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Partial Budgeting Analysis of the Fifty Percent Reduction in Acaricide Use and Adoption of Infection and Treatment Method on Pastoralists' Cattle in Narok County, Kenya

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Abstract:
A 3-month prospective cross-sectional and simulation study was carried out to determine a partial budgeting analysis of infection and treatment method (ITM) using the Muguga cocktail vaccine with the fifty percent reduction in acaricide use on pastoralists cattle in Narok County, 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 with fifty percent reduction in acaricide use. The ITM, with fifty percent acaricide use, realized a net return of Ksh.708.9 per immunized animal. This was significant because the information was generalized to the expansive Narok County. Thus, it can be concluded from the study that it is economically worthwhile to immunize cattle against ECF with fifty percent reduction in acaricide use in Narok County.

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 implementing the decision. The basic framework for partial analysis is: (Brown, 1978; Putt et al., 1983).

Costs	Benefits
a) Extra costs	c) Costs saved
b) Revenue loss	d) 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

While 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 loss 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

The 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. Often, it is calculated as: (Brown, 1978; Gittinger, 1973; World Bank, 1981b).

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 outputs with disease control will reflect a reduction in home consumption of animals due to emergency slaughter and an increase in the final herd value due to the 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 among 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), which 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. Tenesi et al. (2023) did a study on partial budgeting analysis of Muguga cocktail vaccine in Narok County and the net returns were positive. However, no financial viability assessment study on ITM with the current tick control method has been carried out in pastoral systems.

2. Materials and Methods

2.1. Study Design

The cross-sectional and simulation study of pastoralists' herds that participated in Muguga cocktail stabilate (Infection and treatment method) against ECF in cattle with a fifty percent reduction in acaricide use was carried out in the months of October, November and December in the year 2004. The study covered the four trial farms and other thirty (36) pastoralists' farms that had benefited from commercial vaccination launched by the Veterinary Sans Frontier German (VSF-German) in October 2002. The herd data were collected from the respondents of the forty pastoralists' herds. Narok County data were collected from 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) with the fifty percent reduction in acaricide use in Narok County. Partial budgeting provides a simple economic description and comparison of different disease control measures (Dijkhuizen et al., 1995 & Tenesi et al., 2023). 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 net return is negative, then the procedure is not recommended and vice versa.

Table 3: Partial Farm Budget Framework.

Parameters	Components Considered
Additional returns	1. Beef offtake revenue
	2. Lost beef revenue
	3. Lost milk revenue
	4. Lost revenue from surviving
Additional costs incurred	1. Immunization cost
Costs No longer incurred	1. Mortality costs reduced.
Foregone returns	1. Hides revenue

Table 4: Parameters and Components of Partial Budget Analysis in Infection and Treatment Method with Zero Reduction in Acaricide Use in Narok County

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 method with fifty percent reduction in acaricide use in Narok County (Table 4).

4. Results

4.1. Partial Budget Analysis of Infection and Treatment Method with Fifty Percent Reduction in Acaricide Use

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

4.2. Animal Health Economic Spreadsheet

Zebu cattle population in Narok County in 2004 was 488,424 and 76% of this Zebu population was at risk of contracting ECF.

The herd level parameters are shown in table 5. They were collected from the cross-sectional data, longitudinal data and secondary reports.

The production and money values are shown in table 6. They were collected from the cross-sectional data, longitudinal data and secondary reports.

The current tick control method is shown in table 7. The information in this table is collated from tables 5 and 6. The current tick control practice is where cattle are spayed weekly for fifty-two weeks annually.

The fifty percent reduction in acaricide use and adoption of Infection and Treatment Method (ITM) is shown in table 8. The data in this table 8 is compared with the data in table 7 for computing partial budgeting analysis.

The net return of ITM with a fifty percent reduction in acaricide use is shown in table 9. This is the table that produces the four components of partial budgeting analysis. (Additional returns + Costs no longer incurred) – (Additional costs incurred + Foregone returns) = Net return.

Item				
	Proportion	**ECF Incidence**	**ECF Case Fatality**	**Source Calving Rate**
Calves female	7.75%	36.30%	34.20%	Study data
Calves male	3.66%	36.30%	34.20%	Study data
Weaners female	19.86%	16.10%	16.10%	Study data
Weaners male	21.83%	16.10%	16.10%	Study data
Breeding female	44.14%	3.90%	3.90%	Study data 43.1%
Breeding male	2.76%	3.90%	3.90%	Study data
Non- theileriosis for calves	-	-	10%	Study data
Non-theileriosis for weaners	-	-	6%	Study data
Non-theileriosis for adults	-	-	6%	Study data

Table 5: Herd Level Parameters of the Pastoralists' Herds in 2004, Narok, Kenya

Parameter	Value	Source
Milk yield per year	130 kg per cow	Study data
Beef yield per year	60 kg per animal	Study data
Milk loss in surviving affected cows	25%	Mukhebi et al. 1992a
Beef loss in surviving affected calves	5%	Mukhebi et al. 1992a
Beef loss in surviving affected weaners	10%	Mukhebi et al. 1992a
Calf offtake	10%	Study data
Weaners offtake	5%	Study data
Adults offtake	5%	Study data
Beef price per kg	Kshs 140	Study data
Milk price per litre	Kshs 25	Study data
Hides price for calves	Kshs 200	Study data
Hides price for weaners	Kshs 400	Study data
Hides price for adults	Kshs 700	Study data
Treatment costs per treatment	Kshs 650	Study data
Spraying costs for calves	Kshs 5	Study data
Spraying costs for adults	Kshs 10	Study data
Immunization cost per animal	Kshs 600	

Table 6: Production and Money Factors for the Pastoralists' Herds in Narok County, Kenya, 2004

Immunization of cattle against East Coast fever with the fifty percent reduction in acaricide use generated a net output of Kshs 263,109,239, which translated into a mean marginal return of Ksh.708.9 per vaccinated animal (Table 9).

livestock categories	total	incidence of ECF	fatality cases	Healthy surviving	surviving from ECF	Total surviving	non ECF mortality	Total Mortality	Mortality cost	offtake of total surviving
females calves	37,853	13,741	4,699	20,327	9,041	29,368	3,785	8,485	71,270,628	2,937
Male calves	17,876	6,489	2,219	9,599	4,270	13,869	1,788	4,007	33,657,405	1,387
Weaners female	97,001	15,617	2,514	75,564	13,103	88,667	5,820	8,334	140,018,305	4,433
weaners male	106,623	17,166	2,764	83,059	14,403	97,462	6,397	9,161	153,907,400	4,873
Breeding female	215,590	8,408	328	194,247	8,080	202,327	12,935	13,263	445,647,296	10,116
Breeding male	13,480	526	21	12,145	505	12,651	809	829	27,864,583	633
	488,423	61,947	12,545	394,942	49,402	444,343	31,535	44,080	872,365,618	24,379

livestock categories	milk output in sick surviving	lost milk revenue	Total Milk Revenue	Hides revenue from dead ECF cows	Hides revenuefrom dead non ECF	Total hides revenue	Beef yield offtake kg	beef offtake revenue	Beef yield unsold kg	Total Beef value
females calves				939,860	757,060	1,696,920	176,210	24,669,457	1,762,104	246,694,572
Male calves				443,847	357,520	801,367	83,215	11,650,100	832,150	116,500,995
Weaners female				1,005,745	2,328,024	3,333,769	531,999	74,479,925	10,639,989	1,489,598,495
weaners male				1,105,510	2,558,952	3,664,462	584,771	81,867,950	11,695,421	1,637,359,000
Breeding female	262,603	43,105,765	278,655,990	229,539	9,054,780	9,284,319	2,427,920	339,908,835	48,558,405	6,798,176,704
Breeding male				14,352	566,160	580,512	151,808	21,253,171	3,036,167	425,063,417
	262,603		278,655,990	3,738,852	15,622,496	19,361,348	3,955,925	553,829,437	76,524,237	10,713,393,182

livestock categories	sprayed 40%	treated 40%	No sprayed per year	spray cost per year	treatment cost per year	Calving %	lost revenue from surviving	milk output in healthy surviving	lost beef revenue	milk output loss in surviving
females calves	15,141	15,141	787,342	3,936,712	9,841,780		3,797,363		71,270,628	
Male calves	7,150	7,150	371,821	1,859,104	4,647,760		1,793,297		33,657,405	
Weaners female	38,800	38,800	2,017,621	20,176,208	25,220,260		22,012,701		140,018,305	
weaners male	42,649	42,649	2,217,758	22,177,584	27,721,980		24,196,247		153,907,400	
Breeding female	86,236	86,236	4,484,272	44,842,720	56,053,400	83,720	27,149,128	10,883,636	445,647,296	262,603
Breeding male	5,392	5,392	280,384	2,803,840	3,504,800		1,697,529		27,864,583	
	195,369	195,369	10,159,198	95,796,168	25,397,996	83,720	80,646,265	10,883,636	872,365,618	

Table 7: Current Tick Control Method

livestock categories	total	incidence of ECF	fatality cases	Healthy surviving	surviving from ECF	Total surviving	non ECF mortality	Total Mortality	Mortality cost
females calves	37,853	2,748	188	31,320	2,560	33,880	3,785	3,973	33,375,484
Male calves	17,876	1,298	89	14,791	1,209	16,000	1,788	1,876	15,761,503
Weaners female	97,001	3,123	101	88,058	3,023	91,080	5,820	5,921	99,466,660
weaners male	106,623	3,433	111	96,792	3,323	100,115	6,397	6,508	109,333,241
Breeding female	215,590	1,682	13	200,973	1,668	202,641	12,935	12,949	435,070,154
Breeding male	13,480	105	1	12,566	104	12,670	809	810	27,203,236
	488,423	12,389	502	444,499	11,888	456,387	31,535	32,036	720,210,278

livestock categories	offtake of total surviving	sprayed 40%	treated 40%	No sprayed per year	spray cost per year	treatment cost per year	immunized	immunization cost	Calving %	lost revenue from surviving
females calves	3,388	15,141	15,141	393,671	1,968,356	1,968,356	28,390	17,033,850		1,075,265
Male calves	1,600	7,150	7,150	185,910	929,552	929,552	13,407	8,044,200		507,792
Weaners female	4,554	38,800	38,800	1,008,810	10,088,104	5,044,052	4,850	2,910,030		5,078,401
weaners male	5,006	42,649	42,649	1,108,879	11,088,792	5,544,396	5,331	3,198,690		5,582,152
Breeding female	10,132	86,236	86,236	2,242,136	22,421,360	11,210,680	10,780	6,467,700	86,619	5,606,111
Breeding male	634	5,392	5,392	140,192	1,401,920	700,960	674	404,400		350,528
	25,313	195,369	195,369	5,079,599	47,898,084	25,397,996	63,431	38,058,870	86,619	18,200,250

livestock categories	milk output in healthy surviving	lost beef revenue	milk output loss in surviving	milk output in sick surviving	lost milk revenue	Total Milk Revenue	Hides revenue from dead ECF cows	Hides revenuefrom dead non ECF	Total hides revenue
females calves		33,375,484					37,594	757,060	794,654
Male calves		15,761,503					17,754	357,520	375,274
Weaners female		99,466,660					40,230	2,328,024	2,368,254
weaners male		109,333,241					44,220	2,558,952	2,603,172
Breeding female	11,260,517	435,070,154	54,226	54,226	42,082,679	282,868,571	9,182	9,054,780	9,063,962
Breeding male		27,203,236					574	566,160	566,734
	11,260,517	720,210,278		54,226		282,868,571	149,554	15,622,496	15,772,050

Livestock Categories	Beef Yield Offtake Kg	Beef Offtake Revenue	Beef Yield Unsold Kg	Total Beef Value
females calves	203,278	28,458,972	2,032,784	284,589,716
Male calves	95,998	13,439,690	959,978	134,396,897
Weaners female	546,482	76,507,507	10,929,644	1,530,150,140
weaners male	600,690	84,096,658	12,013,808	1,681,933,159
Breeding female	2,431,698	340,437,692	48,633,956	6,808,753,846
Breeding male	152,045	21,286,238	3,040,891	425,724,764
	4,030,191	564,226,757	77,611,061	10,865,548,522

Table 8: 50% Reduction in Acaricide Use and Adoption of ITM

Parameter
*Additional returns Beef offtake revenue kshs (564226757-553,829,437) = kshs 10,397,320 Lost beef revenue kshs (872,365,618-720210278) = kshs 152,155,340 Lost milk revenue kshs (43,105,765 – 42,082679) = kshs 1,023,086 Lost revenue from surviving kshs (80646265 -18200250) = kshs 62,446,015
Additional costs incurred Cost of immunization Ksh38,058,870
Foregone returns Hides revenue kshs (19,361,348 – 15772050) = kshs 3,589,298
Costs no longer incurred Mortality costs kshs (872365618 – 720210278) =kshs 152,155,340 Net return = Ksh 10,397,320 (+152,155,340+1,023,086 +62,446,015+152,155,340) –(38,058,870+3,589,298) = 336,528,933 Average net return per animal = Ksh. 906.6

Table 9: Net Return of Immunization against ECF with Fifty Percent Reduction in Acaricide Use in Narok County, Kenya

* Average exchange rate to U.S. dollars was kshs.80

The ITM, with fifty percent reduction in acaricide use, realized a net return of Ksh.906.6 per immunized animal. The total net return was kshs. 336,528 for about 371,202 susceptible cattle in Narok County.

5. Discussion

Partial budgeting analysis results of the study showed that ITM technology's fifty percent reduction in acaricide use was financially profitable. The ITM, with fifty percent reduction in acaricide use, realized a net return of Ksh.906.6 per immunized animal. This was a significant generalization to the whole of Narok County because it shows a positive net return in ITM with fifty percent reduction in acaricide use. High net returns are indicators of the high profitability of immunization (Dijkhuizen et al., 1995). Tenesi et al. (2023) also found a net positive return per immunized calf. Therefore, this can be concluded from the study that it was still economically worthwhile to immunize cattle against ECF with fifty percent reduction in acaricide use in Narok County.

6. Conclusion and Recommendations

The partial costs and partial benefits showed partial net benefits when Muguga cocktail stabilate is applied with the fifty percent reduction in acaricide use. Comprehensive financial and economic analysis needs to be taken for the financial viability assessment of the ITM. Also, basic scientists can use these results of the study to corroborate their findings.

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