The Economics of Tick and Tick-borne Disease Control in the Former Venda Region of the Limpopo Province

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ABSTRACT

The study is based on a cross-sectional survey of 125 small-scale cattle farmers interviewed in the Venda region of the Limpopo Province of South Africa. It revealed a 3 % mortality rate in spite of the existence of a dipping programme. Cost-benefit analysis revealed a benefit cost ratio of 0.8 (i.e.<1) indicating that the control of ticks and tick-borne diseases by the government is not economically justified. However, because of the economic nature of the service it provides, the dipping of cattle still deserves governmental support. In addition, the provision of tick control services by the government leads to socially optimal level of supply. Sensitivity analysis gives a benefit cost ratio of 1.2 when it is assumed that the mortality rate would have been 10 % without the control programme.

1. INTRODUCTION

Profound changes are underway in delivery systems for animal health inputs and services in much of Africa. Livestock health service delivery in many developing countries is undergoing privatisation as part of an international restructuring programme for economic development. Of relevance to South Africa's developing areas is the recent government withdrawal of dipping subsidies to small-scale cattle farmers. This had some negative impacts on the farmers and the impacts are significant if the multiplier effects are also considered.

The objective of the paper is to demonstrate the costs and benefits of tick control at the farm level. To achieve this objective, the study begins by outlining the methodology applied in this study. The study is conducted within cost benefit analysis framework. The methodological discussion is followed by a cursory discussion of various ticks and tick-borne disease control measures applied in South Africa's developing areas. The "with" and "without" dipping scenario is incorporated into the analysis to provide a basis for cost benefit analysis. The study proceeds with a comparative analysis of costs and benefits for each strategy to determine whether it is economically justified to control ticks and tick-borne diseases. The role of government in the provision of animal health is highlighted. The tail end of the study concludes with some recommendations.

2. METHODOLOGY

On the advice of the former Venda Department of Agriculture (Veterinary Service Division) in the present Venda region of Limpopo Province, it was decided that surveys be conducted in all the veterinary zones namely, Redline, Yellow Line and the Open area. However, due to socio-political reasons, surveys could not be conducted in the Redline area. Two-stage sampling was performed in this study. Firstly, three areas were chosen, each of which contains a diptank for tick control purposes, were chosen within each zone.

Secondly, cattle within each diptank area were stratified by number of cattle, namely 1-10 heads of cattle, 11-20; 21-30 and more than 30 head of cattle representing the categories of stratification. Then, within each stratum, simple random sampling was performed using random number tables. The aim was to obtain 25 respondents from each diptank area using the following formula:

$$(n/N) * 25$$

n= number of cattle owners within each stratum

N= total number of cattle owners in a diptank

The actual number of farmers who participated (125) in the survey is, however, less than the targeted number of 150. The sample was about 80 per cent of the targeted sample, and is considered large enough to be representative.

The study was conducted within a cost-benefit analysis approach because it is much more appropriate for assessing past research projects than for on-going or future research. The main flaw with this technique is that it fails to quantify, in monetary terms, some benefits that farmers derive from cattle production e.g. some small scale cattle farmers keep cattle only for prestige.

3. THE CONTROL OF TICKS AND TICK-BORNE DISEASES

Control measures against ticks and tick and tick-borne diseases were applied on a large scale in southern Africa following the spread of East Coast fever (ECF) from East Africa (Norval, 1994). After the eradication of ECF two options were essentially open to southern African countries; they could either control the remaining major tick-borne diseases (babesiosis, anaplasmosis and heartwater) by vaccination and move towards reduced tick control and endemic stability, or they could continue to control the diseases by intensive dipping. It was established that the most efficient and economical manner for tick control was to target treatment at the parasitic stage and short interval dipping of livestock became the standard method of tick control.

In South Africa, compulsory dipping was abolished and the choice was left to individual farmers (Norval, 1994). However, in some of the previously autonomous South African homelands compulsory dipping carried out by government on communal grazing continued to be enforced through legislation. Although implicitly stated this was also the case in Venda as was stipulated in the Venda Government Gazette which stated that: "By law a stockowner is now compelled to produce his cattle for inspection and tally recording by a stock inspector at the stock inspection point (diptanks) at least every 14 days" (Republic of Venda, 1984). Cattle were brought to the diptank for the aforementioned two purposes to be immersed at the expense of acaricides. According to Lawrence (1996), there is no justification in insisting that every animal be produced every week and immersed at considerable expense in a

tank for other disease control purposes. Compulsory dipping may at one time have been thought to be leading towards eventual tick eradication, which would have provided a possible case for public funding, but today the perception is gaining that eradication is an unlikely prospect.

Cattle were either dipped on a weekly or fortnightly cycle depending on the tick challenge of a particular area, although Bachmann (1992) argues that less than 10 % of the cattle in Africa are dipped with any regularity. There is a large variety of acaricides to choose from, each having its own application and management system (Dipping Policy Survey, 1997). The commonly used acaricides are Grenade, Triatix and Clout (pour-on). Pour-on is generally used in cases where there is a shortage of dipping water and a heavy tick infestation, and when cattle are not in a good enough condition capable of swimming. Unlike Grenade and Triatix provided by the government, Hoechst as part of the Reconstruction and Development Programme package donated Clout. It is a worrying fact that resistance of ticks to the available acaricides is on the increase.

The main reason for the construction of diptanks was because of the outbreak of East Coast fever whose control was dependent on the control of the tick vector. Once East Coast fever was brought under control, it was apparent that dipping was beneficial to the farmer in other ways, as well as to the veterinary services.

The gathering of animals at dipping venues offers opportunities to veterinary services to perform the following important functions:

- Diseases surveillance. The physical concentration of cattle at diptanks is used by the state to perform compulsory cattle inspection. This inspection is in respect to controlled diseases, such as foot-and-mouth disease. Surveillance of foot-and-mouth disease is a function of international, national, provincial and local importance and is based on compulsory inspection at various intervals and movement control (through quarantines) of various intensities in the whole of the foot-and-mouth disease controlled area. However, the danger associated with communal diptanks is that they can act as centres for disease transmission. The surveillance of the status of animals with respect to condition, general health, production and reproduction, as well as monitoring of mortalities is also made possible by the communal cattle dipping system. It is hardly possible, however, to perform diagnostic testing of certain controlled diseases, such as brucellosis, in the absence of the communal cattle dipping set up.
- Extension. Dipping at communal diptanks is also seen as an opportunity for effective extension, education, training, practical demonstration and the collection of census data. Similarly, dipping attendance, *inter alia*, is an important forum for interface between cattle owners and government veterinary officials where cattle statistics are collected and movements permits authorized. Under this system the farmer is obliged to explain the

whereabouts of absent cattle. The costs of performing extension as effectively without this opportunity would be enormous, rendering extension unaffordable and unachievable.

- Dipping venues also offer some unintended services. It was observed that nowadays they also serve as a slaughterhouse for private buyers. Private buyers, e.g. butchers, use diptanks as a place where they can obtain animals for slaughtering, negotiate terms of trade and conclude the transaction only if the buyer and the seller satisfactorily agree on the price. However, the priorities of the cattle owners and the objectives of keeping the cattle play a significant role on the decision to sell. It can be argued that dipping venues provide a place utility to both buyers and sellers and have the advantage of reducing the transaction costs to both buyers and sellers. Fortunately, because of lack of formal reliable markets both farmers and buyers sometimes find themselves in a double coincidence of want situation.

4. COSTS AND BENEFITS OF ALTERNATIVE CONTROL PROGRAMMES

The outbreak of East Coast fever in the early 19th century presented the Venda Government (then the South African Government) with only two basic options, namely to control or not to control. The assessment of an animal health project takes into account the incidence of disease outbreaks before

and after the project, as well as the losses which would result from failure to implement the project (Sidibe, 1981). In this section the two options/scenarios are examined and are referred to as:

- A 'do nothing' strategy ("without" dipping scenario)
- A control strategy ("with" dipping scenario)

Emphasis is given to the comparison of the costs and benefits of each strategy at the household level had the strategy been adopted.

4.1 A 'Do Nothing' Strategy

The introduction of exotic breeds made many of the cattle of Africa vulnerable to tick-borne diseases. Due to breed susceptibility, it would probably have been irrational at the time to adopt this strategy for economic reasons. Had this strategy been adopted, tick-borne diseases would occurred in an epidemic proportions, but as time progressed cattle would have adapted and the situation of enzootic stability would have developed. (Spickett, 1998). The existence of enzootic stability implies that control could have been selective, strategic and focused only on susceptible target cattle populations.

A 'do nothing' strategy would have incurred no additional government expenditure and farmers would have maintained the use of their cattle, although the cattle would not have performed as efficiently as before the introduction of the disease. In addition, the income forgone from cattle

products would have been higher relative to the income forgone under the control strategy discussed below. This is because of the high morbidity and mortality rate estimated to be 4 percent. Although this strategy was not adopted, an effort should be made to estimate the losses in the absence of control and then estimate the extent to which these losses will be reduced by the strategy followed.

4.2 A Control Strategy

One of the most significant consequences of the East Coast fever control programmes was the introduction of compulsory dipping in acaricides throughout the infected areas. Whether eradication of East Coast fever can be attributed entirely to the dipping programme and the other control measures that were applied, or whether climatic changes brought this about, or at least facilitated the elimination of a specific population of ticks responsible for transmission of East Coast fever is open to speculation (Norval, 1994).

The benefits derived under this strategy are higher than the benefits derived under the aforementioned strategy. This is because of a relatively low morbidity and mortality rate of 3 % in the sampled region. Most developing regions were left with a tradition of short interval dipping. If properly applied dipping provides very good control of all tick-borne diseases.

5. A COMPARISON OF THE "WITH" AND "WITHOUT" SCENARIOS.

Project impact analysis attempt to value costs and benefits that arise with the project and compare them with the situation as it would have been without the project (Gittinger, 1982). Both costs and benefits are clearly shown in Table 1 with milk and beef calculated in terms of mortality and a decrease in the productivity of the herd (i.e. morbidity). The forgone income for the "without" scenario due to mortality is higher than the forgone income for the "with" scenario. The difference between the "with" dipping scenario net income and the net income balance for the "without" scenario gives an incremental net loss of R23 475 per sampled herd. This amount represents the loss in income occurred in spite of the existence of the dipping programme. Disease control is economically justified only if the estimated benefits outweigh the costs incurred, i.e. the benefit-cost ratio must be greater than or equal to one. Table 1 shows a benefit-cost ratio that is almost equals to one. (0.8). This ratio was calculated as:

B/C = Δ in total income for both scenario / Δ in total costs for both scenario

According to Morris & Meek (1980: 165)..."monetary values must be used with caution that the numerical values obtained in an economic analysis should be seen principally as a basis for ranking strategies, not as representing the actual benefit which will be achieved under all circumstances".

This ratio suggests that the control of ticks and tick-borne diseases by the government is not economically justified and probably need to be a private sector responsibility. However, in establishing the appropriate roles for the public and private sector in the livestock services industry, it is necessary to obtain a clear understanding of the nature of the tick control service. Not only will the economic nature of the service determine whether private delivery will be feasible, but also whether private provision will results in a socially optimal level of supply (Kirsten & Randela, 1998).

The control of ticks is a private good with externality. This implies that the control of ticks by an individual farmer also benefits other farmers by reducing tick population and the chances of other farmers from getting tick-borne diseases. Therefore due to this free rider problem associated with tick control service delivery, there will be a tendency towards under-provision or no provision of this service when the production decision is profit motivated. Thus, private firms will have no incentive to provide this service because it will not be in the interest of any individual to pay for it.

INSERT TABLE 1 HERE

Furthermore, although the benefit-cost ratio is slightly less than one, this ratio can be improved by reducing the costs involved. This can be done by moving from intensive dipping to a strategic acaricides application. Such a cost

decrease might possibly result in two effects namely, either the same output can be produced more cheaply or the savings can be converted into increases in output. The strategic control of ticks is a strategy based on the fact that ticks exhibit seasonal cycle and that concentration of acaricides application during the peak month of tick activity will effectively interrupt tick feeding cycle, reduce tick population thereby reducing the number of engorged females which lay eggs to perpetuate the generation.

This dipping regime is possible taking into consideration that livestock owners are more particular about regular immersion of their cattle during spring/summer period (September/October – March/April) when the presence of ticks and the damage they cause are obvious, than in winter when only few or no ticks are seen. The presence of ticks on cattle in winter varies from region to region, from few to none, depending on the degree of dryness and severity of winter cold. Thus, in some areas, there may in fact be no need to dip cattle in winter instead of dipping cattle throughout the year. It appears, therefore, that if the strategic dipping regime can be adopted, there can be a significant decrease of the dipping costs and an improvement of the benefit-cost ratio. The magnitude of a decrease in dipping costs depends on the knowledge of the optimal tick control. In addition, the range and magnitude of physical losses avoided, *inter alia*, depends on the control system used, and determined by the technique of control and the success with which it is implemented.

6. SENSITIVITY ANALYSIS

The mortality rate for the "without" dipping scenario is, however, subject to debates and is based on optimistic assumption. Therefore, sensitivity analysis is conducted to determine the robustness of benefit-cost ratio against possible changes in the mortality rates. The sensitivity analysis presented in this section addresses the effects of changes in the mortality rate to 10 % and the results are shown in Table 2. With a 10 % mortality rate without the control programme the benefit-cost ratio increases from 0.8 to 1.2. Thus, it is evident that the benefit-cost ratio is sensitive to changes in the mortality rate. The 10 % mortality rate was chosen assuming that it would have been probably the second lowest mortality rate to prevail in the absence of the control programme.

INSERT TABLE 2 HERE

The sensitivity analysis also shows an incremental net benefit of R10 658 per sampled herd. It is important to note that the incremental net benefit derived represent the loss in income which would have resulted from failure to implement the dipping programme.

Sensitivity analysis based on various mortality rates (i.e. worst case scenario) was also performed. In addition to the 4 and 10 % mortality rate already analysed, Table 3 further shows the probability of occurrence for various

mortality rates together with their respective benefit-cost ratios. It is evident from Table 3 that in the "without" dipping scenario, the would be mortality rate is inversely related to the probability of occurrence. This is because higher mortality rate e.g. 21 % is relatively a worst-case scenario that is unlikely to occur, hence the low probability of 2 %. At 15 % and 21 % mortality rate the benefit-cost ratio is 1.5 and 2 respectively.

INSERT TABLE 3 HERE

Attempts to supplement this analysis with other measures of project value, internal rate of return and net present value, were made. But lack of both benefit and costs series of data as well as data on initial investment costs precluded the performance of the analysis. This lack of data surely underscores the importance of institutionalising project monitoring and evaluation within the South African agricultural research system.

However, wherever programmes involve public expenditure the authorities responsible now require, *inter alia*, clear demonstration that programmes will show a net benefit and the extent of such benefits need to be indicated. In performing analyses of ongoing programmes, there has to be a comparison of projected future progress with what would happen in the future if the programme can be discontinued (Beal, 1980). Therefore, what is of relevance today is the analysis of what will happen in future if dipping can be completely

discontinued. It is estimated that in the first, second and third year farmers are likely to face an average mortality rate of 10, 6, and 4 percent respectively (Spickett, 1998). Thus, it will only take 3 years for the herd to develop an acceptable immune system to the extent that the mortality rate can stabilise at 4 %.

The reason for the high mortality rate in the first year is that dipping to some extent destroyed the immune system of especially the indigenous African breeds. In addition, it resulted in an interruption in the transmission of tick-borne pathogens and led to the establishment of a susceptible cattle population which was followed by the loss of the existing situation of enzootic stability. Considering a 10 % mortality rate, of the total sampled herd of cattle (1976) 198 cattle are expected to die of tick-borne diseases resulting in a R228 0986 (198 * R1 152, see Table 4 in the appendix) loss to the sampled cattle owners. Obviously, dipping should continue but the manner in which it should continue would require further investigation with all participants within the livestock industry.

7. THE ROLE OF GOVERNMENT IN THE PROVISION OF ANIMAL HEALTH SERVICES

The political system of South Africa that changed in 1994 also lead to a profound debate on the role that a state should play. In this process of

changes in roles and responsibilities, one frequently asked question is which institution will provide or lead to an optimal delivery of a particular service, public or private institution? The provision of veterinary services is one area that is included in these debates. In most production system the veterinary service cover three broad areas; animal health care, production and public health. According to Gros (1994) animal health services consists of preventative (e.g. tick control) and curative care, as well as the delivery of veterinary pharmaceuticals. Production services on the other hand, are more specifically geared to increase the production of individual animals and herds; they include services such as artificial insemination to achieve genetic improvements.

Animal health care delivery alone involves a wide range of activities, some of which have private good attributes, while others may best be defined as having public good ones. In the veterinary service area some aspects (i.e. curative services and drug sales) exhibit private good characteristics; thus, other things being equal, if delivered by the private sector an economically optimal quantity is likely to be provided. Curative care is, however, only an imperfect private good. It can be argued, especially where contagious diseases are involved, that all producers benefit when one of their neighbours' animal is cured of a disease. If left untreated such disease could spread to other animals. Hence there is a spill-over effects of externality in such cases.

On the other hand, other aspects such as preventative and promotive services are at best public good which will likely be underprovided unless undertaken by an entity other than the private sector. Thus, the privatisation of public goods especially those involving preventative and public health services is likely to result in significant market failures. The only way such goods can be optimally provided is if some kind of public institution assumes responsibility for service delivery. For instance, although it was a traumatic decision, the killing of Foot and Mouth disease infected animals in KwaZulu Natal offered some positive externalities particularly to the other provinces in South Africa and elsewhere. In addition, the vaccination of animals was undoubtedly within public interest since it reduced the risk of disease occurrence.

Until 1998/99, in South Africa's developing areas animal health services (e.g. tick control) were provided at highly subsidized charges or "free of charge". For instance, in the former Venda homeland it costs the government R12.00 and communal farmers R1.00 to dip a head of cattle per year (Randela, 2000).

The abolition of dipping subsidies by the state in the late nineties deprives both the farmers and the state of the services formerly offered by the diptanks. It is hardly possible to perform diagnostic testing in respect of controlled diseases such as FMD, Brucellosis in the absence of the communal dipping set up. In addition the costs of performing extension as effectively without this opportunity is enormous and is beginning to render extension unaffordable

and unachievable. The principle of "pay for services" is a good principle, but not necessarily of first priority in the complicated field of dipping, especially in controlled areas.

Currently the SA government seems to be reluctant to fund animal health services. This is probably due to the government failure to realise the value to the country of the veterinary service or failure to foresee the consequences to society if such a service is not provided.

8. CONCLUSION

The cost benefits analysis of ticks and tick-borne diseases control programmes was done in two scenario, namely the "with" and "without" control scenario. Emphasis was given to the comparison of the costs and benefits of each strategy at the household level, had both strategies been adopted. The income forgone in terms milk, meat, draught power and low productivity under the "without" scenario is larger than the income forgone under the "with" scenario

The results of this paper reveal a benefit-cost ratio which is less than one (0.8) using a 4 % mortality rate. This ratio can possibly be improved by reducing the current dipping costs through the adoption of a strategic tick control. However, the ratio seem to be sensitive to changes in the mortality rate yielding a benefit cost ratio of 1.2 when the mortality rate is changed from 4 % to 10 %. Although

the benefit-cost ratio is less than one, the dipping programme still deserves government support because of the economic (public) nature of the service it provides. More importantly, in less developed areas dipping forms part of the whole veterinary surveillance programme which in essence is a purely public good. A fundamental requirement for the national and international control of animal disease is the provision of a comprehensive system of disease surveillance and disease reporting. The information from the surveillance programme benefits the whole sector and cannot be appropriated by any livestock farmer. Therefore government intervention is necessary to control disease outbreaks and ensure early warning.

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