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Partial Budgeting Analysis of Muguga Cocktail Vaccine on Pastoralists' Cattle in Narok County, Kenya

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Abstract:
A 3-month prospective cross-sectional study was carried out to determine partial budgeting analysis of infection and treatment method (ITM) using the Muguga cocktail vaccine on pastoralists calves in Narok district, Kenya. The study was carried out in Osupuko and Loita sub-counties in Narok County. Partial budgeting analysis recorded positive net returns, an indication of the profitability of the ITM technology. The ITM realized a net return of Ksh.1, 559.59 per immunized calf. This was significant in the study area since the average price of a calf was relatively low (Ksh.4, 700.00). High net returns are indicators of the high profitability of immunization. Thus, it can be concluded from the study that it is economically worthwhile to immunize calves against ECF in Narok County. If immunization against the disease is integrated with reduced acaricide usage, then accrued returns are even much higher.

Keywords: *Infection and treatment method, partial budgeting analysis*

1. Introduction

Partial budgeting analysis refers to the financial or economic analysis of only those parts of a production system that would be affected by the decision to be made (Sloan & Arnold, 1970). It is, thus, a decision-making tool, assisting in arranging information in such a way that the economic implications are clear. It is time-saving since analyzing only the relevant parts of the production system will take less time than analyzing the whole production system with and without the implementation of the decision. The basic framework for partial analysis is: (Brown, 1978; Putt et al., 1983).

Costs	Benefits
Extra Costs	Costs Saved
Revenue Loss	Extra Revenue

Table 1: The Basic Framework for Partial Budget Analysis

Partial analysis can be undertaken for one year or for a period of several years. If the analysis only covers one year, benefits and costs can be compared as shown:

a + b = Total costs and c + d = Total benefits
Net benefit = Total Benefits – Total Costs = (c + d) – (a + b)
Benefit-Cost ratio = Total Benefit / Total Costs = (c + d) / (a + b)

Table 2: The Partial Budget Analysis Computation for One Year

When looking at several years, the costs and the benefits should be quantified separately for each year, using the basic partial analysis framework. However, they cannot simply be added up, as shown immediately above. The comparison of costs and benefits should then be made according to the rules of discounting (Gittinger, 1973).

The four categories of benefits or costs provide a checklist for ensuring that all areas of cost and benefit resulting from the decision under consideration have been covered. If the decision is whether or not to implement a given livestock project, then the four components of the basic framework are some of the items that might be identified. It should be noted that all four categories will not always be needed. Many projects will not involve any revenue lost or cost saved. All projects will involve extra revenue (hopefully, unless the project is a failure) and extra costs (Brown, 1978; Gittinger, 1973; World Bank, 1981b).

1.1. Extra Costs

Extra costs consist of the basic costs of the livestock project. These could involve pasture improvement, housing improvement, extension inputs, nutritional supplements, disease control inputs such as veterinary interventions, drugs, disinfectants, fees for vaccinations and dipping (Brown, 1978; Gittinger, 1973; World Bank, 1981b). They also include extra time invested by the producer in implementing the project, although this may be difficult to value. Where livestock numbers increase as a result of the project, extra costs will also include the extra cost of maintaining the animals.

1.2. Revenue Lost

Revenue lost refers to revenue lost as a result of the type of project implemented. For many projects, there may not be any items to fill in revenue lost. Animal disease control provides some examples: a reduction in emergency slaughtering due to a reduction in mortality rates or a reduction in the value of the herd due to the slaughtering of diseased stock (Brown, 1978; Gittinger, 1973; World Bank, 1981b).

1.3. Costs Saved

Projects do not always involve cost savings, but these do occur where the project makes it possible to produce livestock products at a lower cost. Again, livestock disease control provides a useful example. Where a disease is present in the livestock population, a comprehensive control programme should lead to a reduction in the incidence or severity of the disease. This should lead to a saving in the costs of measures previously used to deal with the disease, especially in treatment costs and in time spent caring for the sick animals (Brown, 1978; Gittinger, 1973; World Bank, 1981b).

1.4. Extra Revenue

Extra revenue is usually the ultimate goal of a livestock project. In order to estimate it correctly, it is necessary to go through all the items included in the output calculation. According to Brown (1978), Gittinger (1973), and World Bank (1981b), it is often calculated as:

Extra revenue = output with the project minus output without the project

This works very well, but in this case, any revenue lost will usually be automatically accounted for in the above calculation and should not be estimated separately. For example, if there is a reduction in mortality due to disease control, the extra revenue or difference between output with disease control and output without disease control will reflect: a reduction in home consumption of animals due to emergency slaughter, an increase in the final herd value due to presence of these animals. Estimating the reduction in home consumption again separately under the heading revenue lost would thus not be correct in this case (Brown, 1973; Gittinger, 1973; World Bank, 1981b).

1.5. Financial Viability Studies

The aspect of ITM financial viability using the cost/financial analysis of ITM can be observed from studies carried out by different scholars as outlined below. Mbogo et al. (1994) carried out a study in Limuru and Kikuyu sub-counties of Kiambu County to assess morbidity and mortality amongst immunized and non-immunized calves. Twenty-three calves were immunized and compared to 24 controls over a 7-month period. Results obtained from the study showed that the annual mortality risk in immunized calves was 45% compared to 84% in the non-immunized group. The annual incidence rate for ECF amongst immunized calves was 9.1% compared to 61.7% amongst the non-immunized. However, the differences in the incidence rates were at $p=0.21$ at 5% significance level.

Muraguri et al. (1998) carried out a cost analysis of immunization against ECF on smallholder dairy farms in central Kenya. Data from an immunization trial carried out on 102 calves and yearlings on 64 farms in Githunguri Sub-county of Kiambu County was used in the analysis. A reference base scenario of a mean herd size of five animals, a 10% rate of 15 reactions to the immunization and a 2-day interval monitoring regimen (a total of 10 farm visits) was simulated. Under these conditions, they showed that the mean cost of immunization per animal was US$ 16.48 (Ksh.955.78 at the 1998 exchange rate). This was equivalent to US$82.39 (Ksh. 4,778.90) per five-animal farm. They noted that under the commonly reported reactor rate of 3%, the cost per animal would decrease to US$14.63 (Ksh.848.29). Reducing the number of farm monitoring visits from 10 to 7 would further reduce the total cost by 10%, justified if farmers were trained to undertake some of the monitoring work. The fixed costs were 53% of the total cost of immunization per farm. They further noted that the cost of immunization decreased with an increasing number of animals per farm, showing economies of scale.

Mukhebi et al. (1992) estimated that the benefit-cost ratio of immunization against ECF was in the range of 9-17, thus indicating a high level of economic returns. Data obtained from a trial site in Kitale showed that tick control by means of acaricide application could be reduced by 83% (from weekly dipping to only nine times a year) without increasing the risk of cattle contracting ECF under mixed crop-livestock production systems typical of Kitale (Kiara et al., 2000). Observations by Wesonga et al. (1998) and Rumberia et al. (1998) during trial studies in Nakuru and Trans-Nzoia counties showed that the dipping interval could be relaxed from once weekly to once every three weeks following ECFiM without exposing animals to increased risks of contracting ECF or other tick-borne diseases. A similar study by the Tick-borne Diseases Division (TBD) at Muguga on 30 farms in Limuru and Kikuyu sub-counties of Kiambu County showed that the mean acaricide application frequency reduced from 3.03 times a month to twice a month, thus representing a 34% reduction in an acaricide use or a 34% reduction in the cost of tick control as no other TBDs were reported during the study period (Mbogo et al., 1996). The age at which calves were treated against ticks rose from a mean of 2.5 months to 3 months, thus representing a 20% increase. While this had the potential of increasing the incidence of ECF, it was, however, advantageous because it created a chance for immunity against other TBDs, such as babesiosis and heartwater, to develop. However, no financial viability assessment study on ITM has been carried out in pastoral systems.

2. Materials and Methods

2.1. Study Design

The financial analysis of Muguga cocktail stabilate against ECF in cattle was carried out in the months of October, November and December 2004. The study covered the four trial farms and was assumed to be representative of the County in terms of clinical ECF and other tick-borne diseases. The herd data were collected from the respondents of the four trial herds. Narok County data were collected from the Narok County Veterinary and Livestock production officers. The other data were collected from the existing reports.

2.2. Partial Budget Analysis

Partial farm budget analysis was used to estimate the profitability level of herd immunization against ECF by the infection and treatment method (ITM) in Narok County. Partial budgeting provides a simple economic description and comparison of different disease control measures (Dijkhuizen et al., 1995). The partial budget framework and the components and parameters used are shown in tables 3 and 4, respectively.

1. Additional returns
2. Costs no longer incurred
3. Subtotal: 1 + 2
4. Foregone returns
5. Additional costs
6. Subtotal: 4+5
7. Difference: 3 – 6: Derived net return. If the net return is negative, then the procedure is not recommended and vice-versa.

Table 3: Partial Farm Budget Framework

Parameters	Components Considered
Additional returns	Extra Calves Sold =ECS x (CP NI Group- CP I Group)
Additional costs incurred	1.Cost of vaccination = VC x NoA I Group 2.Cost of treatment of reactors= TC x (R x NoI) 3.Cost of treatment of infected calves= TC x ECFInc group I x No animals group I 4. Tick control (NI Group and I Group)
Costs No longer incurred	1. Costs with treatment of diseased calves= TC x ECFInc Group NI x No animals GroupI 2. Tick control. It is envisaged that tick control costs will be reduced by 50% among immunised animals (GPI).
Foregone returns	None since calves that died had no salvage value

Table 4: Parameters and Components of Partial Budget Analysis in Infection and Treatment Method in Narok County
Key: CP= Cost per Head, ECFINC= East Coast Fever Incidence, ECS =Extra Calves Sold, I = Immunized Group, NI= Non-Immunized Group, Noa= Number of Calves, R= Percentage of Reactors to Vaccination, TC= Treatment Cost, VC = Vaccine Cost

3. Data Management and Analysis

The partial budget analysis was computed based on the partial budget framework (Table 3) and parameters and components of partial budget analysis in infection and treatment methods in Narok County (Table 4).

4. Results

4.1. Partial Budget Analysis of Infection and Treatment Method

Partial farm budget analysis was used to estimate the profitability level of herd immunization against ECF by the infection and treatment method (ITM) in Narok County.

4.2. Cost of Immunization

The mean herd size was 32 calves ranging between the age of 1-month and 12-months.

The immunization costs are shown in table 5. The consumable items included syringes, hypodermic needles, microscopic slides and staining reagents.

The estimates of the cost of an immunizing dose of stabilate are based on the current production costs of 100,000 doses at VRC Muguga. The current total cost of producing the stabilate (100,000 doses) was USD 113,300. This included the cost of quality control processes (cross-immunity trials, titration and screening for pathogens).

The total cost of a dose of the vaccine (inclusive of all costs) was 7.50 USD (Table 5) (equivalent to Ksh. 600 at the average exchange rate of Ksh.80 to the dollar at the time of the trial in 2004).

Based on the data collected from the 4 trial farms, the average cost of treating a calf (up to 12 months of age) for ECF was Ksh.300, while the average annual cost of application of acaricides per animal was Ksh.260 (Table 6).

Item	Category*	Cost in USD		Percentage of the total cost
		Per farm	Per animal	
Stabilate production	Variable	36.16	1.13	15.07
Blocking drugs	Variable	15.36	0.48	6.40
Consumable items	Variable	51.2	1.60	21.33
† Labour (monitoring)	Fixed	-	-	-
Transportation	Fixed	25.28	0.79	10.53
Professional charges		112.0	3.50	46.67
Total		240.00	7.50	100.00

Table 5: Estimated Cost of the Various Components of ECF Immunization in Kenya, 2004

*Parameters cost per animal (animal-dependent) were termed as "variable" while those cost per whole farm were termed as fixed.

†No reactors were expected when 30% oxytetracylines formulation was used. This eliminates the need for monitoring.

Parameter	Value in Number and Kshs.		Source
	Immunized	Non-immunized	
No of calves (NoA)	123	119	Study data
Market value of a calf (CP)	*Kshs 4,700	Ksh 4,700	Study data
ECF cumulative incidence (CumInc)	1.6	15.1	Study data
ECF cumulative mortality (CumMort)	0	14.1	Study data
Vaccine Cost (Ksh) VC	Ksh 600		Study data
Cost of treatment (Ksh) TC	Ksh 300	Ksh 300	Study data
Percentage of reactors to vaccination (R)	0	-	Study data
Cost of tick control Annual basis per animal (TCA)	Kshs 260	Ksh 260	Study data

Table 6: Inputs Used in Partial Farm Budget Analysis of the Financial Benefits of East Coast Fever Immunization by the Infections and Treatment Method in Narok County, 2004

*Based on field data from elsewhere, the price of immunized calves is expected to increase by at least 50% (Babo Martins et al., 2010).

Immunization of calves against East Coast fever generated a net output of Ks 377,420.00, which translated into a mean marginal return of Ksh.1, 559.59 per vaccinated calf (Table 7).

Parameter
*Additional returns
Additional costs Cost of vaccination Ksh.73,800.00 Cost of treatment of infected calves-immunized group Ksh. 59,040.00 Tick control Ksh.62,920.00
Costs no longer incurred Treatment of diseased cattle Ksh.557, 190.00. (Non-immunized calves) Tick control Ksh. 15,990 Net return = Ksh (557,190.00 + 15,990.00) –(73,800.00 +59,040.00 + 62,920.00) = 377,420 Average net return per calf = Ksh. 1,559.59

Table 7: Net Return of Immunization against ECF in Narok County
** Accurate Records of Extra Calves Sold as a Result of Immunization Not Available*

The number of animals immunized per farm had a major influence on the mean cost per animal, with the total cost of immunization decreasing as the number of cattle per herd increased. In this analysis, the cost of monitoring, professional fees and transportation costs were termed as fixed costs since they were charged uniformly, irrespective of the number of animals on the farm. This cost contributed 57.2% of the total cost, hence the high cost when few animals were immunized on the farm.

The ITM realized a net return of Ksh.4, 261.45 per immunized calf. If immunization against the disease is integrated with reduced acaricide usage, then accrued returns are even much higher. If the tick control frequency is reduced to once every two weeks, this will result in a 50% reduction in acaricide costs. The annual cost of tick control per animal (cattle) dropped from Ksh.260 to Ksh. 130.

5. Discussion

Partial budgeting analysis results of the study showed that ITM technology was financially profitable even when the extra calves sold as a result of reduced mortality and the expected increase in the price of immunized calves were not taken into consideration. The ITM realized a net return of Ksh.1, 559.59 per immunized calf (Tenesi et al., 2015). This was significant in the study area since the average price of a calf was relatively low (Ksh.4,700.00). High net returns are indicators of the high profitability of immunization (Dijkhuizen et al., 1995). Thus, it can be concluded from the study that it was economically worthwhile to immunize cattle against ECF in Narok County. If immunization against the disease is integrated with reduced acaricide usage, then accrued returns are even much higher. If the tick control frequency is reduced to once every two weeks, this will result in a 50% reduction in acaricide costs. The annual cost of tick control per animal (cattle) will drop from Ksh.260 to Ksh. 130. Another benefit that can be derived from immunization is the increased value of the immunized cattle. For instance, among the Masaai pastoralists of Tanzania, immunized calves are sold at a price 50% higher than the non-immunized calves (Babo Martins et al., 2010).

6. Conclusion and Recommendations

The partial costs and partial benefits showed partial net benefits when Muguga cocktail stabilate was integrated with reduced acaricide application. Comprehensive financial and economic analysis needs to be taken for the financial viability assessment of the ITM.

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