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## A benefit–cost analysis of veterinary interventions in Afghanistan based on a livestock mortality study

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### Abstract

This article evaluates a veterinary intervention program of the Dutch Committee for Afghanistan, started during the Soviet invasion of Afghanistan, a 10 year period during which veterinary services were otherwise completely disrupted. The veterinary field program was carried out mainly by paravets. A questionnaire-based survey was conducted to measure livestock mortality in districts that received veterinary services through the project and in neighboring districts that had not had veterinary services for about 10 years. The survey indicated that livestock mortality in districts that received veterinary services was lower than in districts without any veterinary services. Comparison of each of the 22 age-species-specific district pairs showed a difference in favor of the covered district in 18 pairs. In 12 out of these 18 pairs, this difference was significant. Overall annual mortality rates differed (in relative amounts) by 25%, 30%, and 22%, in calves, lambs, and kids, respectively, and in adult cattle, sheep, and goats, by roughly 30%, 40%, and 60%, respectively. In the absence of any other obvious distinctive features between the compared districts, we concluded that this difference in mortality was due to the presence or absence of veterinary services. A benefit–cost analysis showed that the benefit–cost ratio for the program was between 1.8 and 4.8. The high benefit–cost ratio resulted partly from the fact that the costs of the program were low, because it was implemented by a volunteer-run, non-governmental organization. In addition, due to the special circumstances prevailing in the country, any input in combatting diseases at this stage was bound to have a relatively high impact. We concluded that: (1) the veterinary program was important for the rebuilding of numbers of livestock and thus for the economy of Afghanistan, and (2) veterinary intervention programs under these and comparable circumstances can be highly cost-effective.

*Keywords:* Epidemiology; Afghanistan; Livestock mortality; Mortality rates; Diseases in ruminants; Surveys; Cost–benefit analysis; Benefit/cost ratio; Veterinary program

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## **1. Introduction**

The livestock sector has always been of major economic importance to Afghanistan, providing important constituents of the daily diet and a source of income for more than 80% of the population. The Soviet invasion in December 1979 triggered off a decade of war in which most of Afghanistan's infrastructure was destroyed. Rural Afghanistan witnessed, in this period, a complete disruption of veterinary services, which led to serious threats to the already decimated livestock population. The agriculture survey carried out by the Swedish Committee for Afghanistan in 1988 indicated that numbers of livestock inside Afghanistan were approximately half of what they had been before the war (Swedish Committee for Afghanistan, 1988).

With the establishment in September 1988 of the Veterinary Training and Support Center (VTSC) in Peshawar, Pakistan, by the Dutch Committee for Afghanistan (DCA), an emergency-orientated veterinary program was begun. Its aim was to provide basic veterinary care for the remaining Afghan livestock population. The DLO-Central Veterinary Institute in the Netherlands (presently ID-DLO) provided technical support from the inception of the project.

Project activities included the training of intermediate-level veterinary auxiliary staff (paravets and vaccinators). Students were recruited from areas of Afghanistan where need for veterinary assistance was identified. Graduated students were then deployed in these areas under the supervision of higher qualified veterinary personnel and within the structure of Veterinary Field Units (VFUs), which were expected to cover most of a district.

Their tasks were primarily in preventive veterinary medicine: (1) vaccinating against major infectious diseases in large and small ruminants and in poultry, and (2) providing and administering anthelmintic drugs against nematodes and liver flukes. Vaccinations were done regularly against anthrax, blackleg, enterotoxemia, hemorrhagic septicemia (HS), and Newcastle disease in target animals. In addition, veterinary personnel were also involved in curative treatments for which they were allowed to charge. Cost-recovery has also been introduced for the provision of anthelmintics (50% at the time of this study), while for vaccinations a symbolic fee has been requested.

Gradually the DCA-VTSC program has evolved from an emergency program to a program for rehabilitating veterinary infrastructure and services in Afghanistan, with international agencies like UNDP and FAO adopting the VFU concept for their nation-wide program. In certain districts, where DCA-VTSC field activities had been ongoing for 3 years, we were able to evaluate the impact of the program.

The first part of this paper compares livestock mortality in districts where veterinary support had been provided for 3 years with livestock mortality in districts that had been devoid of any veterinary care for more than 10 years. The second part reports the results of a benefit-cost analysis of the DCA veterinary program.

## **2. The livestock mortality survey**

Under the prevailing conditions, with cold-chain facilities for storage of samples lacking due to absence of electricity in most parts of the country and possibilities for laboratory

confirmation of disease outbreaks or disease surveillance virtually non-existent, the only possible approach to measuring the impact of such a scheme was considered to be the use of farmer questionnaires. The survey focused on collecting data on livestock productivity and mortality over a period of 2 years. This report presents and uses the data on livestock mortality only.

### *2.1. Methods of livestock mortality survey*

Material and methods used in this study have been described in detail elsewhere (Schreuder et al., 1996). A summary will be given here.

#### *2.1.1. Selection of districts*

Mortality figures were collected for 2 years on livestock belonging to farmers in four districts with (covered) and four districts without (control) a veterinary program. All districts were purposely selected. The covered districts were chosen in four different provinces and had approximately 3 years functional, DCA-provided, animal health coverage (the actual extent of which was not precisely known). Selected control districts were districts that had had no veterinary care for about 10 years. Care was taken to ensure that these selected control districts were comparable with the districts covered by the animal health program, as far as ecological conditions, animal husbandry practices and effects of war, were concerned. This would allow a comparison between pairs of districts. All but one control district was adjacent to covered districts and the questionnaire covered items such as summer migration, and acreage for fodder crops.

#### *2.1.2. Selection of villages*

Within each district, three villages were randomly selected. This was done by drawing up a list of villages for each of these districts and assigning each a numerical code (according to the Provisional Gazetteer, Ministry of Interior, Kabul, 1975). A district contained, on average, 80 villages. A random number generator was used to select the three villages.

#### *2.1.3. Selection of farmers*

In each randomly selected village, 30 farmers were interviewed. They were not randomly sampled, but were selected in terms of ruminant-herd size: 10 large, 10 average, and 10 small farmers per village, a distinction that was left to the judgment of the enumerators. This way, the sample was thought to be representative for the whole village. The average village in the survey area did not count more than 50 households. In case a village had less than 30 farmers, the nearest village was used for topping up.

Because of close contact between herds of different farmers from one village (communal grazing!), the villages were the clusters in the sampling process. The survey therefore resulted in cluster sampling up to village level, and possible clustering at higher levels would not be accounted for in the pairing of adjacent districts.

#### *2.1.4. Herd size*

The average, individually owned, herd size for cattle was 5.5 (SD 3.5) in the covered areas and 6.0 (SD 3.6) in the control areas. For sheep, the average flock size was 20 (SD 59.9) in the covered and 32 (SD 46.7) in the control areas, and for goats 13 (SD 30.9) and 26 (SD 52.6), respectively.

### 2.1.5. Questionnaire survey

The questionnaire survey, prepared in 'EPI-INFO' (epidemiological program of the Center for Disease Control, Atlanta/WHO, Geneva), was administered by neutral enumerators hired from outside the implementing agency. More than 700 farmers were interviewed in the selected villages during the summer and early autumn of 1992.

The questionnaire was used in the summertime, which is after the lambing season and also after the main calving season. The questions related to the period of 2 consecutive years, the 24 months immediately preceding the survey.

Questions were included on the presence or absence of animal health measures, the availability of medicines and anthelmintics, animal husbandry practices, and the numbers of livestock owned, born, sold, and died. The survey was fully based on farmers' recollection.

## 2.2. Analysis of results

Data were collected on mortality in cattle, sheep, and goats, both in young and adult animals, for the four pairs of districts. Results were processed using the Lotus spreadsheet program. A one-sided, unpaired *t*-test was used for calculating statistical differences within each of the four pairs and for each animal species and age group. The overall figures, i.e. the results combined for both years covered by the survey and for the four districts of each group, were used for the benefit–cost analysis in the second part of this paper.

### 2.2.1. Definitions

Annual adult mortality was defined as the number of adult animals that died (including emergency-slaughtered ones) during an observation period of 1 year as a proportion of the number of adult animals present at the start of the same observation period. For cattle, an adult was defined as an animal over 18 months old; for sheep and goats, over 12 months.

For young animals, mortality was defined different for large and small ruminants. For small ruminants, it was defined as the number of young animals that died during the observation period as a proportion of the number of young animals born in the same observation period. Lambs (kids) were considered young until 12 months old or until mated, whichever came first. For calves, mortality was defined as the number of calves that died during the observation period as a proportion of the number of calves born in or present at the start of the same observation period. Calves were considered calves until approximately 18 months old or until mated, whichever came first.

Animals sold, given away or consumed, were asked for but not included in the calculations, as this outflow was more than compensated for by the inflow of young animals into the adult group. In general, livestock outflow was limited in this period of rebuilding individual herds. In the case of cattle, for example, the outflow involved less than 10% of the herd or flock.

Estimates of mean mortality per individual herd were obtained by taking the number of deaths as a proportion of the number of animals at the farm. Estimates of mean mortality for each village (cluster) were obtained in a similar way, using the numbers for each village. Estimates of mean mortality for each investigated district were obtained by calculating the

mean of the mortality percentages of the three villages. The overall figures for the control and the covered group were calculated in both ways, while for the benefit–cost analysis the more conservative estimate of the two was used.

### 2.3. Results of the livestock mortality survey

Table 1 shows the results of the questions on livestock mortality, in a paired comparison of the individual four pairs of districts, specified for each animal species and age group, but

Table 1

A paired comparison of livestock mortality in four pairs of districts in Afghanistan over a 2 year period

	Annual mortality in percentages		P-value <sup>a</sup>
	Covered district	Control district	
<b>Adult cattle</b>			
Pair 1	7.0	5.4	0.77
Pair 2	1.8	10.0	<0.01
Pair 3	4.6	1.8	0.96
Pair 4	0.9	8.6	<0.01
<b>Calves</b>			
Pair 1	16.6	27.1	0.04
Pair 2	23.5	20.4	0.76
Pair 3	10.9	7.7	0.87
Pair 4	6.8	37.2	<0.01
<b>Adult sheep</b>			
Pair 1	10.9	14.3	<0.01
Pair 2	–	–	–
Pair 3	5.7	18.4	<0.05
Pair 4	17.2	28.5	0.04
<b>Lambs</b>			
Pair 1	21.9	23.3	0.11
Pair 2	–	–	–
Pair 3	9.8	42.5	0.06
Pair 4	17.2	28.5	0.02
<b>Adult goats</b>			
Pair 1	9.2	12.6	0.09
Pair 2	7.8	22.8	0.01
Pair 3	3.2	6.0	0.34
Pair 4	5.0	13.1	<0.01
<b>Kids</b>			
Pair 1	12.3	18.8	0.08
Pair 2	25.8	29.1	0.03
Pair 3	15.7	43.5	0.04
Pair 4	17.4	26.5	0.09

<sup>a</sup>P values calculated with *t*-test; significant difference when  $P < 0.05$ .

Table 2  
Summary of annual livestock mortality in eight districts in Afghanistan over a 2 year period, 1991–1992

	Four districts covered by veterinary services			Four control districts (not covered)		
	No. animals at risk	Dead		No. animals at risk	Dead	
		No.	% <sup>a</sup>		No.	% <sup>a</sup>
Adults						
Cattle	2217	84	3.8 (3.6)	3227	171	5.3 (6.5)
Sheep	9047	745	8.2 (7.2)	14433	1960	13.6 (15.1)
Goats	5814	349	6.0 (6.3)	13701	2140	15.6 (13.6)
Young						
Calves	974	158	16.2 (14.5)	1217	262	21.5 (23.1)
Lambs	4830	837	17.3 (16.3)	8621	2172	25.2 (31.4)
Kids	3343	639	19.1 (17.8)	6524	1602	24.6 (29.5)

<sup>a</sup>First figure calculated by animal-level analysis, the second (between parentheses) calculated as mean of the district percentages.

combined for both years covered by the survey. Of the 22 pairs, 18 pairs had a difference in livestock mortality between the control and covered districts in favor of the covered district. In 12 out of these 18 pairs, this difference was significant ( $P$  values calculated with a  $t$ -test).

Table 2 summarizes the same results, but now combined for the four districts of each group (control or covered) and for both years covered by the survey. The overall annual mortality differed by roughly 25, 30, and 22%, in calves, lambs, and kids, respectively, while mortality in adult cattle, sheep, and goats differed by roughly 30, 40, and 60%, respectively, all in favor of the covered districts.

The results of the other questions of the survey did not indicate any significant difference between the groups of control and covered districts, in terms of summer migration, acreage for fodder crops, feeding of concentrates, reproduction rate, and number of animals killed by mines (data not presented). The only difference noted between the two groups was that the average herd size for small ruminants was significantly larger in the control group. In the absence of any other relevant distinctive features between the compared group of districts, we nevertheless concluded that the established differences in mortality are due to the presence or absence of veterinary services.

### 3. Benefit–cost analysis of the veterinary program

#### 3.1. Methods

##### 3.1.1. Costs

The DCA veterinary program has been equally supported by the Dutch Government Emergency Assistance Program, and by the United Nations Development Program. The former contribution was mainly used for the training program, and the latter more for

Table 3  
Overview costs of DCA–VTSC veterinary program and physical output in initial 5 years of project

	Project year					Totals
	1	2	3	4	5	
(a) Costs (US\$) <sup>a</sup>						
Project costs						
Training	368400	472500	516400	397000	397100	2151400
Operational expenditure	57760	330000	566840	414360	600000 <sup>b</sup>	1968960
Value technical backstopping	20000	20000	20000	20000	20000	100000
Local contribution	0	0	11480	97790	300000 <sup>b</sup>	409270
Total costs	446160	822500	1114720	929150	1317100	4629630
(b) Physical outputs						
Trained staff						
Paravet	20	40	40	40	40	180
Vaccinator	25	30	30	30	30	145
Districts served (cumulative)	6	14	22	35	50	–

<sup>a</sup>At 1992 rates.

<sup>b</sup>Represents estimates.

support of the field program. The contributions from both donors have been included in calculating the cost of the program. Table 3 shows the total costs and the physical outputs (trainees and districts provided with veterinary service) of the project over a 5 year period.

The actual project costs are divided into training cost and operational expenditure. The costs for training individual paravets or vaccinators were calculated by calculating the average costs per month of training. The training costs for the average 2.5 paravets and one vaccinator in each district were then spread over 5 years, which was the estimated effective period of service (conservative estimate). Training of veterinarians was not required as unemployed veterinarians were available at the inception of the project. Training costs for the average 0.5 veterinarian per district were thus not included in the standard benefit–cost calculation.

Operational expenditure covers all actual costs involved in executing the field program, including cost of expatriate and local staff and the administrative cost for the implementing NGO. These actual costs do not cover the cost of technical backstopping by ID-DLO. The estimated value of this support, US\$ 20 000 per annum, is added in the table. The increasing share of the local contribution by the livestock owners is stated separately in the table to arrive at the total cost of services provided.

### 3.1.2. Benefits

Estimating benefits resulting from veterinary services necessarily requires a number of assumptions. Part of these assumptions refer to proportions and the attribution of values; in these cases different proportions and values were taken to demonstrate the effect of the assumptions on the benefit/cost ratio (see sensitivity analysis).

Table 4  
Calculation of benefits of veterinary program in districts within DCA's working area

Animal species	Average animal population covered per district	Mortality (%)		Fewer deaths per district (animals)	Value per animal (US\$)	Benefits per district per year (US\$) <sup>a</sup>
		Without veterinary services	With veterinary services			
<b>Cattle</b>						
Adult	10000	5.3	3.8	150	193	28909
Young	3000	21.5	16.2	159	81	12845
<b>Sheep</b>						
Adult	20000	13.6	8.2	1080	36	39011
Young	15000	25.2	17.3	1185	12	14795
<b>Goats</b>						
Adult	10000	15.6	6.0	960	22	21585
Young	7500	24.6	19.1	413	8	3475
<b>Total</b>	–	–	–	–	–	120620

<sup>a</sup>Exchange rates per 1992: 1 US\$ = 33 Pakistan Rupees = 1650 Afghanis.

The overall results of the livestock mortality survey (Table 2) were the starting point for estimating the benefits, using the most conservative estimate of difference in mortality between covered and control groups. The following assumptions were made.

(1) The difference in mortality between the control and the covered districts is solely due to veterinary interventions. This is argued for in the first part of this paper.

(2) This difference in mortality, established in the period when cost-recovery for medicines (especially anthelmintics) was at a 50% level, is not substantially affected by higher levels of cost-recovery in later project years (100% in 1993, Project Year 5).

(3) The estimated animal population covered in each district is 10 000 head of cattle and 30 000 small ruminants and a proportionate number of young stock (Table 4). As alternatives, population sizes of 75% and 50% of these numbers have been taken.

(4) Dead animals are considered to have no salvage value. As an alternative assumption the salvage value of dead animals is set at 25% of the market value of live animals. The latter assumes that 50% of the mortality cases refer to animals found dead in the field. These are considered to have no salvage value in this Islamic country. The remaining 50% refers to sick animals slaughtered in extremis with a value of 50% of the market value of live animals.

The market value of each type of animal was based on average market prices in various provinces within the project working area in 1992. The average prices reflect the prices paid for animals intended for slaughter as well as the generally higher prices paid for animals to be used for productive purposes.

### 3.2. Results of benefit–cost analysis

The benefit–cost analysis has been done at the district level because the district is the smallest operational unit.



### 3.2.1. Training costs

The average costs for training per month were calculated at US\$ 1658, with no adjustments for level of training. Thus, the paravet training costs (6 months) amounted to US\$ 9949 and the vaccinator training costs (1.5 months) to US\$ 2487.

With training costs for district staff divided over 5 years of expected service, this component amounts to US\$ 5472 per annum for each district. Inclusion of the training cost of the average 0.5 veterinarian per district, with an estimated total cost for training of US\$ 50 000 (own estimate) and an expected period of service of 20 years, would add US\$ 1250 per annum per district to the training component.

### 3.2.2. Operational costs

The total cost for the provision of services, composed of operational expenditure, the value of technical backstopping and the local contribution, over the total project period (Table 3) amounts to US\$ 2 478 230 for the total project working area. In the project period an annually increasing number of districts have been served; total services provision amounted to 127 district years. This brings the average annual operational costs per district to US\$ 19 514.

### 3.2.3. Total cost

The total cost of providing veterinary services per district per annum amounted to US\$ 24 986. Inclusion of the estimated training cost of the veterinarian resulted in annual district costs of US\$ 26 236.

This figure not only included the salaries and operational expenses of the employed veterinary personnel, but also the training costs of the veterinary auxiliary personnel, the costs of the veterinary inputs such as vaccines and partly subsidized medicines, the costs of monitoring and supporting the program, and the administrative costs for the implementing NGO.

### 3.2.4. Benefits

The annual financial benefits resulting from the standard assumptions made in the Methods section were calculated at US\$ 120 620 per district (Table 4). With 50 districts served, the total benefits for the whole project working area were estimated at just over 6 million US\$ per year.

### 3.2.5. Benefit–cost ratios

Comparison of the benefits (according to the standard calculation) with the actual costs resulted in a benefit–cost ratio for the veterinary program of 4.8. Inclusion of the cost for training the veterinarian reduces the ratio to 4.6.

### 3.2.6. Sensitivity analysis

The various alternative assumptions with regard to the estimated animal population covered and value of dead animals result in benefit–cost ratios varying from 3.6 to 1.8 (Table 5).

Table 5  
Sensitivity analysis of benefit/cost ratio

Assumption regarding size of district herd covered	Assumption regarding the value of dead animals (benefit/cost ratio)	
	No salvage value (standard)	With salvage value (25% of market price)
Coverage as estimated	4.8	3.6
Coverage at 75% of estimate	3.6	2.7
Coverage at 50% of estimate	2.4	1.8

#### 4. Discussion

##### 4.1. Possible bias introduced by clustering of data

The randomly selected villages can be considered as a sampling unit. Within each group of interviewed farmers of a particular village, clustering of data will definitely occur. Between the villages, clustering is not considered a serious problem; in mountainous, rural Afghanistan, with all its remote valleys, contacts even between neighboring villages are scanty. Nomadic flocks could, however, increase chances for spreading diseases—the effect of which goes even beyond the district level.

The 'risk' that control districts could have benefitted from the program carried out in an adjacent covered district, is considered not realistic, and would, anyway, have enforced the case by lessening the relative advantage of the covered districts.

##### 4.2. Possible bias introduced by the farmers or enumerators

It is difficult to assess the amount of possible bias introduced by the farmers' answers to the questions. Farmers, probably all over the world, may tend to adjust their statements out of self-interest. Afghan farmers will certainly not be an exception. Conceivably, farmers in areas without veterinary services may have exaggerated their problems—hoping to receive these services earlier. The enumerators were specifically briefed to pay attention to this possibility. The questionnaire also contained several cross-check questions to check for this possible bias.

The enumerators employed in the survey were trained and experienced in this field of work. In addition, they had been recruited from a neutral organization outside DCA-VTSC (the project-implementing organization) to avoid a possible bias introduced by using field staff involved in the veterinary program. The enumerators had no direct interest in the outcome of the survey.

##### 4.3. Discussion on the benefit–cost analysis

With estimated annual benefits in the order of 500% of the total annual cost of the provision of veterinary services, the benefit–cost ratio of the veterinary program is

around 5. This is high by any standards. Even the 'worst-case scenario' in the sensitivity analysis results in a benefit–cost ratio of 1.8, which is well acceptable for a livestock project.

The high benefit–cost ratio partially resulted from the fact that the costs of the program were (relatively) low because it was implemented by a volunteer-run, non-governmental organization without substantial overhead expenditures for the organization. All costs incurred by the NGO are, however, included in the total operation costs. The high benefit–cost ratio can also be partly explained because of the special circumstances prevailing in the country: devoid of any veterinary care, disease impact will be at its peak and any input in combatting diseases at this stage will therefore have a relatively high impact.

We stress that all training and operational costs are included in calculating the costs, such as board and lodging for trainees, supply with equipment, vaccines, anthelmintics and other medicines (be they paid by the local population or from project funds), salaries, travel allowances, means of transport, costs for administrative and financial support and monitoring, costs for technical backstopping, and costs for the implementing agency. Almost all inputs were acquired locally, i.e. in the region, and at commercial rates.

The benefits in the standard calculation were calculated based on an estimated coverage of the animal population, because census data for livestock were not available. Even a considerably lower coverage still resulted in a benefit–cost ratio substantially larger than 1 (Table 5).

Where we had the choice (e.g. Table 2), we opted for the more conservative estimate. In addition, we have not elaborated upon any increase of productivity as a consequence of veterinary care, which would in turn increase the benefit–cost ratio. We therefore confidently conclude that the veterinary program is economically feasible.

Comparison with other benefit–cost analyses is difficult as these are generally limited to studies of specific interventions (Food and Agriculture Organization of the United Nations, 1990). Usually the lack of a proper control situation prevents looking into the overall impact of an animal health program. In this respect, the present study is unique, as were—unfortunately—the circumstances in Afghanistan.

What we did not touch was the question of whether the present level of inputs was the optimum. This level seems to be determined rather by external factors, such as donor interest or fatigue, than by economic factors. In the long-term, it will be determined by the 'carrying capacity' of the farming community, which is presently so seriously affected by the sequels of the war.

The reduced mortality rates will lead, over a longer period, to a combination of higher offtake rates and an increase of the animal population. Comparison of the present livestock population numbers with the much higher pre-war figures shows that such an increase is possible for an extended period, presuming that the pre-war figures were not endangering the countries' carrying capacity. The continuation of providing veterinary services therefore remains of prime importance for rebuilding the numbers of livestock.

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