DEMAND FOR LIVESTOCK TICK CONTROL SERVICE IN THE VENDA REGION, NORTHERN PROVINCE

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This article analyses factors influencing farmers' willingness-to-pay for dipping services, as well as the revealed preference for dipping frequency using the multivariate and the logistic regression models. The study is based on a cross sectional survey of 125 small-scale cattle farmers interviewed in the Venda region of the Northern Province. Empirical multivariate and the logistic regression analysis show that liquidity, human resource, satisfaction with the programme and structure of production significantly influences farmers' willingness-to-pay. However, the most important factor influencing both the willingness-to-pay and the dipping frequency is liquidity (employment). The results of this study have important implications for the delivery of veterinary services particularly in developing regions.

1 INTRODUCTION

Animal health control services remain an important input support function for any livestock farmer, as diseases and high mortality are major constraints on livestock production in Southern Africa (Nell *et al.*, 1998). In South Africa's developing areas animal health services are provided at highly subsidised charges or "free of charge". It costs the government R12.00 and communal farmers R1.00 to dip a head of cattle per year. Under government service, it is compulsory by law for farmers to take their animals for dipping at stated intervals to achieve more effective and widespread control. Cattle are either dipped weekly or fortnightly depending on the tick challenge.

The main objectives of this study is to identify factors that influence farmers' willingness-to-pay, as well as the revealed preference for dipping frequency from the point of view of the respondents if dipping legislation were to be relaxed. To achieve this, a multivariate regression analysis and a logistic regression model are applied. A fundamental purpose of multivariate

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regression analysis is the prediction of the dependent variable with a set of independent variables. In addition, logistic regression analysis presents a unique complement to multiple regression in its ability to utilise a binary dependent variable but also predicts the probability of an event.

Identification of factors that determine the demand for livestock services can possibly have promising and cost-saving impacts on the planning and extension of future livestock disease control programmes. In addition, the rationale for identifying those factors is important, more particularly to extension educators, technical assistants and policy makers involved in livestock development in order to target and deliver effective tick control programmes. However, due to communal farming complexities, this analysis is based on the assumption that dipping price per head of cattle per year remains fixed irrespective of dipping frequency. It is important to note that data limitations precluded the significance and inclusion of all the factors likely to influence the demand for dipping service and the willingness-to-pay for such a service.

2. STUDY AREA, DATA COLLECTION AND SAMPLING PROCEDURE

The survey was conducted in two veterinary zones, Yellow Line and the Open area in the Venda region. On the advice of the Department of Agriculture (Veterinary Service Division), the following diptanks within the Yellow Line area were chosen, namely Tshifudi, Malongana and Matshena. And within the Open area it was Vyeboom, Guyuni and Dzanani diptanks. Personal interviews using a questionnaire were used to elicit information from the farmers.

Two-stage sampling was performed in this study. Cattle within each diptank were stratified by number of cattle, namely 1-10 heads of cattle, 11-20; 21-30 and more than 30 heads of cattle representing the categories of stratification. Then within each stratum a simple random sampling was performed using random number tables. It was targeted that 25 respondents from each diptank should be obtained. However, the actual number of farmers who participated in the surveys is 125.

3. METHODOLOGIES FOR MEASURING DEMAND FUNCTIONS

3.1 Multivariate Regression Model

The multivariate regression model can be expressed as:

$$y_i = \delta_0 + \sum_{i=1}^{n} \delta_i x_i \quad (1)$$

Y_i is the dependent variable, X_i are the explanatory variables. These can include both the dichotomous and continuous variables.

3.2 Logistic Regression Model

The logistic regression model can be expressed as:

$$\text{Log}\left(\frac{P_{(y=1)}}{1-P_{(y=1)}}\right) = \beta_0 + \sum_{i=1}^{n} \beta_I \chi_I \text{ or as} \left(\frac{P_{(y=1)}}{1-P_{(y=1)}}\right) = e^{(\beta_0 + \sum_{i=1}^{n} \beta_i \chi_i)} \quad (2)$$

Where P is the probability that $y = 1$ and χ_i are the set of explanatory variables. In this analysis χ will contain both dichotomous and continuous variables as in the multivariate regression analysis in the previous section. In the second expression in equation (2) the left-hand side is an odds ratio and the right hand side gives the marginal effects of χ_i on the odds.

3.3 Dependent and explanatory variables

The multivariate regression analysis will use the price farmers are willing to pay and the frequency with which farmers would like to dip their animals as dependent variables. These are both continuous. The first variable will be transformed into binary form for the logistic regression. The price farmers are willing to pay will be 1 when the price is higher than what they are currently paying for the dipping service (i.e.>R1.00) and 0 if it is lower (i.e. ≤R1.00). This cut-off in prices was chosen primarily to determine the factors that determine whether a farmer is willing to pay more for the dipping service than (s)he is currently paying.

Several independent variables were selected to estimate the predicted values of the dependent variables. The choice of variables used is largely based on Tambi *et al* (1999) who extensively reviewed factors influencing farmers' demand for private veterinary services. Factors that influence both the willingness-to-pay and the revealed preference for dipping services are arguably similar. Some of the variables chosen were either dichotomous or continuous and are listed in Table 1.

Table 1: Definition of variables influencing both farmers' willingness-to-pay and the revealed demand for dipping services

Explanatory Variables	Variable description
Dichotomous variables	
Residential status	1 – if the farmer is employed 0 – if farmer is not employed
Breed composition	1 – if farming with exotic breed 0 – if farming with Nguni only
Outreach programmes (e.g. farmers' days)	1 – if farmers have outreach programmes 0 – if farmers do not have outreach programmes
Investment	1 – if farmers have alternative investment opportunity beside cattle farming 0 – if farmers do not have alternative investment opportunities.
Crop farming	1 – if farmers also practice crop farming 0 – if farmers do not practice crop farming.
Satisfaction with the dipping programme	1 – if satisfied with the dipping programme. 0 – if not satisfied with the dipping programme.
Perception about the disease*	1 – if farmers associate ticks with diseases. 0 – if farmers do not associate ticks with diseases
Continuous Variables	
Age	Age of farmers in years
Educational qualification	The level of education in years
Farming experience	Number of years of experience with livestock farming acquired by the farmer
Value of the cattle	The value of cattle measured in monetary terms

* *This variable is assumed to have no influence on the farmers' willingness-to-pay for dipping services*

These factors are hypothesised to have different impacts on the dependent variables and the rationale for including these variables in the model is as follows. Demand for the dipping service and the willingness-to-pay are hypothesised as a positive function of employment. This is attributed largely to the income (salary) received which is likely to increase farmers ability and willingness to pay a higher price and possibly demand more animal health services. As far as farmers' age is concerned the relationship may be positive or negative depending on the stages of development. Younger farmers are assumed to have relatively high socio-economic status. These farmers may recognise the importance of maintaining a healthy herd through intensive dipping and as such may be prepared to pay higher prices for dipping services probably because of their understanding of the 'paying for the

service' principle. Whereas very old farmers tend to be less energetic and more relaxed about disease and pest control, obviously these farmers might not be prepared to pay higher prices for a service that they might seldom use.

Closely related with age is experience. It is hypothesised that long term farming experience is negatively related to the willingness-to-pay and positively related to the dipping frequency. Farmers with long term farming experience are generally pensioners and are traditionally not used to the payment of rising prices and are characterised by the dependency syndrome. They have traditionally also been exposed to an intensive dipping frequency at a fixed cost. Thus, the number of years in livestock farming could positively or negatively influence the willingness–to-pay depending on the farmers position in the life cycle.

The variable breed composition was included to account for the differences in responses between farmers with exotic breeds and the Nguni breed. Breed of cattle is expected to influence farmers' willingness-to-pay for dipping services, as well as the revealed preference for dipping either negatively or positively depending on the genetic potential of the breed kept. Exotic breeds are more susceptible and less tolerant to diseases than the Nguni breed. It is therefore hypothesised that farmers with exotic breeds are expected to prefer an intensive dipping programme and will be willing to pay a higher price for the service. This is because farmers with exotic breeds are likely to be those with relatively higher socio-economic status, and *vice versa* for the Nguni breed farmers.

Education and training have been shown to influence farmers' adoption and farm management behaviour (Jones *et al*., 1989). Educated farmers tend to be more conversant with improved husbandry methods and generally recognise the importance of having a healthy herd through disease and pests control. For such farmers, demand for animal health services is high. Thus, farmers with a high level of formal education are expected to prefer an intensive dipping programme and would be willing to pay more for dipping services probably because high education level is mostly associated with higher paying jobs.

Outreach programmes (e.g. farmers' days) are expected to positively influence the willingness-to-pay and negatively influence the dipping frequency. This might probably be the result of the current emphasis on the 'paying for the service' principle and the tick control strategy advocated under the tick control programmes is one of less acaricides application (strategic dipping). In addition, outreach programmes are assumed to be more relevant and

informative than formal education, *ceteris paribus*. The attendance of farmers' days by rural livestock households in less developed areas to an extent reflect the degree of farmers' involvement and commitment in livestock production. Such attendance helps them to be up-to-date and remain informed.

There seems to be a limitation of investment opportunities in rural areas with cattle being the main and better investment opportunity as expressed by 88% of the sampled farmers. Under these circumstances one would expect that farmers without better alternative investment opportunity would be willing-to-pay a higher price and would prefer an intensive dipping service. This is probably because farmers will want to ensure that their investment (livestock) is highly protected from any natural shocks e.g. diseases. Intensive dipping would therefore be preferred to maintain a good health of the animal thereby ensuring the highest possible return from the investments. Crop farming is expected to positively influence the willingness-to-pay and negatively influence the revealed demand for dipping. The positive relationship might be attributed to the income derived from both enterprises that likely increases the buying ability assuming that farmers do sell their surplus produce. The negative relationship, however, can be attributed to labour flexibility between the livestock and crop farming enterprises such that the farmer might not prefer dipping his cattle intensively, as (s)he would like to devote more time towards crop production.

Satisfaction with the programme was also included in the model to reveal farmers' attitude towards the dipping programme. Unsatisfactory services usually yield negative attitudes towards that particular service. Therefore, farmers' willingness-to-pay and the demand for dipping are hypothesised as a positive function of farmers' satisfaction with the dipping service. In addition, satisfaction with the dipping programme implies that farmers might be getting value from their contribution.

The value of the cattle expressed in monetary terms is expected to positively influence both dipping frequency and the willingness-to-pay. Similarly, farmers who highly value their livestock are expected to prefer an intensive dipping frequency. This is due to the fact that healthy animals are usually valued higher than the unhealthy ones, hence the preference of an intensive dipping frequency in order to maintain the value of an animal. If this value can actually be realised, the more farmers will be willing to pay a higher price due to higher income likely to be received. Demand for tick control services is also hypothesised as a positive function of farmers' knowledge about tick-borne diseases herein referred to as perception about the disease. Thus, if

farmers associate ticks with diseases, more farmers would like to intensively control ticks so as to avoid the cause of the disease (i.e. ticks).

4. EMPIRICAL RESULTS

4.1 Factors influencing farmers' willingness-to-pay

Empirical estimates derived from the multivariate regression analysis are presented in Table 2.

Table 2: Multivariate and logistic regression for factors influencing the willingness-to-pay

Independent variable	Multivariate regression results		Logistic regression Results		
	δ_I	t-value (t-Prob)	β_i	t-value (t-Prob)	Exp (β_i)
Constant	2.46	1.24 (0.21)	-0.13	-0.08 (0.93)	0.87
Human resource					
Educational qualification	0.30	0.64 (0.52)	0.31	0.88 (0.38)	1.36
Farming experience	-0.02	-0.77 (0.44)	-0.03	-1.67 (0.09)	0.97
Liquidity					
Residential status (Employment)	1.34	1.48 (0.14)	0.53	0.89 (0.37)	1.69
Structure of production					
Herd composition (Exotic/Nguni)	-1.25	-1.61 (0.11)	-1.07	-1.84 (0.07)	0.34
Value of cattle	0.01	0.49 (0.62)	0.01	0.74 (0.46)	1.01
Crop farming	1.00	1.15 (0.32)	0.37	0.47 (0.64)	1.45
Extension					
Outreach programmes	-1.07	-1.19 (0.24)	0.63	0.87 (0.38)	1.88
Attitude					
Satisfaction with dipping service	1.92	1.47 (0.14)	0.03	0.03 (0.98)	1.03
Regional differences					
Dzanani	-1.77	-1.23(0.22)	-1.55	-1.39 (0.17)	0.21
Guyuni	-3.22	-2.54 (0.01)	-2.76	-2.24 (0.27)	0.06
Matshena	-0.99	-1.05 (0.30)	-0.49	-0.75 (0.45)	0.47
Goodness of fit	0.11		0.81		

The level of significance chosen was 15%, and it was chosen because of the limited number of usable observations from the farmers' survey in estimation. In addition, the level of statistical significance was chosen to be able to determine those variables most affecting the independent variables. The

results of the multivariate regression analysis on the willingness-to-pay indicate that at least three variables are statistical significant, namely residential status (P = 0.14), herd composition (P = 0.11) and satisfaction with the programme (P = 0.14). As expected residential status and satisfaction with the programme variables are of the hypothesised positive sign. Contrary to expectation, however, farmers with exotic breeds are not willing to pay a higher price. This can be ascribed to the communal grazing complexities where a farmer might unintentionally end-up farming with exotic breeds as a result of his/her cattle (possibly Nguni) mating with the exotic bulls of other farmers usually of a relatively high socio-economic status. This to a certain extent indicates a need to strengthen the delivery of extension services to the study area. The extension messages should, *inter alia*, cover topics on the advantages of keeping indigenous African breeds. As such this is an added advantage for ease of implementation of strategic tick control.

There also appears to be strong regional differences with regard to farmers willingness-to-pay. For unknown reasons, the results indicate that farmers in Guyuni are not willing to pay a higher price for dipping services. The goodness of fit is measured by R^2 and judging from the results the explanatory variables explain at least 11% of the variation in the farmers willingness to pay. In models with qualitative dependent variables, the conventionally computed R^2 is likely to be much lower than one because corresponding to a given dependent and independent variables is 0 or 1. As a result the "use of the coefficient of determination as a summary statistic should be avoided in models with qualitative dependent variables" (Gujarati, 1988:472).

Applying the logistic regression model, at least two variables, namely farming experience (P=0.09) and herd composition (P=0.07) were significant at the 10% level of significance as indicated in Table 2. Farmers with a relatively long term farming experience are not willing to pay a higher price for dipping services as expected. Again, as in the multivariate regression analysis farmers with exotic breeds are not willing to pay a higher price for dipping services. There is a slight indication of regional differences in farmers' willingness-to-pay amongst Dzanani, Guyuni and Matshena. The negative sign of all the coefficient in all the aforementioned diptanks indicate that farmers in those diptanks are not willing to pay a higher price. These results are consistent with the results of the multivariate regression analysis. A possible explanation that can be advanced is that the three diptanks probably experience a low tick challenge such that farmers might not see the need for a higher price. If this explanation holds true, it therefore indicates that there are some dynamics in tick occurrence or changes in tick distribution taking place within and

amongst the veterinary zones because one would expect a higher tick challenge in Matshena (Yellow Line area). The specified model provided encouraging results with a goodness of fit of 0.82.

The existence of regional differences in farmers' willingness to pay is probably an indication that financial contribution by farmers towards dipping needs to vary from a region to a region. This is sensible taking into consideration the variation in tick challenge amongst the regions. It appears irrational for farmers in different regions facing different tick challenge and different dipping frequency to contribute an equal amount of dipping costs. It seems therefore that farmers' contribution need to be closely linked with dipping frequency so as to avoid cross subsidisation.

The exponential of β_i column (Exp (β_i)) in Table 2 shows the odds of having an event occurring versus not occurring, per unit change in an explanatory variable. Using this interpretation, the odds for farming experience and herd composition (exotic breeds) to be willing to pay a higher price are 0.97 and 0.34 times less that of their counterparts, respectively. This means that for an additional year of farming experience gained farmers have 0.5 probability to be willing to pay a higher price for dipping, and those owning exotic breeds have a low probability (0.25) to be willing to pay a higher price i.e. exotic breed farmers have a higher probability (0.75) to be willing to pay a lower price. There also appears an indication that farmers in Dzanani, Guyuni and Matshena have a low probability (0.18 on average) to be willing to pay a higher price.

4.2 Factors influencing dipping frequency

Unlike the analysis on the willingness-to-pay, factors influencing dipping frequency were determined using the multivariate regression analysis only. This is because of a lack of clear quantitative identification between intensive and strategic tick control dipping frequency for the survey area. The results are indicated in Table 3.

At least one variable, namely employment ($P<0.001$) was the only significant variable. As expected the demand for the dipping service is of a hypothesised positive function of employment. Thus, employed farmers are prepared to adopt an intensive dipping frequency than the unemployed ones. There is also a slight indication of regional differences in dipping frequency preferences in Dzanani and Tshifudi. Sampled farmers in Dzanani do not prefer an intensive dipping whereas those in Tshifudi seem to prefer an intensive dipping frequency. This probably confirms the existence of differences in tick

prevalence between the two areas, Yellow Line and the Open area, with the former considered as a high tick prevalent area. The goodness of fit as measured by R^2 is impressive since the explanatory variable explain 67% of the variation in the dipping frequency.

Table 3: Multivariate regression for factors influencing the dipping frequency

Independent variable	Dipping frequency Percentage of median	
	δ_I	t-value (t-Prob)
Constant	2.45	0.63 (0.53)
Human resource		
Farming experience	-0.06	-0.97 (0.33)
Liquidity		
Residential status (Employment)	37.66	13.64 (<0.001)
Structure of production		
Herd composition (Exotic/Nguni)	-1.26	-0.52 (0.61)
Value of cattle	0.01	0.88 (0.38)
Crop farming	3.70	1.15 (0.25)
Extension		
Outreach programmes	-1.80	-0.67 (0.50)
Regional differences		
Dzanani	-5.29	-1.60 (0.11)
Tshifudi	4.51	1.38 (0.17)
Goodness of fit	0.67	

The results obtained from both Table 2 and 3 suggest a more significant role of human resource, liquidity, attitude and structure of production (herd composition) over other factors in affecting both the willingness-to-pay, as well as the dipping frequency. However, most governments according to Umali *et al* (1994) no longer have enough funds, are unable to meet the increasing needs of farmers and the availability and quality of veterinary service is rapidly declining. Therefore, information provided by the results of the study illustrate that a good understanding of those factors is necessary for those who want to get into private veterinary practice and for government wanting to privatise the delivery of veterinary services. This is because from a provider standpoint, demand must be large enough to make private practice a profitable endeavour. In addition, the results obtained have certain implications for the extension services especially towards the adoption of new practices. Prospects indicate a move from intensive acaricides application in

favour of less intensive dipping based on strategic tick control. An awareness of those factors influencing the adoption of new practices is, *inter alia*, helpful to the extension agents in selecting the teaching tools to be used to yield the desired resultant end products.

An important question that one may ask is how extension agents can use the results to influence the diffusion process in adopting strategic dipping given factors influencing the willingness-to-pay and dipping frequency? The effectiveness of the extension services or method depends upon the knowledge of the target group. Thus, before strategic dipping can be implemented it is important to know the target group so that the extension method employed can be effective towards its adoption. This is crucial considering that in most cases adoption behaviour differs across socio-economic groups and overtime. From the study results, one can realise that there are various groups of farmers that can be categorised into potential adopters and non-potential adopters. In this regard, extension agents might increase their impact by co-operating with potential adopters since they tend to be people who are capable, willing and sometimes in a position to influence other farmers.

5. CONCLUSION

This paper attempted to identify factors influencing both the demand for dipping services and farmers' willingness-to-pay using the multivariate regression and the logistic regression model. Significant factors influencing the willingness-to-pay were human resource, structure of production, and liquidity. Liquidity also influences the dipping frequency. The influence of liquidity (employment) on both the willingness to pay and the dipping frequency underscores the importance of job creation. More importantly job creation strategies in rural areas should, *inter alia*, aim at increasing the utility farmers gain from cattle by providing marketing opportunities for cattle and their products. These results are an indication that the significant possible predictor variables of adoption must be attended to when adoption policies are set for veterinary services in general.

The structure of production, herd composition in particular, provides an interesting results with both models indicating the unwillingness-to-pay a higher price for dipping services by farmers owning exotic breeds. This to an extent implies that private veterinarians intending to provide veterinary services in less developed regions need to seriously consider the structure of production in order to stimulate the demand for animal health services. On the basis of the preceding discussion, the results of the study seem to indicate

that research needs to be done focussing on the effects of various breed types on the demand for animal health services.

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