How do you learn about new possibilities for investment and innovation?

- 1 = from neighbours
- 2 = from relatives
- 3 = via advertisement (e.g. posters, billboards)
- 4 = via newspapers
- 5 = via extension
- 6 = self help group
- 7 = via shops
- 8 = via radio
- 9 = from a cooperative
- 10 = from agricultural shows
- 11 = from field days
- other (specify) _____

SECTION G L/S AND L/S (CATTLE) DISEASE MANAGEMENT

G/1 Please, indicate the type of feeding system practised on your farm for each category of cattle:

Cattle category*		Feeding system
[]	[]	[]
[]	[]	[]
[]	[]	[]
[]	[]	[]
[]	[]	[]

Feeding systems

- 1 = Only stall-feeding
- 2 = Mainly stall-feeding with some grazing
- 3 = Equal combination of stall-feeding & grazing
- 4 = Mainly grazing with some stall-feeding
- 5 = Only grazing (free or tethered)
- Other (Specify)

* First column: A = grade, B = crossbred, C = zebu,

Second column : 1 = suckling calf, 2 = weaner, 3 = heifer, 4 = cow, 5 = mature bull

G/2 For those who practise stall-feeding (with or without some grazing), ask the following questions.

What do you stall-feed (and for grass and hay in which season)?

☐ grass

from to..... (fill in months)

☐ hay

from to..... (fill in months)

☐ napier

☐ supplements

☐ fodder trees

☐ banana stems

☐ potato vines

☐ maize stover

☐ other (specify)

What are the main sources of fodder? ☐ own farm

☐ roadside, or other public grazing grounds

☐ own distant shambas

☐ from other farmers, traders, etc.

☐ other (specify)

When do you stall-feed?

☐ throughout the year

☐ dry season

☐ wet season

G/3 For those who practise grazing (with or without some stall-feeding), ask the following questions for each category of cattle that is grazed.

Cattle category*		Frequency of grazing	Season of grazing	Where grazed	Grazing pattern
[]	[]	[]	[]	[]	[]
[]	[]	[]	[]	[]	[]
[]	[]	[]	[]	[]	[]

- First column: A = grade, B = crossbred, C = zebu,
- Second column : 1= suckling calf, 2 = weaner, 3 = heifer, 4 = cow, 5 = mature bull

Frequency

1 = < 30 d/yr.
 2 = >30 and <120 d/yr
 3 = > 120d/yr
 4 = the whole year

Where grazed

1 = on-farm
 2 = road side
 3 = communal
 4 = own distant shamba(s)
 Other (specify) _____

Season

1 = throughout year
 2 = dry season
 3 = wet season

Grazing pattern

1 = same paddock /grazing area throughout
 2 = several paddocks/grazing areas in rotation

G/4 What according to you, are the three most important cattle diseases in your area?

For each disease, what are the reasons for it being important?

For each disease, what are the three most important clinical signs?

Reasons for being important

Disease	Reasons for being important	Clinical signs
1. []	[, ,]	[, ,]
2. []	[, ,]	[, ,]
[, ,]	[, ,]	[, ,]

D = Death
 P = Production loss
 T = Transmission, speed of spread
 C = Cost of treatment
 L = Duration of illness
 PP = Loss of production potential
 O1 = Other _____

Clinical signs

F = Fever
 C = Cough
 D = Diarrhoea
 Lnn = Lymphnode swellings
 A = Anorexia, loss of appetite
 F = Feaces hard
 S = Skin damage

P = Production loss
 U = Urine black
 B = Blisters, sores
 □ = Death
 O1 = Other _____
 O2 = Other _____
 O3 = Other _____

G/5 Recall whether the farmer reported having lost cattle due to diseases (refer to C/3, if necessary).

Did any of your cattle fall sick over the last 12 months?[] (Y for yes, N for no) If yes,

Cattle ID / name	Cattle category*		Name of disease	Signs	When was sick (months)**	Outcome
	[]	[]	[, ,]	[,]	-	[]
	[]	[]	[, ,]	[]	-	[]
	[]	[]	[, ,]	[]	-	[]

* First column: A = grade, B = crossbred, C = zebu,

Second column : 1= suckling calf, 2 = weaner, 3 = heifer, 4 = cow, 5 = mature bull

** Fill in the month of disease onset and the month when the disease disappeared.

Disease name

FMD = Foot and Mouth Disease
A = Anthrax
ECF = East Coast Fever
Ap = Anaplasmosis
Bb = Babesiosis
D = Diarrhoea
Res = Respiratory disorders / pneumonia
LSD = Lumpy Skin Disease
MF = Milk Fever
M = Mastitis
H = Helminthosis
E = eye infections

Td = tick damage
Bq = Black quarter
Fr = Foot rot
Tryp = trypanosomosis
RP = Rinderpest
Hw = heartwater
Bc = Brucellosis
Rab = rabies
CL =Cattle louse
Other pecify)_____

Disease outcome

TD = treated and died
TR = treated and recovered
TNR = treated and not fully recovered
NTD = not treated and died
NTR = not treated and recovered
NTNR = not treated and not fully recovered
S = sold, slaughtered
D = died of something else
O = other (specify) _____

G/6 Do you ever see ticks on the skin of your cattle? [] (Y for yes, N for no)

If no, please give reasons: 1 = there are no ticks in the area
2 = the cattle do not go anywhere near ticks
3 = the cattle are treated with acaricides
4 = I do not know
Other (specify)_____

If yes, please describe what they look like, where they are attached and when you see them most?

Tick location on animal	Tick colour	Tick numbers	Season when tick occurs	Month when tick numbers are largest
[]	[]	[]	[]	[]
[]	[]	[]	[]	[]
[]	[]	[]	[]	[]

<u>Tick Location</u>	<u>Tick colour</u>	<u>Tick numbers</u>	<u>Season</u>
1 = ears	1 = brown	1 = < 5(v. few)	1 = wet season
2 = neck & body	2 = blue (dog tick)	2 = 5 –10	2 = dry season
3 = under the tail	3 = colourful	3 = 10-30 (many)	3 = throughout the year
4 = chest/udder/scrotum	4 = other (specify) _____	4 = >30 (very many)	4 = other (specify) _____

G/7 1. How do ticks infest cattle? Where do they come from?

- 0 via air
0 via contact with other animals
- 0 via the mother
0 other _____

What do ticks do to cattle?

- 1 = I do not know
- 2 = nothing
- 3 = make the animal sick, cause disease
- 4 = suck blood / weakens the animal, but does not cause disease
- 5 = damage the skin
- 6 = reduces (milk)production
- Other (specify) _____

For those who did not mention option #3 (ticks can cause disease), ask them:

Can ticks cause disease in cattle? 1 = Yes 2 = No 3 = I do not know

Continue the rest of F/7 only for those who think ticks cause disease (thus the ones who mentioned #3 or answered yes to the previous question):

2. Do all ticks cause disease? 1 = Yes 2 = No 3 = I do not know

3. Do all ticks cause the same disease(s)? 1 = Yes 2 = No 3 = I do not know

4. How many ticks are necessary to make an animal sick?

1 = one 2 = only a few (< 10) 3 = many (10 – 30)

4 = very many (> 30) 5 = I do not know

5. Which diseases in this area are caused by ticks? (English / local names)

1 _____

2 _____

3 _____

4 _____

5 _____

G/8 1. What can be done to effectively prevent cattle from being infested by ticks?

1= I do not know

6 = acaricide spraying

2= nothing

7 = acaricide dipping

3= remove them by hand

8 = restricting grazing

4 = pye grease

9= clip the tail swish

5 = acaricide handwash

Other (specify) _____

2.What have you done to prevent your cattle from being infested by ticks over the last 12 months?

Tick control practice	Frequency	Effectiveness	Chemicals used	How applied
Restricted grazing	[]	[, ,]	NA	NA
Remove by hand	[]	[, ,]	NA	NA
Pyegrease	[]	[, ,]	[, ,]	[]
Ac. Handwash	[]	[, ,]	[, ,]	[]
Ac. Spray	[]	[, ,]	[, ,]	[]
Ac. Dipping	[]	[, ,]	[, ,]	[]
Nothing	NA	[, ,]	NA	NA
Other specify) _____	[]	[, ,]	[, ,]	[]

Frequency	Effectiveness	Chemicals
1 = once a week	1 = Not effective	1 = Triatix
2 = twice a month	2 = Protects damage to hides well	2 = Almatix
3 = once a month	3 = Protects damage to hides not well	3= Supona
4 = once a year	4 = Protects from diseases caused by ticks well	4 = Taktic
Other (Specify) _____	5 = Protects from diseases caused by ticks not well	Other _____
	6 = Avoids getting into trouble with government	
	Other (Specify) . _____	

For the ones not thinking that ticks cause disease (ECF) and who did not mention

ECFunder G/7.5, ask:

Do you know East Coast Fever (ECF)? [] (Y for yes, N for no)

If no, skip question G/9 entirely

G/9 1. What can be done when cattle are infected by TTBD's, in particular ECF?

- 1 = I do not know
- 2 = nothing
- 3 = acaricides
- 4 = tetracyclines, butalex
- 5 = berenil
- 6 = herbs

7 = pray, wait and see 8 = consult a vet 9 = slaughter / sell

Other (specify) _____

2. What have you done if or when your cattle was infected by ECF?

1 = Not applicable, cattle have not been infected

2 = Nothing

3 = Pray, wait and see

4 = We collected and gave herbs ourself

5 = We called a herbspecialist

6 = We bought drugs and treated the sick animal ourself

7 = We called for veterinary assistance

8 = We burnt the lymphnodes ourself

9 = We called a specialist for burning the lymphnodes

10 = Isolation

Other (specify) _____

Do you take the same prevention measures for all your cattle, regardless of age, breed or sex

? [] (*Y for yes, N for no*)

Are cattle of all age categories affected in the same way by ECF?

0 yes

0 calves are more severly affected than adults

0 adults are more severly affected than calves

0 I do not know

How much did you spend in total for all your animals to prevent ticks and ECF over the past
12 months?

How much in total did you spend on ECF treatments over the past 12 months?

G/10 People, although they know it is better to do certain things to avoid problems, such as the problems of ticks and ECF, may find themselves not doing it. In your case, what are the reasons for that difference in knowing and doing with regard to the prevention of ticks and ECF?

1 = I do all that I know

2 = lack of cash

3 = shortage of labour

4 = poor availability or accessibility of the prevention

measures (specify)_____

5 = poor quality of the prevention measures specify)_____

6 = other more pressing priorities (specify)_____

7 = I do not think ticks or ECF are a problem for my cattle

8 = I generally do not care about the animals / diseases / tick-borne diseases (*strike out what is not applicable*)

9 = I do not know what the reasons are

Other (specify)_____

G/11 1. Are you familiar with cattle vaccines? [] (Y for yes, N for no)

Which vaccines do you know? Can you give examples of vaccines?

1. _____

2. _____

3. _____

2. Have your cattle been vaccinated in the last 12 months? 1 = Yes 2 = No 3 = Don't know

If no, What is /are the reason(s) you do not use vaccines?

☐ the diseases are not common in the area

☐ my cattle is not exposed to the diseases

☐ my cattle is not susceptible

☐ it is too much hassle (labour, distance, other transaction costs)

☐ they are expensive

☐ they make the cows sick (safety)

☐ the vaccines do not work (effectivity)

☐ vaccines work only for very short (longivity)

☐ the meat or milk after vaccination are dangerous

☐ other (specify) _____

☐ I do not know

If yes, What cattle vaccinations were given on this farm in the last 12 months?

- circle the right answer

Vaccine	Against what diseases?	Who vaccinated?	Asked or told to vaccinate	Vaccine source	Total cost - KSh./animal	Would you vaccinate again?
1.	[]	[]	A / T*	[]		Y / N*
2.	[]	[]	A / T	[]		Y / N
3.	[]	[]	A / T	[]		Y / N

Diseases

FMD = Foot and mouth
 ECF = ECF
 A/B = Anthrax/Black leg
 NN = Don't know
 O = Other _____

Who vaccinated

1 = Self/neighbour
 2 = Govt Vet/AHA
 3 = Private vet/AHA
 4 = Co-op
 5 = Other (Specify) _____

Source

1 = Govt vet /AHA
 2 = Co-op
 3 = Private vet /AHA
 4 = Other (Specify) _____

3 Why did you vaccinate your cattle?

1 = I do not know

2 = It protects from the disease

3 = It cures sick animals

4 = It fattens the animal

5 = I was told to do so by the govt. /co-op

6 = Other (specify) _____

For those who vaccinate because they are told,

Would you have your cattle vaccinated, if the government did not announce it?

1 = Yes 2 = No 3 = Don't know

For those who are familiar with ECF (and answered question G/9), ask the next questions:

4 Would you vaccinate against ECF, if there were a vaccine available?

1 = Yes 2 = No 3 = Don't know

5 Would you vaccinate the whole herd against ECF or only for certain cattle?

0 whole herd

0 calves only

0 adults only

0 all except the zebu

0 other (specify) _____

_____ **REST OF THE QUESTIONNAIRE FOR ALL** _____

No.	Card number: farmer's ranking
1.	(most preferred card)
2.	
3.	
4.	
5.	
6.	
7.	
8.	(least preferred)

G/13 CONTINGENT VALUATION (see separate sheet)

SECTION H OPINIONS, PREFERENCES AND PRIORITIES

(Ask for each question whether the respondent agrees or disagrees and then to what extent and tick the appropriate box . Ask to give his / her first thought. We need intuitive answers)

- = disagree fully

0 = neutral

+ = agree fully

H/1 1. All good farmers.....

- a. work hard
- b. have big farms
- c. have a lot of cows

-0+

-0+

-0+

-0+

-0+

-0+

- d. are clever
- e. attend courses, workshops, meetings, etc.
- f. market (part of) their produce
- h. feed their family well
- i. make their farm bigger
- j. are very time conscious (e.g. planting, milking, etc.)
- k. have higher yields per acre than others
- l. spend more on inputs
- m. act on what may happen in the future
- n. other: _____

-	0	+
-	0	+
-	0	+

2. Feeding the family well is more important than re-investing in the farm

- 3. Modern farming techniques will change traditions
 - 4. I fear ECF more than any other cattle disease
 - 5. Zebus produce less than grades,
- but the quality of the products (milk, meat and manure) is better
- 6. I attend training events and meetings as much as possible
 - 7. Vaccines are safer than drugs

-	0	+
-	0	+
-	0	+
-	0	+

8. The only reason I do not have grade cattle is, that I have not enough feed
- 9. It is important to stay with tradition, because it is what we know
 - 10. Paying school fees is more important than expanding the farm
 - 11. Using acaricides for the whole herd all year round is better than having to treat ECF cases

-	0	+
-	0	+
-	0	+
-	0	+

12. The only reason for not having grades is, that I cannot afford
to buy one

13. It is important to make sure that you do not loose what you have

14. The only reason I do not have grade cattle is, that I fear it to die

15. I am always eager to try something new

16. I cannot buy enough inputs to produce enough food for the
family

17. I make absolutely sure I have enough good quality seeds
to secure a harvest that will support the family

18. Parties are fun and make you forget your difficulties

19. I sell harvest surplus, because I fear it will go to waste

20. It is better to take a risk and may be do better in the future,
than never try and always stay where you are

- 21. Other farmers often ask me for advice
- 22. Confining cattle in zero grazing units requires less labour time than herding
- 23. If I harvest more than I need for home consumption I sell it, because I need the cash
- 24. Other farmers often ask me for favours, like loans or employment
- 25. It is better to invest time and money in other enterprises than dairying

(Do not forget to thank the farmer genuinely!)

- 0 +
- 0 +
- 0 +
- 0 +
- 0 +

To be answered privately by the enumerator immediately following the interview

(1) In your opinion, how did you establish rapport with this respondent

- 1 = with ease 2 = with some persuasion 3 = with difficulty
- 4 = it was impossible

(2) Overall, how did the respondent give answers to your questions?

- 1 = willingly 2 = reluctantly
- 3 = with persuasion 4 = it was hard to get answers

(3) How often do you think the respondent was telling the truth?

- 1 = rarely 2 = sometimes 3 = most of the time 4 = all the time

(4) I certify that I have checked the questionnaire two times to be sure that all the questions have been answered, and that the answers are legible.

Signed _____ Date ____/____/____

APPENDIX 4: Hypothetical Scenario 1

(Prepared by Dr. T. F. Randolph, ILRI)

Willingness to pay for an ECF vaccine (sub-unit vaccine)

I would like to give you some information about a vaccine against ECF that might become available here in a few years. You would buy it from a vet or a paravet who would give your animal two shots- a first one and then another 4 weeks later. You would need to pay for another shot once every two years from then on. You must understand, though, that like the foot-and-mouth disease vaccination, the shot doesn't always work: one of ten cattle that would have gotten sick with ECF still might get sick with ECF anytime even after getting the shot. The shot also doesn't stop your cattle from getting other diseases from ticks like anaplasmosis, so you may still need to dip your cattle or use pour-ons, if you do those now, though possibly less than before.

(1) Based on what I have told you, do you think that you have enough information to know what it would be like to use the vaccine and its benefits in order to decide whether you would want to use it?

YES

NO

(circle answer)

If No: go through the explanation again and/or ask if the respondent has specific questions.

I now want to ask you about how much you would be willing to pay for each of your cattle to be vaccinated against East Coast fever if the new vaccine were to be made available here. This is the price that you would pay in cash to the vet at the time the shot is given. You should think of what you know is the risk and danger of ECF in this area and how important you feel it is to keep your cattle from getting the disease. I am going to ask you if you would be willing **and able** to pay a specific amount for the shot. Please answer 'yes' only if you are sure that you would pay. Please do not answer 'yes' if you cannot afford it, or you feel that you have more important things to spend your money on.

(2) What if the vaccination costs----- KSH for each animal, would you be willing to pay this amount?

	YES	NO*
(3) If Yes: would you be willing to pay----- KSH? (+25%)	YES	NO

(4) If No: would you be willing to pay -----KSH (-50%)	YES	NO*
---	------------	------------

<i>Are answers to (2) and (4) both NO*:</i>	YES: <i>Then ask Question (5)</i>
	NO: <i>Stop here</i>

(5) You have told me that you will not be willing to buy the vaccination at the two prices that I proposed. Which of the following reasons best describes why you wouldn't be willing:

- I could afford to pay, but don't think that my cattle are in danger of getting ECF (the risk is sufficiently low).
- I could afford to pay, but don't believe that the shot would bring about the benefits described.
- I could afford to pay, but I don't want to buy something that I must repeat every year.
- If the shot doesn't guarantee 100% that my cattle won't get ECF, then it is not worth it to me.
- I cannot afford to pay, but would be interested in buying the shot if it was much cheaper.
- None of the above, specify other:-----

APPENDIX 5: Hypothetical Scenario 2

(Prepared by Dr. T. F. Randolph, ILRI)

Willingness to pay for ECFiM (ITM)

I want to give you information about a vaccine against ECF that might become available here soon. It is called ECFiM and sold to vet by Cooper. You would buy it from a vet who would give your cattle a shot just once. The shot contains both the vaccine and antibiotics so that your cow doesn't get sick. Despite the antibiotics given with the vaccine, cattle sometimes get sick with ECF during the month following the shot, so the vet has to come back every couple of days during that month to make sure that none of the cattle are getting sick. Only one in a twenty cattle get sick with ECF in the month following the shot, and they are almost always cured if the vet is checking regularly during that time. You would never need to repeat the shot for an animal. You must understand, though, that like the Foot-and-Mouth Disease vaccination, the shot doesn't always work; one out of ten cattle that would have gotten sick with ECF anytime even after getting the shot. The shot also doesn't stop your cattle from getting other diseases from ticks like anaplasmosis, so you may still need to dip your cattle or use pour-ons, if you do those now, though possibly less than before.

(1) Based on what I have told you, do you think that you have enough information to know what it would be like to use the vaccine and its benefits in order to decide whether you would want to use it?

YES

NO

If No: go through the explanation again and/or ask if the respondent has specific questions.

I now want to ask you about how much you would be willing to pay for each of your cattle to be vaccinated against East Coast fever if ECFiM were to be made available here. This is the price that you would pay in cash to the vet at the time the shot is given. You should think of what you know is the risk and danger of ECF in this area and how important you feel it is to keep your cattle from getting the disease. I am going to ask you if you would be willing **and able** to pay a specific amount for the shot. Please answer 'yes' only if you are sure that you would pay. Please do not answer 'yes' if you think that you cannot afford it, or you feel that you have more important things to spend your money on.

(2)What if the vaccination costs----- KSH for each animal, would you be willing to pay this amount?

YES NO*

(3) If Yes: would you be willing to pay----- KSH? (+25%) YES NO

(4) If No: would you be willing to pay -----KSH (-50%) YES NO*

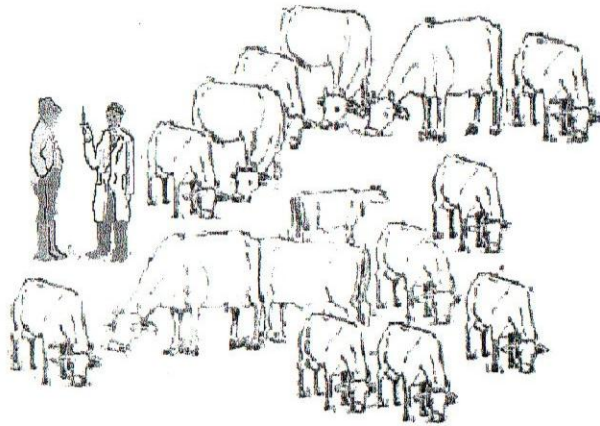
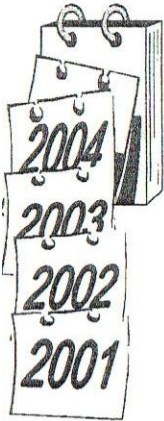
Are answers to (2) and (4) both NO*: ☐YES:Then ask Question (5)
☐NO: Stop here

(5) You have told me that you will not be willing to buy the vaccination at the two prices that I proposed. Which of the following reasons best describes why you wouldn't be willing:

- I could afford to pay, but don't think that my cattle are in danger of getting ECF (the risk is sufficiently low).
- I could afford to pay, but don't believe that the shot would bring about the benefits described.
- I could afford to pay, but I don't want to take the risk of my animal getting sick from the shot.
- If the shot doesn't guarantee 100% that my cattle won't get ECF, then it is not worth it to me.
- I cannot afford to pay, but would be interested in buying the shot if it was much cheaper.
- None of the above, specify other: -----

APPENDIX 6: Cards for eliciting farmer preferences

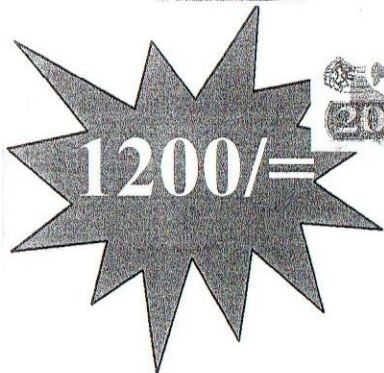
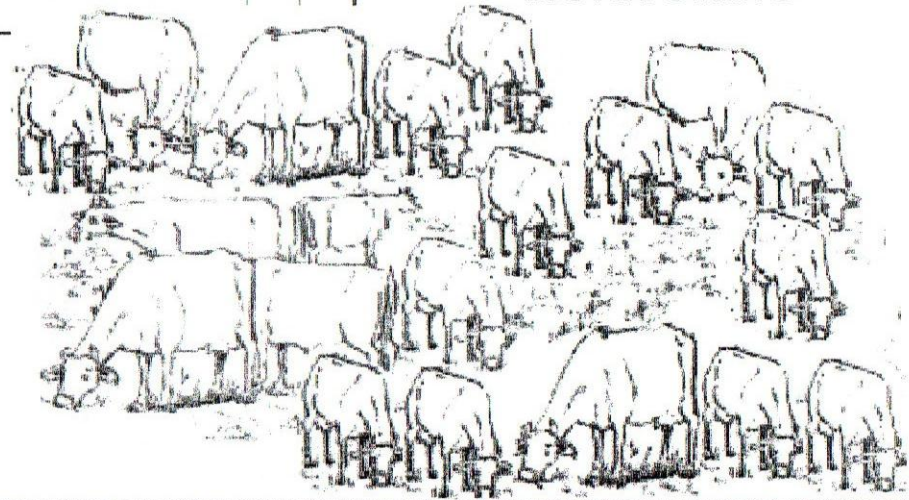
(Prepared by Dr. T. F. Randolph, ILRI)



MODERATELY EFFECTIVE

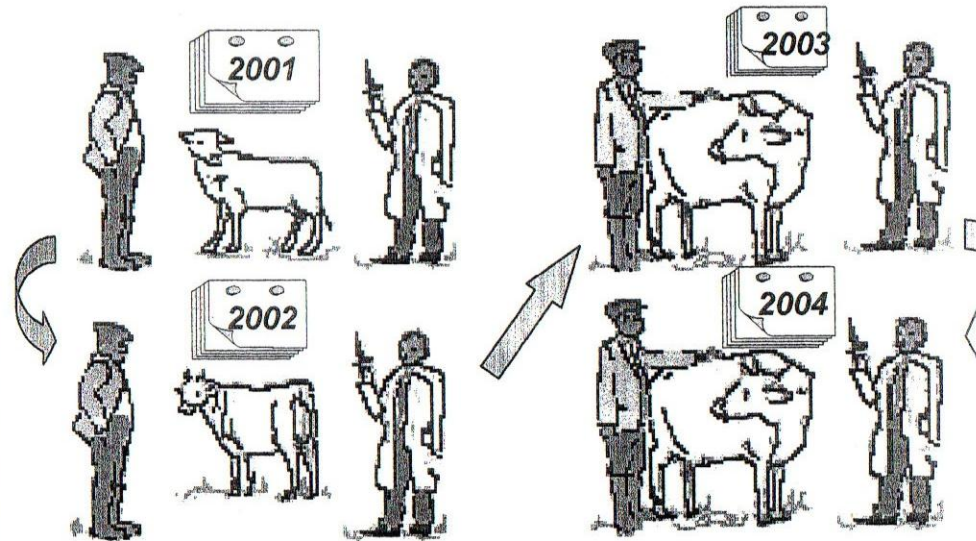
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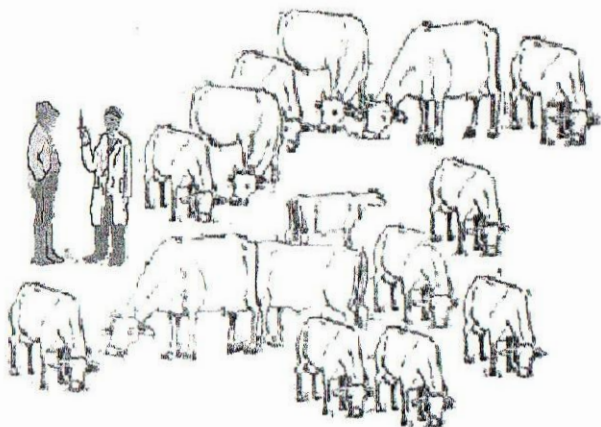
**NO SIDE EFFECTS,
SO NO
MONITORING**



**PRICE OF VACCINE
& SERVICE**

ANNUAL BOOSTERS REQUIRED

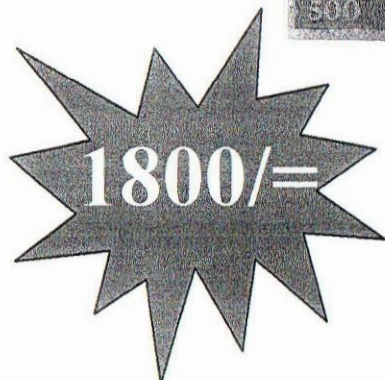
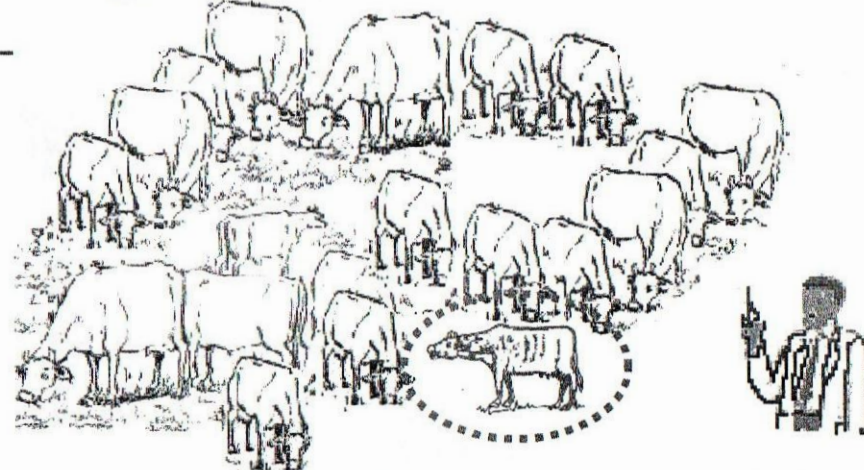




MODERATELY EFFECTIVE

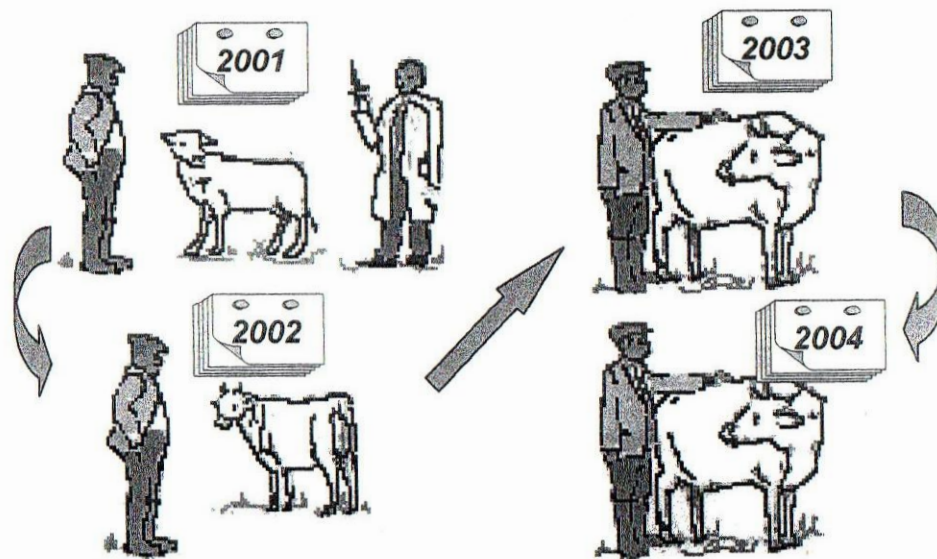
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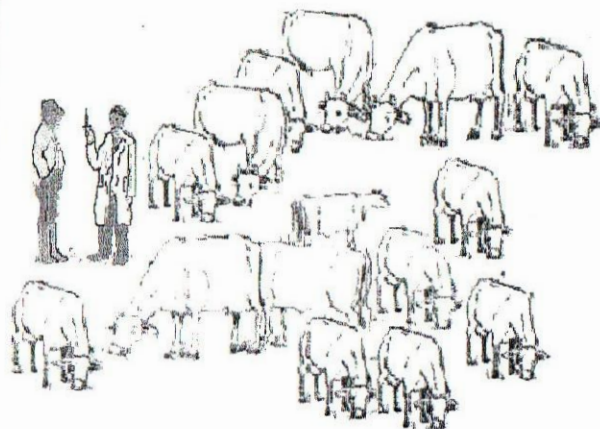
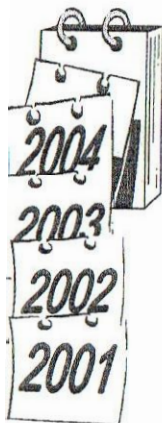
**POSSIBLE SIDE EFFECTS,
MONITORING REQUIRED**



**PRICE OF VACCINE
& SERVICE**

ONE-TIME VACCINATION

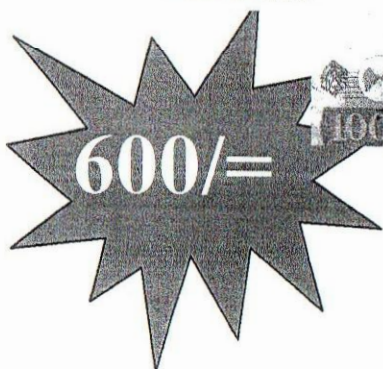
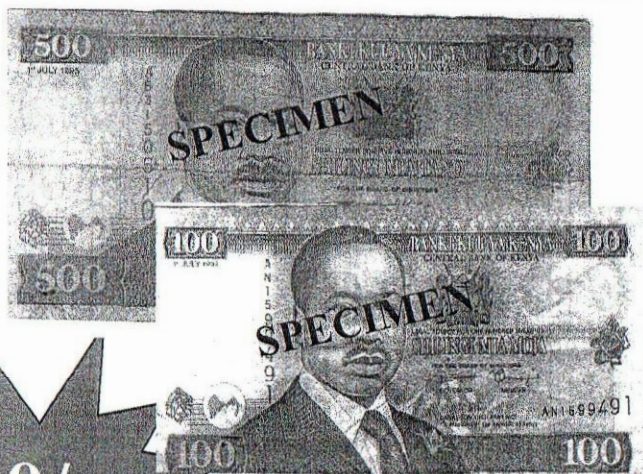
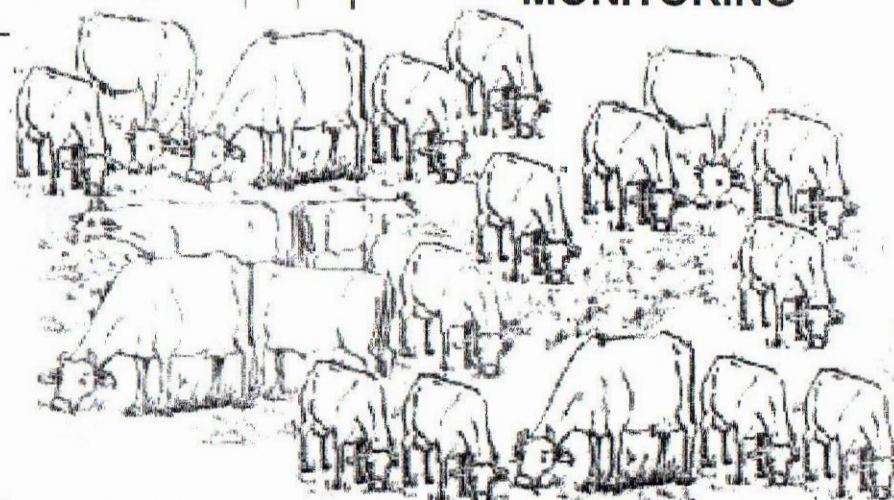




MODERATELY EFFECTIVE

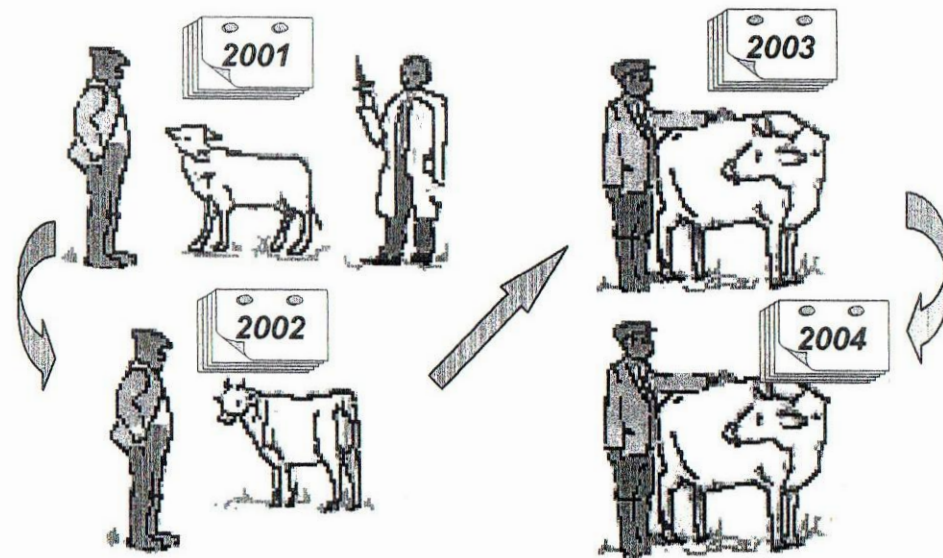
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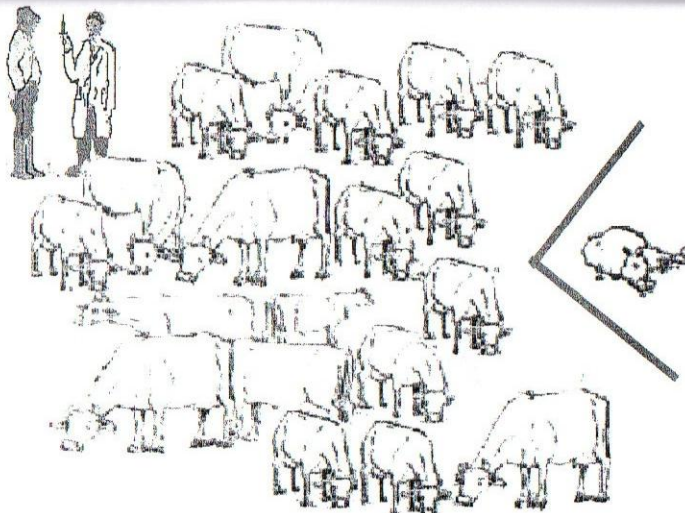
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SO NO
MONITORING**



**PRICE OF VACCINE
& SERVICE**

ONE-TIME VACCINATION

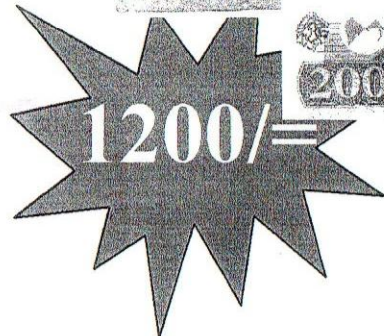
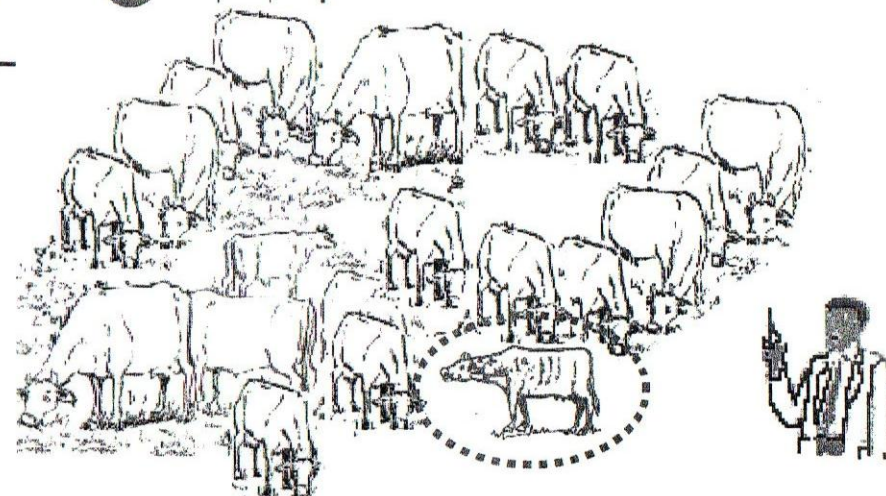




VERY EFFECTIVE

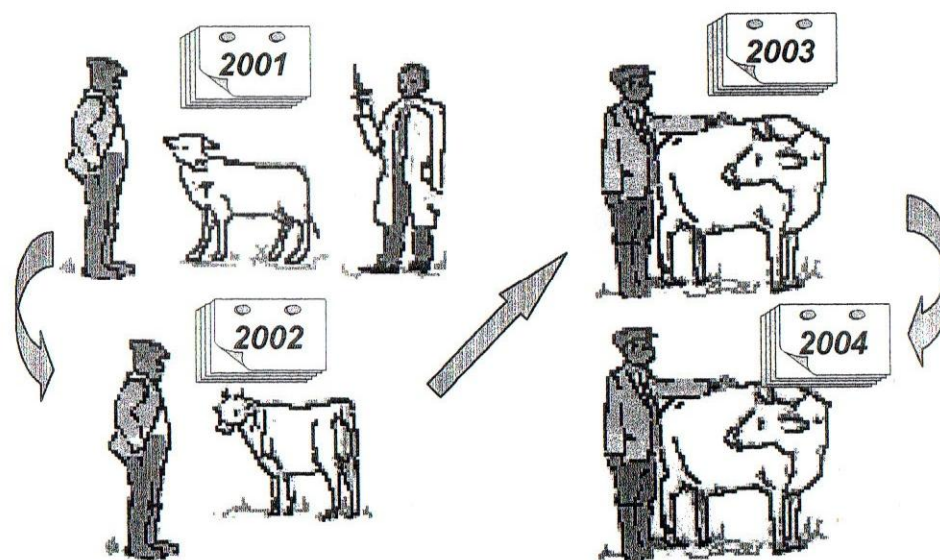
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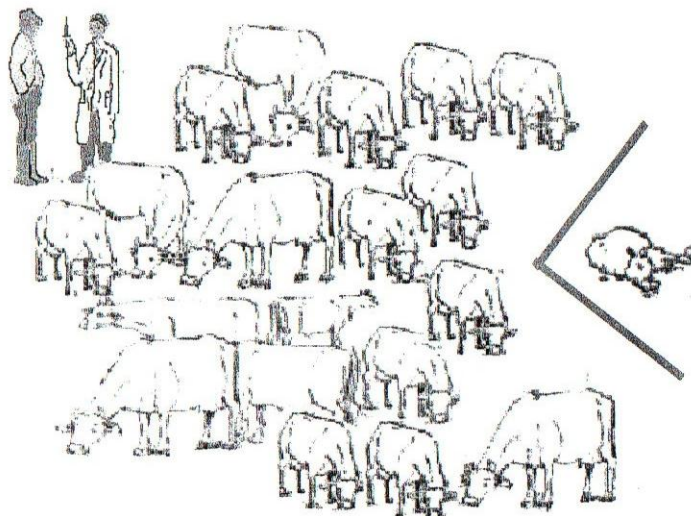
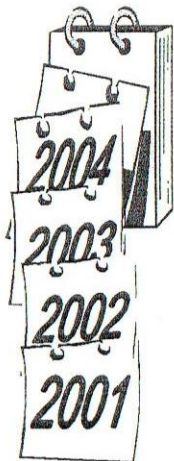
**POSSIBLE SIDE EFFECTS,
MONITORING REQUIRED**



**PRICE OF VACCINE
& SERVICE**

ONE-TIME VACCINATION

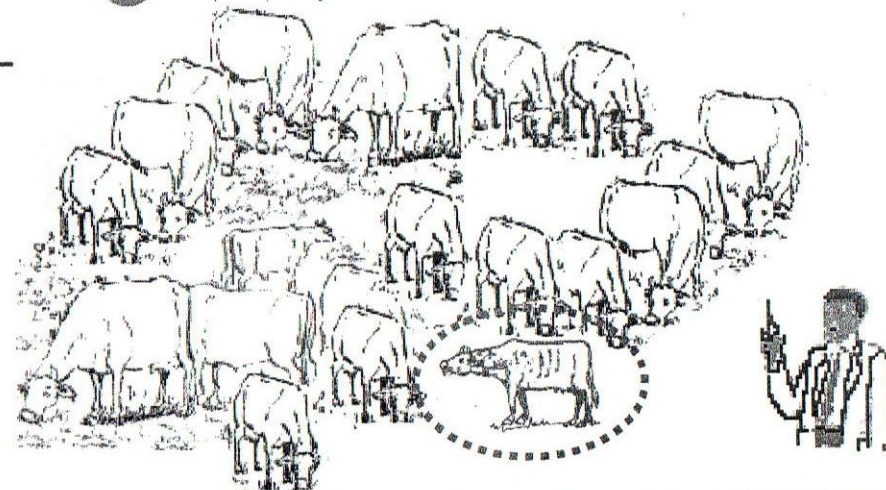




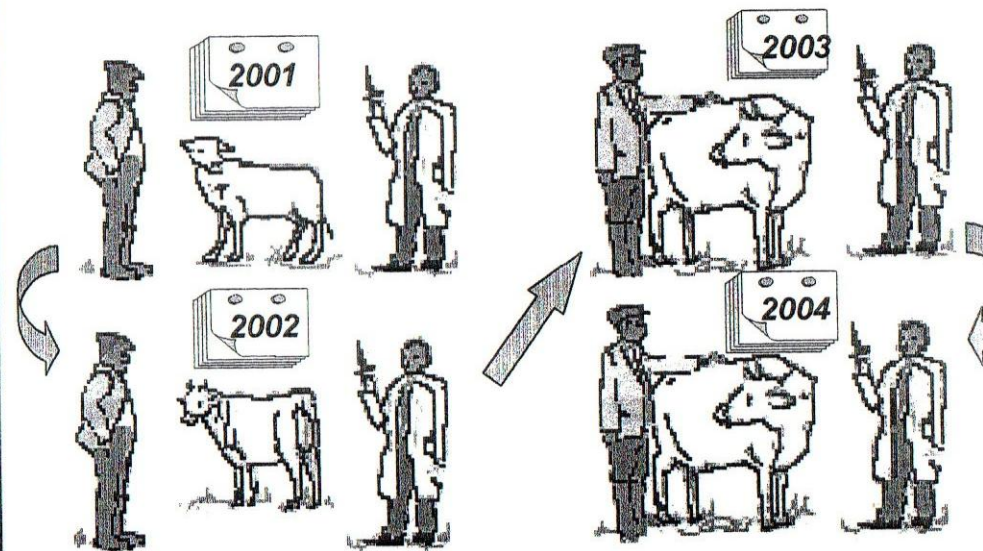
VERY EFFECTIVE

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**POSSIBLE SIDE EFFECTS,
MONITORING REQUIRED**

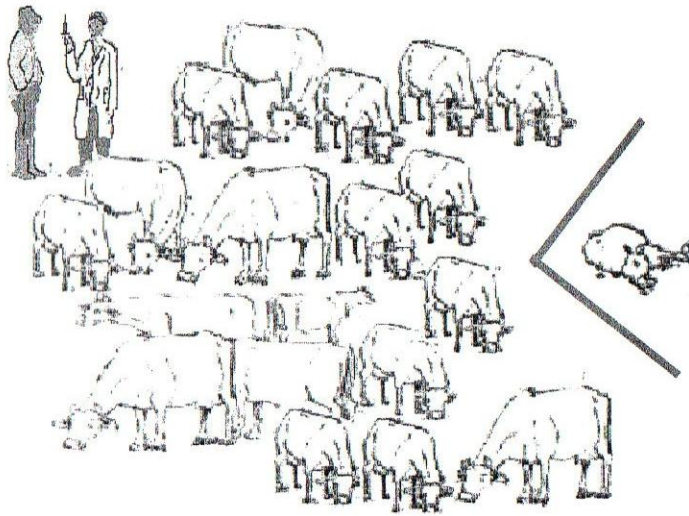


ANNUAL BOOSTERS REQUIRED



600/=

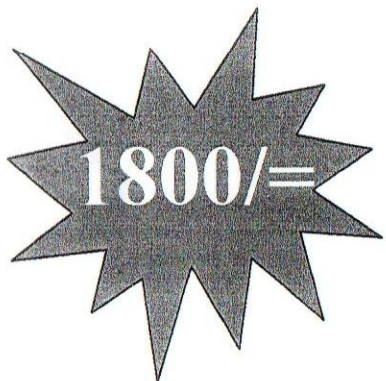
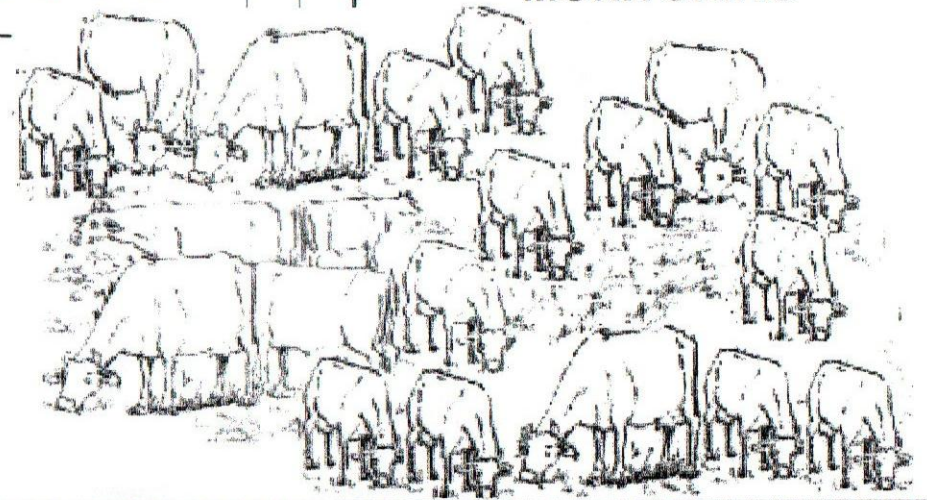
**PRICE OF VACCINE
& SERVICE**



VERY EFFECTIVE

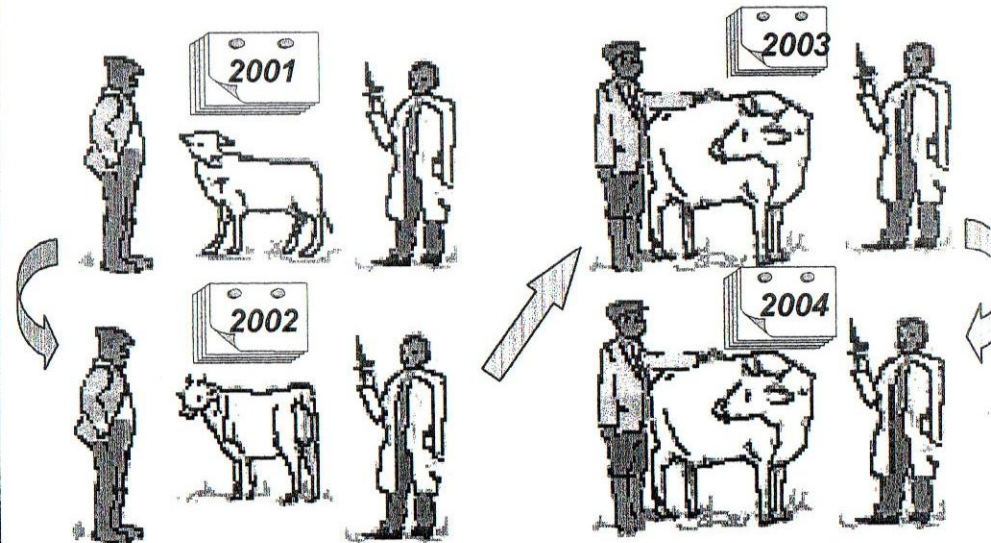
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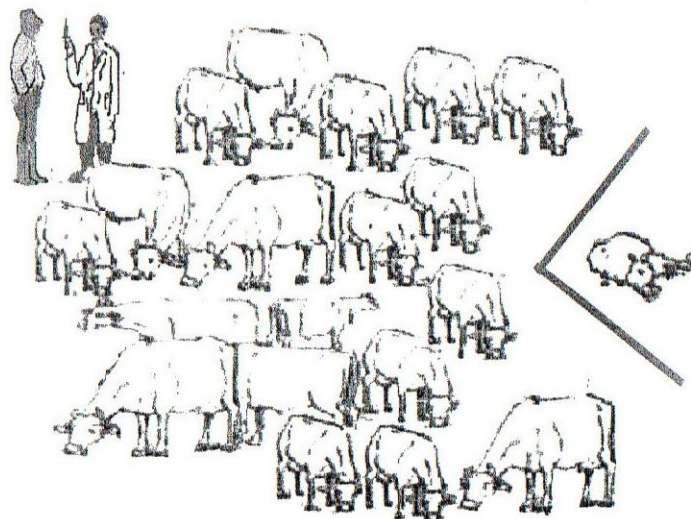
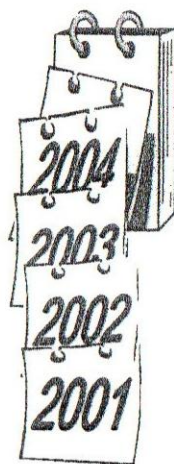
**NO SIDE EFFECTS,
SO NO
MONITORING**



**PRICE OF VACCINE
& SERVICE**

ANNUAL BOOSTERS REQUIRED

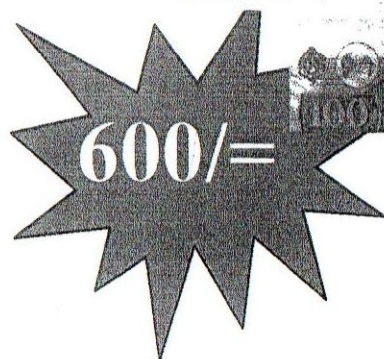
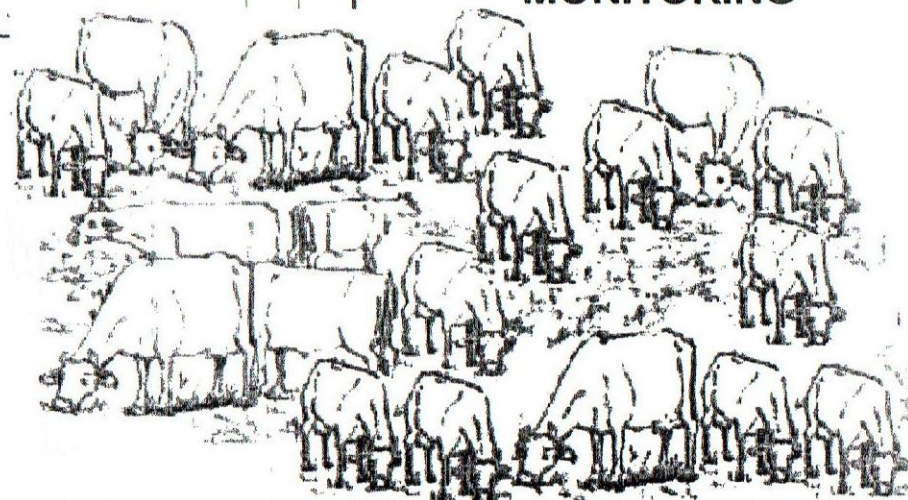




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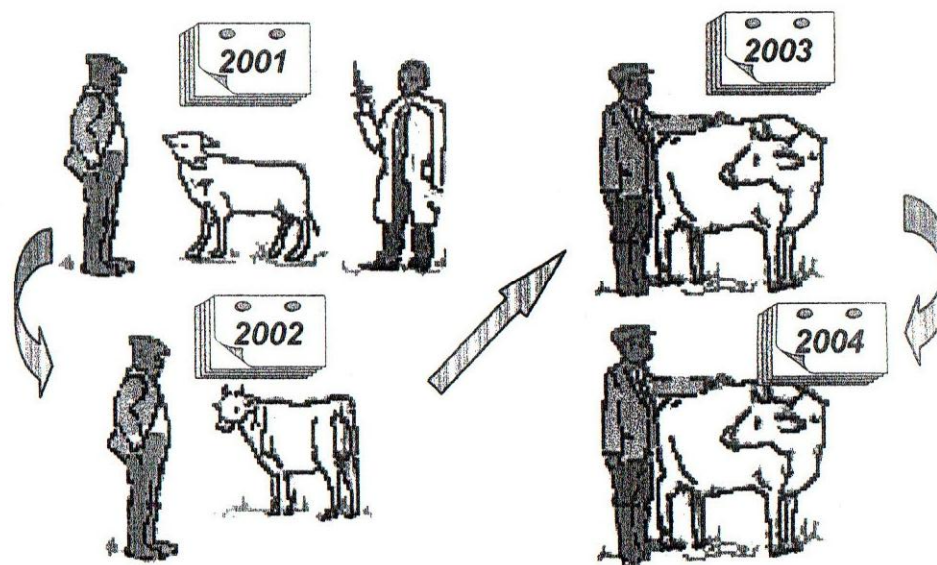
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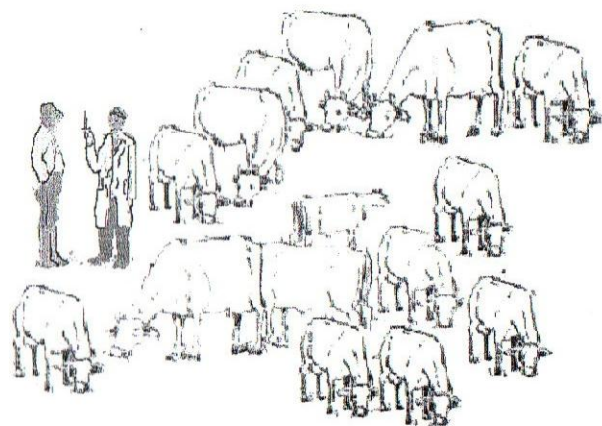
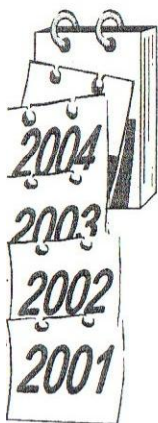
**NO SIDE EFFECTS,
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MONITORING**



**PRICE OF VACCINE
& SERVICE**

ONE-TIME VACCINATION

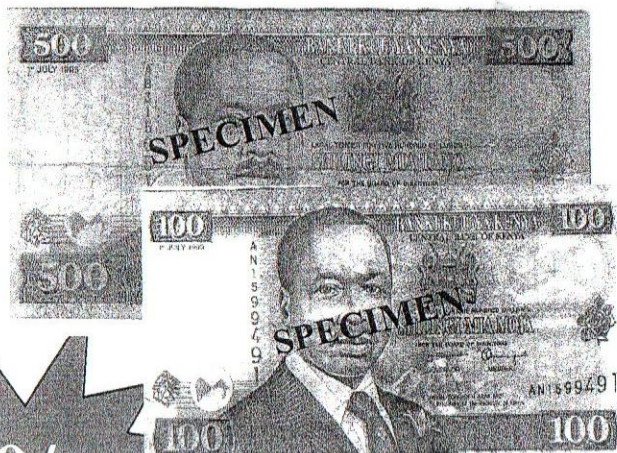
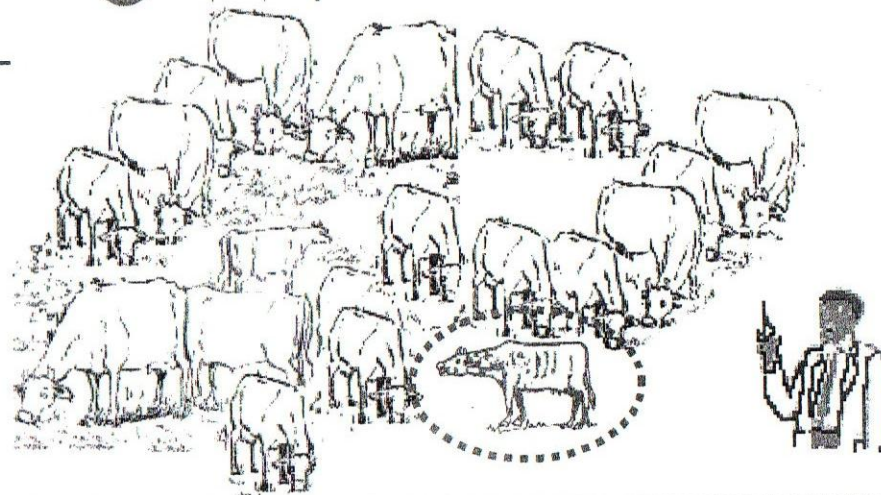




MODERATELY EFFECTIVE

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**POSSIBLE SIDE EFFECTS,
MONITORING REQUIRED**



600/=

**PRICE OF VACCINE
& SERVICE**

ANNUAL BOOSTERS REQUIRED

