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Constraints in the control of animal trypanosomiasis by cattle farmers in coastal savannah of Ghana: Quality aspects of drug use

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ABSTRACT:

Cattle trypanosomiasis is a major constraint to livestock development in Ghana and is demonstrated by the fact that cattle farmers treat the disease by themselves. The main objective of this study is to identify the constraints associated with the control of trypanosomiasis by cattle farmers. To identify the constraints, 250 herdsmen were interviewed on the use of trypanocides to treat cattle trypanosomiasis. The interview focused on treatment procedures such as knowledge of diagnosis, trypanosomiasis treatment procedures, dilutions, injection techniques, volume of trypanocides used and prophylaxis use. The data were supplemented by relevant records and information from the following sources: Department of Veterinary Technical officers (Community Animal Health/Frontline Staffs), District veterinary doctors and the National Head of Tsetse and trypanosomiasis Control Unit.

To empirically estimate the marginal effect of constraints affecting the control of trypanosomiasis, multiple regression equations were run on the PC-SPSS version 16 programme by Ordinary Least Squares (OLS) analysis. In this analysis, the "general to specific" approach of Hendry as found by Koutsoyiannis (1977) was adopted in order to arrive at a coherent regression results. This provided a reliable means of recommending appropriate and effective control strategies and good drug services for traditional husbandry systems.

In this research, certain factors were identified as affecting cattle production. They are, inappropriate dosage of Berenil® used by farmers, selective treatments adopted, pour-on techniques and lack of extension training. Others were the criteria for treatments, inappropriate treatment intervals, underdosing of Berenil® used, and cost of inputs and services. Some others were injection techniques, lack of knowledge of trypanocides and dilution of drugs. These are factors that affect productivity and need to be addressed by policy makers especially by the Veterinary department to improve drug use by herdsmen.

Keywords:
Trypanocides, Berenil® Trypanosomiasis, Constraints, Drug use, Quality Control.

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INTRODUCTION

Certain policies have been instrumental in affecting veterinary drug use, especially trypanocide in Africa. Prominent among these policies is the Structural Adjustment Programme (SAP) which has been a strong factor in the move towards privatization in Africa. A "free market policy" as a component of SAP, has triggered privatisation and commercialisation of almost all sectors of the economy including animal production and the social marketing of Veterinary drugs (especially trypanocides) by the private sector. The belief was that, a free market with price flexibility could maximize the effect of SAP and thereby stimulate economic growth. But the decentralization of the ministry of food and agriculture as a component of SAP created stagnation in national livestock services projects because of unclear responsibilities and lack of communication at national, regional and district levels (Ghana, 1998a) and thereby enabling cattle farmers to treat their own livestock – especially animal trypanosomiasis.

The constraints inherent in SAPs does not only affect the poorest sections of the population, but also failing to steer the economy towards self-sustaining development (Araka Morna *et al.,* 1990). In the agricultural sector for example, the rapid change in the privatization of the veterinary services and provision of drugs has serious implications on disease control. In fact, the failure of livestock production to grow and contribute to national development is not only due to policy changes, nor lack of requisite drugs, inputs and finance. Indeed it is related to drug use.

Until the problems and constraints associated with drug use against animal diseases are recognised, policy reforms promoting livestock production cannot be implemented. This section discusses some important aspects of veterinary drug use especially trypanocides for cattle trypanosomiasis control and makes recommendations. A comprehensive quantification of the impact of trypanosomiasis control on productivity by herdsmen has never been attempted mainly due to a paucity of data on such important factors as diagnosis of the disease, drug dosages, farmers' knowledge of trypanosomiasis and treatment strategies. Prominent among these constraints is the lack of knowledge of on the effects of the disease on livestock productivity; especially the difficulties in quantifying the values of livestock and their products in traditional husbandry systems (ILCA, 1992a).

At the herd or household level, livestock productivity can be measured in terms of the output of meat, milk, inputs of preventive and curative treatments using trypanocidal drugs (Swallow, 2000) whilst incomes, expenditures and profits are commonly used economic measures. Therefore this procedure, analyses the annual costs of livestock products such as milk, meat, manure, hides, and cost of cattle sales in economic terms. Infact, cattle farmers are more concerned with profitability of the use of trypanocide in relation to their livestock and products rather than the products by itself. The productivity in this study was therefore measured and calculated for sales and profits and analysed in the model.

African Trypanosomiasis is one of the most important constraints to livestock development in sub-Saharan Africa. Despite almost a century of research on the subject, and considerable investments, little impact has been made on its control. African trypanosomiasis are caused by species of trypanosomes, protozoan parasites (*Trypanosoma congolense, T. vivax, T. brucei*) that are transmitted by tsetse flies. Currently, the only effective treatment is the continuous dosage of trypanocidal drugs such as *Diminazene aceturate* (Berenil®) and *Isometamedium chloride* (Samorin®). In an area of intensive tsetse challenge, each animal may need several treatments per year.

This study examines the impact of a spectrum of factors on sales, profits, drug use and the prevalence of animal trypanosomiasis among cattle farmers in the coastal Savannah zone of Ghana. This is necessary to identify major factors influencing production and to quantify the relationships. It will also help to inform farmers on the appropriate choice of control measures for cattle trypanosomiasis in the coastal savannah. The objective is to establish a relationship between cattle management practices and cattle productivity as found in the village production systems where animal trypanosomiasis is controlled by cattle farmers themselves. Identifying the procedures and constraints associated with the control of animal trypanosomiasis by cattle farmers is what this research seeks to answer. The models used for the analysis consist of trypanosomiasis prevalence, drug use and sales and variable profit functions.

METHODOLOGY

Trypanocide usage and the constraints in the control of trypanosomiasis by livestock keepers

Knowledge of diagnosis and treatment procedures of trypanosomiasis by 250 herdsmen was assessed by questionnaire to interview respondents on the use of trypanocides to treat cattle trypanosomiasis. Records included the volume of berenil administered to cattle. The data were supplemented by relevant records and information from the following sources: Department of Veterinary Technical officers (Community Animal Health/Frontline Staffs), District veterinary doctors and the National Head of Tsetse and trypanosomiasis Control Unit.

The Models

The research problem discussed in this section considers the impact of farming practices associated with sales and profits on cattle farms. Sales turnover is a measure for defining the scale of enterprises (Harper, 1984). Value added or profit, which is the difference between sales and the cost of purchased material supplied or labour, is a further refinement and theoretically preferable version of sales turnover. The reason is that profit measures the scale of what actually happens in the businesses and excludes the value of materials which are merely bought and sold (Harper, 1984).

This study is the type needed at the micro-level for the successful implementation of agricultural economics and drug use policies. Another advantage of this model is that it helps in the forecasts on sales and profits of cattle productivity as well as factors associated with the control of trypanosomiasis. The research problem is linked to a policy question and the approach to the policy question is in turn embedded in the econometric framework.

Variables used for the Models

The collection and organization of data for this model is described and presented below. Data were required for the dependent variables (sales, profit, trypanosomiasis prevalence, Berenil® dose rate) and independent variables and are presented as follows:

s = Dependent Variable 1: Sales ($)

π = Dependent Variable 2: Profit ($)

λ = Dependent Variable 3: Trypanosomiasis Prevalence (%)

σ = Dependent Variable 4: Dosage of Berenil (mg/kg body wt)

Independent Variables:

VAL.INPUTS: Value of Inputs (in US$)

COST.SERVICES; Cost of Veterinary Services (in US$)

AGE.ENTPRISE: Age of enterprise or kraal (years)

MANAGEMNT.EXP : Management Experience (years)

HERD.SIZE : Herd size (number of cattle)

DOSE Dosage: Estimated Berenil® dosage (milligrams/ kg body weight of cattle)

0 = < 1.9 1 = 1.9-3.4 2 = 3.5-7.0

EDUCATN: Education of herdsman

0=No education, 1 = Basic/primary/JSS, 2 = Secondary/Technical, 3= Training College/Diploma/ University

EXTN.TRG : Extension training (1 if herdsman received extension training, 0 if otherwise)

BUSS.OWN: Business Ownership of livestock (1 if partnership, 0 if sole ownership)

ENCOUNTER.TSETSE : Encounter tsetse during migrations, movements or grazing (1 if cattle do not encounter tsetse flies during cattle migrations, 0 if encounter tsetse flies during cattle migrations or grazing)

KNOW.TRYPANOCIDE : Knowledge of Trypanocides (1 if farmer has knowledge of Trypanocides, 0 if otherwise)

PROF.ADVICE : Professional advice. (1 if farmer seeks or adopts Veterinary Technical advice on trypanocide use, 0 if farmer does not seek professional advice prior to trypanocide use).

DILUTION : Dilution of trypanocides (1 if correct dilution of trypanocide-Berenil® i.e. 1 sachet of Berenil® in 125mls of distilled water, 0 if otherwise)

INJECTION.TECNIQUE: Injection Techniques (1 if farmer uses appropriate needles ie 4 cm (16G) 1.5 mm and injects at appropriate sites i.e. neck or rump and excess injected at two separate sites; or injection by Veterinary Technical officer and 0 if otherwise).

TREATMT.INTERVALS: Treatment Intervals. Correct intervals (3 to 4 months) between Treatments 1, prolonged intervals (> 6 months) between treatments 0)

SANATIVE.PAIR: Sanative pair. Uses sanative pair of drugs (Isometamedium and Diminazene)for trypanosomiasis treatment 1; does not use sanative pair of drugs, 0)

SELECTIVE.TREATMT: Selective treatment. Adopts selective treatment of infected cattle only 1; adopts mass treatment of all animals whenever trypanosomiasis cases are detected 0)

PROPHYLAXIS: Prophylaxis use (1 if farmer treats all animals with samorin® prior to the Period for highest risk such as rainy season and movement of cattle, 0 if otherwise).

ANTIBIOTICS.USE: Antibiotics use (against secondary infections) in conjunction with Trypanocides (1, does not use antibiotics in conjunction with trypanocides for trypanosomiasis treatments; 0 if otherwise)

POURON.TECHNIQUE: Pour-on technique. (Use integrated vector control strategies of pour-on for disease control 1, does not use pour on technique 0)

CRITERIA.TREATMNT: Criteria for trypanosomiasis treatment (ie for drug use). (1 drug used when animal has all the following characteristics: lean, off-feed,diarrhoea, watery eyes, or clinically diagnosed; 0 if drug is used only when animal is lean, weak, off-feed or whenever drug is available).

Production or sales

The sales production function is specified as:

Equation 1.1

S = *f* (VAL.INPUTS, COST.SERVICES, AGE.ENTERPRISE, MANAGEMT.EXP, HERD.SIZE, DOSE, EDUCATN, EXTN.TRG, BUSS.OWN, ENCOUNTER.TSETSE, KNOW.TRYPANOCIDE, PROF.ADVICE, DILUTION, INJECTION.TECHNIQUE, TREATMT.INTERVALS, SANATIVE.PAIR, SELECTIVE.TREATMNT, PROPHYLAXS, ANTIBIOTICS.USE, POURON.TECHNIQUE, CRITERIA.TREATMNT)

where,

S = Sales

VAL.INPUTS = Value of inputs (US$)

COST.SERVICES = Cost of Services (US$)

AGE.ENTERPRISE = Age of enterprise/kraal (years)

MANAGEMNT.EXP = Management experience (years)

HERD.SIZE = Herd size (number of cattle)

DOSE = Dosage of Berenil® used by farmer

EDUCATN = Education of herdsmen

EXTN.TRG = Extension training

BUSS.OWN = Business ownership of livestock

ENCOUNTER.TSETSE = Encounter tsetse (during migrations, movements or Grazing)

KNOW.TRYPANOCIDE = Knowledge of trypanocides

PROF.ADVICE = Professional advice
DILUTIONN = Dilution of trypanocides
INJECTION.TECHNIQUE = Injection technique
TREATMNT.INTERVLS = Treatment intervals
SANATIVE.PAIR = Sanative pair
SELECTIVE.TREATMNT = Selective treatment
PROPHYLXS = Prophylaxis
ANTIBIOTICS.USE = Antibiotics use
POURON.TECHNIQUE = Pour-on technique
CRITERIA.TREATMNT = Criteria for treatment

Variable Profit Function

The variable profit function is specified as:

Equation 1.2

$\pi = f$ (VAL.INPUTS, COST.SERVICES, AGE.KRAAL, MANAGEMT.EXP, HERD.SIZE, DOSAGE, EDUCATN, EXT.TRAING, BUSS.OWN, HUSBNDRY.TYPE, CATTLE.MOVEMNT, ENCOUNTER.TSETSE, ORIGIN.TSETSE, DIAGNS, CLIN.DIAGNS, KNOW.TRYPANOCIDE, PROF.ADVICE, DILUTION, INJECTION.TECHNIQUE, REGULAR.TREATMNT, TREATMT.INTERVALS, SANATV.PAIR, SELECTIVE.TREATMNT, PROPHYLAXS, ANTIBIOTICS.USE, STERILITY, POURON.TECHNIQUE, CRITERIA.TREATMNT

Where,

π= profit

The other independent variables are the same as in (Equation 7.1) above

Functional Forms

In terms of functional forms, equations (Equation 7.1) and (Equation 7.2) are estimated as log-linear equations. The log-linear sales function is shown as:

Equation 1.3

LogS=logb_0+$b_1$logVAL.INPUTS+$b_2$logCOST.SERVICES+b_3ENTRPRSE+$b_4$logMANAGEMNT.EXP+$b_5$logHERD.SIZE+$b_6$logDOSE+$b_7$logEDUCTN+$b_8$logEXTNSN.TRG+$b_9$logBUSS.OWN+b_{10}logENCOUNTER.TSETSE+b_{11}logKNOW.TRYPANOCIDE+b_{12}logPROF.ADVICE+b_{13}logDILUTN+b_{14}logINJEC.TECHNQ+b_{15}logTREATMNT.INTERVALS+b_{16}logSANATV.PAIR+b_{17}logSELECTV.TREATMNT+b_{18}PROPHYLAXS+b_{19}logANTIBIOTICS.USE+b_{20}logPOURON.TECHNQ+b_{21}logCRITERIA.TREATMNT

Equation 1.4

Logπ=logb_0+$b_1$logVAL.INPUTS+$b_2$logCOST.SERVICES+$b_3$logENTRPRSE+$b_4$logMANAGEMNT.EXP+$b_5$logHERD.SIZE+$b_6$logDOSE+$b_7$logEDUCTN+$b_8$logEXTN.TRG+$b_9$logBUSS.OWN+b_{10}logENCOUNTER.TSETSE+b_{11}logKNOW.TRYPANOCIDE+b_{12}logPROF.ADVICE+b_{13}logDILUTN+b_{14}logINJEC.TECHNIQUE+b_{15}logTREATMNT.INTERVALS+b_{16}logSANATIVE.PAIR+b_{17}logSELECTIVE.TREATMNT+b_{18}PROPHYLAXS+b_{19}ogANTIBIOTICS.USE+b_{20}logPOURON. TECHNIQUE+b_{21}logCRITERIA.TREATMNT

Equation 1.5

Logλ=logb_0+$b_1$logVALINPUTS+$b_2$logCOST. SERVICES+$b_3$logENTRPRSE+$b_4$logMANAGEMNT.EXP+$b_5$logHERD.SIZE+$b_6$logDOSE+$b_7$logEDUCTN+$b_8$logEXTN.TRG+$b_9$logBUSS.OWN+b_{10}logENCOUNTER.TSETSE+b_{11}logKNOW.TRYPANOCIDE+b_{12}logPROF.ADVICE+b_{13}logDILUTN+b_{14}logINJEC.TECHNIQUE+b_{15}logTREATMNT.INTERVALS+b_{16}logSANATIVE.PAIR+b_{17}logSELECTIVE.TREATMNT+b_{18}PROPHYLAXS+b_{19}logANTIBIOTICS.USE+b_{20}logPOURON.TECHNIQUE+ b_{21}logCRITRIA.TREATMNT

Equation 1.6

Logσ=logb_0+$b_1$logVALINPUTS+$b_2$logCOST.SERVICES+$b_3$logENTRPRSE+$b_4$logMANAGEMNT.EXP+$b_5$logHERD.SIZE+$b_6$logDOSE+$b_7$logEDUCTN+$b_8$logEXTN.TRG+$b_9$logBUSS.OWN+b_{10}logENCOUNTER.TSETSE+b_{11}logKNOW.TRYPANOCIDE+b_{12}logPROF.ADVICE+b_{13}logDILUTN+b_{14}logINJEC.TECHNIQUE+b_{15}logTREATMNT.INTERVALS+b_{16}logSANATIVE.PAIR+b_{17}logSELECTIVE.TREATMNT+b_{18}PROPHYLAXS+b_{19}logANTIBIOTICS.USE+b_{20}logPOURON.TECHNIQUE+ b_{21}logCRITRIA.TREATMNT

Estimation Procedures

The Ordinary least Squares (OLS) was applied to the data regressions in equations (Equation 1.1) and (Equation 1.2). When ordinary least squares is appropriately applied to data, the choice among all possible lines is normally done on the basis of the least squares criterion. The rationale for this criterion is easy to understand:

It is intuitively obvious that the smaller the deviation from the line, the better the fit of the line to the scatter of the observations. Consequently from all possible lines, we choose the one for which the deviation of points is the smallest possible. The least squares criterion requires that the regression line be drawn (i.e. its parameters be chosen) in such a way as to minimize the sum of squares of the deviation of observations from it.

Test of Significance

Test of significance of parameter estimates was carried out by the use of the student t-test. Traditionally, in econometric applications, researchers (Koutsoyiannis, 1977; Wonocott and Wonocott 1979) test the null hypothesis H_0 : b = 0 for each parameter, against the alternative hypothesis $H_1 : b_1 \neq 0$

This type of hypothesis implies a two-tail test of a chosen level of significance, usually at the 5 % (and more rarely at the 1% level). We compute the t ratio for each b_1. This is the observed (or sample) value of the t ratio which we compare with the theoretical value of t obtainable from the t-table with n-k degrees of freedom (where n = number of observations and k = number of independent variables). The decision rule (for significance tests) is that the t-values associated with independent variables that are equal to or greater than theoretical value ($t_{.05\ (2)n-k}$) are considered to have significant effects on the dependent variables (eg. sales, profits) and are retained in the model (Koutsoyiannis, 1977).

Testing for the overall significance of a regression, we generalize the test for models including any number of explanatory (independent) variables. Such tests aim at finding out whether explanatory variables do actually have any joint significance influence on the dependent variable. Formally the test of overall significance of the regression implies that the null hypothesis

$$H_0 : b_1 = b_2 = \ldots\ldots\ldots\ldots\ldots\ldots b_k = 0$$

Against the alternative hypothesis

$$H_1 : \text{not all } b_1\text{'s are zeros}$$

If the null hypothesis is true, that is, if all the true parameters are zeros, there is no linear relationship between Y and the regressors. To test for the overall significance of the regression, F ratio is computed and compared with the theoretical F* (at p = 0.5 level of sinificance) with v_1 = k-1 (numerator) and v_2 = n-k (denomenator) degrees of freedom. If F* > F, we reject the null hypothesis, ie. we accept that the overall regression is not significant: not all b1's are zeros. If F* < F, we accept the null hypothesis, that is, we accept that the overall regression is not significant. In general, higher values of F* suggest significant relationships between the dependent variable and the independent variables.

The generalization of the formula of the coefficient of multiple determination maybe derived by inspection of the values of R^2 (goodness of fit). It should be noted that the inclusion of additional independent variables in the function can never reduce the coefficient of multiple determination and would usually raise it. By introducing a new regressor, (independent variable) the value of the numerator of the expression for R^2 is increased, and the denominator remains the same (Koutsoyiannis, 1977). It is important to adjust $R^2 (\check{R}^2)$ by taking into account degrees of freedom [df] which decrease as new regressors (independent variables) are introduced into the function. The R^2 expresses the goodness of fit or the coefficient of multiple determination. In this case it expresses the proportion of the total variability on dependent variables (sales and profits) attributable to the dependence of sales and profit on the joint independent variables. The greater the proportion (near unity), the better the goodness of fit of the values of joint independent variables around their mean.

In conclusion, it should be noted that, while the t values determine the significance of the respective independent variables, the F-value determines the overall (or collective) significance of the independent variables of the results obtained from the computer. The R^2 determines coefficient of multiple determination of the regressors (independent variables).

Economic Theory and "a Priori" Expectations

Certain independent variables were included in the sales (Equation 1.1) and the profit functions (Equation 1.2). The reasons for inclusion of these variables may be explained by the fact that some were variables to be tested in the hypotheses. Others were findings from the field research while the rest were derived from literature review and also responses from respondents as factors affecting the control of animal trypanosomiasis.

Among the variables included in the equations, expectations were made on the signs of each as they could affect sales and profit. For example, in equation 1.1 coefficients b_1 (value of inputs) and b_2 (cost of services) were expected to have negative signs. This is because profitability of the use of trypanocides is determined by the cost of inputs (drugs) and services/ treatments (Brandl, 1988). Jahnke (1974) and Adelheim (1980) estimated the cost of treatment to be between 50 and 100% of the cost of drugs. In Uganda for example, (Jahnke, 1974) estimated that the cost for trypanocides used by pastoralists amounted to 50% of their family incomes. The age of cattle business b_3 (Enterprise) and b_4 (management experience) were expected to be positive because most of the herdsmen have many years of experience. Hisrich and Peters (1992) have explained that entrepreneurial experience is one of the best predictors of success, particularly when the new venture is in the same field as the entrepreneur's (herdsman's) new experience.

The herd size (coefficient b_5) was expected to be positive and the dose rate b_6 negative. Appropriate dosage rate in the field is difficult because procedures depend on the accurate estimation of body weight (Connor, 1992). The coefficients b_7 (education of herdsmen) was expected to have positive signs because as noted by Harper (1984), educational background or training normally equip the entrepreneur (farmer) with knowledge to plan and manage his business and thereby survive in economically turbulent times (Anheier and Siebel 1987). Furthermore Swallow (2000) found that migratory pastoralists with higher education raise more livestock as compared with less educated. Extension training (b_8) was expected to be positive because this could assist the farmer with the knowledge to increase productivity. Business ownership type (b_9) was expected to be negative in the area. Sole and family proprietorships are unable to meet adequately the financial needs of Small Scale Enterprises SSEs (Popiel 1994; Soyibo 1996; Aryeetey 1995). On credit they are constantly being discriminated against obtaining credit (Liedholm and Mead 1987) and they are unable to meet the cost of inputs.

The presence of tsetse (b_{10}) is expected to be negative because as livestock pass through high-risk areas they are infected with trypanosomiasis that could deteriorate animal health and decrease productivity (Brandl, 1988). Knowledge of trypanocides (b_{11}) and professional advice (b_{12}) are both expected to be negative because the herdsman or owner carries out the treatment without regular Government Veterinary supervision. Dilution (b_{13}) of drugs and injection techniques (b_{14}) are both expected to be negative because of the difficult nature of making up solutions correctly on the field (Connor, 1993) and the difficulty of getting access to the use of appropriate needles.

Treatment interval (b_{15}) and the use of "sanative pairs" of drugs (b_{16}) are expected to be negative because they are generally done without regular Veterinary supervision. The amount of trypanocidal drugs used in Africa is known to be small in relation to the numbers of animals at risk (Anheier and Siebel 1987). (Trail, Murray *et al.,* 1984). Although the concept of a "sanative pair" of drugs is known to be effective against trypanosomes (Brandl, 1988) drug use among farmers depends on availability. Selective treatment (b_{17}) is expected to be positive because mass treatment is now known to have led to the appearance of resistant trypanosomes (Geerts and Holmes 1998). Prophylactic drug use (b_{18}) is expected to contribute positively in the control of the disease (Lee and Maurice 1983). Antibiotic use (b_{19}) is expected to contribute negatively because of the likelihood of drug misuse (Roderick, Stephenson *et al.,* 2000). The use of the pour-on (b_{20}) is expected to be positive because it prevents infection with trypanosomes and thereby improve animal health to increase productivity (Brandl, 1988). Trypanosomiasis control requires an integrated approach using drugs and vector control to reduce the tsetse challenge (Peregrine, 1994). Criteria for treatment (b_{21}) are expected to be negative because farmers were not trained to identify the disease.

Sales and Profit Function Results

The findings of sales and profit functions indicate that the signs of the coefficients were all similar except for cost of services (b_2), education of herdsmen (b_7) and the criteria for trypanosomiasis treatments (b_{21}) which were positive for profit models. Contrary to expectations, the coefficient b_1 (value of input) was positive. The cost of service (b_2) was negative for the profit model as expected. Management experience (b_4) was positive as expected and herd size (b_5) was positive for both sales and profit. Other findings were that: age of enterprise (b_3), dosage of Berenil® (b_6) and business ownership (b_9) were positive while education of herdsmen (b_7), Presence (or encounter) of tsetse were negative as expected. Contrary to expectation, Knowledge of trypanosomiasis (b_{11}) was positive for both sales and profit. Dilution of drugs (b_{13}), injection techniques (b_{14}) and treatment intervals b_{15} were all positive in the model. Furthermore, it was observed that the following coefficients were positive as expected: sanative pair of drugs (b_{16}), selective treatments (b_{17}), prophylaxis (b_{18}), and pour-on technique (b_{20}). The criteria for treatment (b_{21}) was negative as expected. Antibiotic use (b_{19}) turned out to be positive.

Re-estimation of the models

In this study, only certain variables turned out as expected in the previous equations (Equation 1.2 and 1.4), Apart from the variables that were dropped by the computer itself probably due to collinearity, those variables that had very low t-values ($p > 0.05$) were also dropped from the subsequent equation to re-estimate the model. The reason was that, these variables were unreliable.

Re-estimated Sales and profit function results

The re-estimated sales model is presented in Table 1 and while the re-estimated model for profit is presented in Table 2. The re-estimated models for trypanosomiasis prevalence and dosage of Berenil® by herdsmen are presented in Table 3 and Table 4 respectively.

DISCUSSION

Constraints associated with drug use by herdsmen

The findings of this model have been compared to the objectives, hypothesis, and literature review and are discussed below. The focus of this discussion is mainly on the constraints associated with the use of Diminazene aceturate (Berenil®) by herdsmen for the

Table 1: Re-estimated sales model of herdsmen

Variables	Beta	t-value	p-value
Constant (K)	2.3890	26.5500	0.001
Farm size	0.2000	8.9810	0.001
Management experience	0.2110	3.5581	0.001
Prophylaxis	0.1000	3.5990	0.000
Age of enterprise (kraal)	0.2060	2.9840	0.003
Dosage of Berenil®	0.0056	2.6640	0.008

Table 2: Re-estimated Profit model of herdsmen

ariables	Beta	t-value	p-value
Constant (K)	2.3420	24.219	0.001
Farm size	0.1760	7.488	0.001
Age of enterprise (kraal)	0.2640	3.545	0.001
Prophylaxis	0.0082	2.761	0.006
Management experience	0.1680	2.655	0.008
Dosage of Berenil®	0.0074	3.105	0.002
Extension training	-0.0071	- 2.376	0.018
Business/cattle ownership	0.0035	2.117	0.035

control of cattle trypanosomiasis.

Important issues have emerged in this model. Firstly, it has been observed that, there is a significant ($p < 0.05$) impact of the joint regression between sales and the independent variables and also a significant ($p < 0.05$) impact on the joint regression between profit and the independent variables. Similar findings were observed for trypanosomiasis prevalence and dosage of Berenil® as dependent variables in relation to the respective independent variables. However only certain independent variables were identified to have significant ($p < 0.05$) impacts on sales, profit, trypanosomiasis prevalence and dosage of Berenil®. Although some variables were insignificant ($p > 0.05$) others had positive impacts on productivity. For example, it was observed that cattle management experiences ($p < 0.001$), age of kraal ($p < 0.001$), farm size ($p < 0.001$), dosage of Berenil® ($p < 0.001$) and prophylactic use of drug ($p < 0.001$) had positive impacts on sales. This establishes an important equation which explains that those who adopt prophylaxis and an increased dosage of Berenil® have higher chances of increasing their output for sales and profit margins.

Farm size was observed to have a positive impact on productivity (Table 1). In other words large scale farmers (> 99 cattle) appear to have more outputs and benefits than medium (50-99 cattle) and small scale farmers (<50 cattle). The results show that for every unit of increase (1%) in farm size increases sales by 0.002 and profit increases by 0.00176. This is an encouraging finding for farmers whose priority is cattle population increase. However some workers believe that as livestock population increases and/or tsetse free areas are taken up by other forms of land use, it may become necessary for livestock owners to enter tsetse infested areas and there is a tendency for some of the cattle to acquire trypanosome infections (Lee and Maurice, 1983). Jordan (1986) explained that as challenge increases the problem of administering drugs effectively and the consequent risk of a high incidence of drug resistance developing also increase. The result further shows that farm management experience had a significant ($p < 0.001$) impact on profit. The issue of farm management has been noted by other researchers (Trail, Sones *et al.,* 1985). They showed that a good farm management and an efficient trypanosomiasis monitoring programme (chemoprophylaxis) is highly effective in maintaining cattle in areas of high tsetse challenge.

On the issue of farm management, (Sadhu and Singh 1995) explained that the farmer normally acts as entrepreneur or proprietor of the farm business and is responsible for framing the general policy or plan of his business or his system of farming. Indeed some writers (Haaijer-Ruskamp and Dukes 1993) have noted that these social and cultural setting influence peoples' response to the drug. They further explained that pharmacology, epidemiology and social sciences determine drug use. There is no doubt that in areas of

Table 3: Re-estimated trypanosomiasis prevalence model

Variables	Beta	t-value	p-value
Constant (K)	1.1530	17.984	0.001
Treatment intervals	-0.0088	- 3.080	0.002
Dilution	-0.2140	- 2.992	0.003
Dosage of Berenil®	0.1070	2.394	0.017
Selective treatment	0.1110	2.084	0.038

Table 4: Re-estimated model; dosage of Berenil® usedby herdsmen

Variables	Beta	t-value	p-value
Constant (K)	3.131	6.833	0.001
Education of herdsmen	0.543	4.919	0.001
Pouron technique	-0.652	-3.683	0.001
Districts	0.00528	2.161	0.032
Ownership of business	-0.177	-1.990	0.048

low trypanosomiasis challenge, it is more economical to control the disease by chemotherapy than by tsetse control (Jordan, 1986).

Brandl (1988) has added that, the prevention of loss of performance of animals as a consequence of trypanosomiasis has economic significance for the livestock enterprise and for the national economy. The cultural setting determines how society views drug use in terms of its social acceptability and its social significance (Haaijer-Ruskamp and Hemminki, 1993). Non-compliance has become an important issue in medical, veterinary and socio-scientific research. It becomes more pronounced where the prescribed treatment is complex (Hingson, 1981) and long (Sackett and Snow 1979) or where there are side effects (Christensen, 1978). Haaijer-Ruskamp and Hemminki (1993) clarified this issue by explaining that health care systems vary widely from country to country because they are embedded in different historical, social, cultural and political values of the country. For example, the principle of equal access to drugs is associated with a more general emphasis on social equality and with a socio-political structure that more readily accepts governmental control.

Prominent among the constraints associated with drug use was the dose of Berenil® used by farmers and its positive impact on trypanosomiasis prevalence. For the fact that dosage of Berenil® had a positive impact on trypanosomiasis prevalence suggests that there could be a threat of resistance of trypanosomes to the drug (Berenil®) in the study area. Dosage of Berenil® however had a significant ($p < 0.05$) impact on both sales and profit. Although dosage was expected to have a negative ($p < 0.001$) impact on both sales and profit, it was contrary. But the survey showed that only two districts (Akatsi and AMA) used the appropriate dose (3.5 to 7.0 mg/kg body weight of Berenil®). One of the main difficulties in the field is to achieve correct dosage rate because appropriate dose depends on the accurate estimation of body weight which is difficult to achieve.

When subcurative doses of trypanocides are given by livestock owners or herdsmen, there is the danger of selecting resistant trypanosomes (Connor, 1993). Weight estimation by eye is a method which is prone to inaccuracy and perhaps the greatest source of error in the accurate administration of drugs (Boyt, 1984). This method is ineffective (Connor, 1993) especially with trypano-susceptible cattle. The reason is that the animals have to be treated several times if sub-therapeutic doses are given. In fact it is a method which requires skills that can only be acquired by training which only few livestock owners and veterinary staff have the opportunity to acquire (Connor, 1993). The risk associated with frequent treatment of cattle with trypanocidal drugs especially in cattle with poor body condition has been noted in Kenya by Stevenson and Sones *et al.,* (1995).

The effects of trypanocide dilution and treatment intervals on trypanosomiasis were both inversely proportional and tend to decrease trypanosomiasis prevalence (Table 3). The survey indicates that most farmers had two blanket treatments yearly; the dilution was a sachet of Berenil® in 125 mls of distilled water. It was usually measured with a syringe that were recommended for the appropriate amounts. Therefore preparation of injectable solution was not a problem among farmers in the study area as expected. However the appropriate dose was not administered by all farmers. Surveillance is necessary in addressing the problem of dosage and in determining the treatment intervals of chemoprophylactic regimes. Although drug surveillance schemes were set up in 1964 to identify risks WHO (1972) it is not effective in developing countries. The need for treatment is judged by the farmer. The farmer's response generally is to treat only problem animals i.e those with clinical disease that are recognised as sick and whose productivity or life is visibly threatened (Connor, 1993).

(Brandl, 1988), explained that under normal circumstances herd treatment should be carried out through regular administration of a curative dose of Berenil® or Samorin® as a prophylaxis. But the cost of monitoring and logistical requirements limit the efficiency of prophylactic regimens. The requirements today of farmers to pay for such treatments make it less likely that herd prophylaxis will be widely practised under traditional management systems. The explanation is that, there is a general belief that the cost of trypanocidal drugs and their use is high. Trail *et al.,* (1985) argued that "notions" of high cost of trypanocidal drugs and their use is a reasonable but unfounded assumption because there is little published information on the economics of use of trypanocidal drugs on livestock productivity. But some writers (Haaijer-Ruskamp and Dukes 1993) believe that alongside the medical/veterinary and social determinants of drug use economic factors play an important role. They argued that money has always been relevant to the use of drugs and indeed the best medicines were available only to the wealthy. On the cost factor, Kimbel (1993) added that although it concerns national administration it is a matter that must concern the health professionals as a whole. In the light of this argument one observes that drug utilisation can make an important contribution by striking a balance between the benefits and the risk of drug use (Haaijer-Ruskamp and Dukes, 1993).

The age of cattle business/enterprise (Kraal) (Tables 1 and 2) had positive impacts on sales and profit respectively. In fact the entrepreneurial age (age of herdsmen reflected in experience) and their chronological age are the best predictors of success particularly when the new venture is in the same field as enterpreneur's (herdsman) new experience (Hisrich and Peters, 1992). Cattle farming as an enterprise has been noted to be an old business among Fulani herdsmen in particular (Dickson and Benneh, 1995) and this could have an advantage in enhancing productivity.

Certain factors had positive impacts on the dosage of drug use (Table 4): Education of herdsmen had positive impacts on the use of Berenil®. Extension training was inversely correlated with profit. Extension training and educational background in general normally equip the herdsman with knowledge to plan and manage a business. This is however not the case in the study area where extension training has not yet been given to most of the farmers.

Pour-on techniques and farm/business ownership had negative impacts on drug use. In other words farmers with a higher education level who used pour-ons (jointly with drugs) tend to decrease the dosage of Berenil® used and communal farms did not comply with appropriate doses as compared to farms that were family owned or solely owned. It is like farms that where farms were communally owned, different farmers attempted to influence the herdsmen's practices. Other constraints were identified in the model and are were presented in the model itself. Antibiotic use in conjunction with Berenil® had some positive impacts on sales and profit and even decreased trypanosomiasis prevalence. The use of antibiotics mixed with trypanocides has had also been noted among cattle farmers (massai pastoralists) in Kenya by (Roderick, Stephenson *et al.,* 2000). These farmers used homidium or diminazene in conjunction with oxytetracycline in the absence of Veterinary supervision. There were other factors correlated with trypanosomiasis prevalence in the model but these were not significant ($p > 0.05$). These were the poor injection techniques and criteria for treatment. Other factors had negative impacts on trypanosomiasis prevalence. These factors were: knowledge of trypanocides, professional advice, sanative pair of drugs and prophylactic drug use.

The variable "criteria for trypanosomiasis treatment" tends to increase trypanosomiasis prevalence. This implies that the diagnosis and treatment of cattle trypanosomiasis among farmers have been questionable. Farmers normally attribute anaemia to trypanosomal infection but it is important to note that there are other important anaemia causing pathogens such as gastrointestinal helminths that affect cattle productivity (Agyemang, Dwinger *et al.,* 1997). Farmers and veterinarians normally resort to treatment of only sick animals with trypanocides based solely on certain retrospective symptoms (Connor, 1993), but the presence of concurrent diseases could mask trypanosomiasis and complicate the clinical picture. However, some of the basic symptoms generally adopted by farmers in the study area are anaemia, rough hair coat and diarrhoea (Aning, Karbo *et al.,* 1998).

CONCLUSION

This research has shown that there is no control of drug use, especially trypanocide (Berenil®) by cattle farmers. The effect is that there are constraints associated with trypanosomiasis control limiting the expansion of livestock expansion in the study area. This model has identified some constraints associated with trypanocide drug use by herdsmen. Some of these constraints pose threats to the emergence of resistance strains of trypanosomes. To address these problems, there is the need for a trypanocide classification system as a tool for comparative studies of both supply/ marketing and use. Such a system will provide a solid basis on which to compare trypanocide drug use among farmers in the study area. Furthermore, the veterinary department and the Ghana standards board in consultation with the government should promote the accreditation of Veterinary drug stores at national, regional and district levels. The Ghana Veterinary Medical Association should be encouraged to promote professional ethical standards by formulating a code of ethics assuring quality of services provided for the community.

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