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Empirical validation of reliability of triangulation methods of mixed-method mode research: Quality improvement strategies for trypanosomiasis control

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ABSTRACT:

This paper presents a continuum of triangulation designs ranging from Participatory Rural Appraisal (PRA), surveys, parasitological to satellite data for a holistic approach to a research on trypanosomiasis – a disease affecting human and livestock. The purpose is to combine several methods to improve the quality of trypanosomiasis control in the coastal savannah. This is the most extensive work on trypanosomiais in an African coastal savannah ecosystem, covering eleven districts in Ghana. In this study, quantitative results were supplemented by qualitative methods to improve on the validity and reliability. The study focused on farmers' production objectives, constraints associated with the use of Berenil® to control trypanosomiasis, and satellite data for mapping areas at the risk of diseases for appropriate targeting, predictions and control. This mixed-method studies seeks convergence (triangulation), of results by examining different aspects of a phenomena (complementarity) on using methods sequentially (development) on discovering paradox and fresh perspectives (initiation), and on adding breadth and scope to a project (expansion). In this paper, issues of triangulation, validity and reliability has been discussed.

Keywords:
Triangulation, Tsetse, Trypanosomiasis, Berenil, Dosage, Mixed-Method.

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INTRODUCTION AND PROBLEM STATEMENT

Multiple methods have in social science a distinct tradition of research strategy. This study adopts a multimethod/multitrait (Campbell and Fiske, 1959; Creswell, 1994), or "triangulation" (Webb *et al.,* 1966). These notions share similar conception that there is the need to combine qualitative and quantitative methods as complementary. But combining methods alone has been viewed as somewhat controversial (Hilton, 2002) because there are other types of triangulation that need to be addressed for confirmation and completeness. Some of these triangulations are theory, data sources, methods and analysis. The reason for such mixed-methods is that limitations in single methods do not manifest in mixed-methods (triangulation) and this could improve the validity of research findings (Mathison, 1988). It is not the simple combination of different kinds of data that matters but the attempt to relate them so as to complement each other and counteract the threats to validity in each. This is what the current paper seeks to explain. It gives an in-depth analysis and explanation and exemplifies how multi-methods could be used to converge and validate data for a holistic approach as evidence for decision making on trypanosomiasis planning and control.

Problem Statement

Tsetse and trypanosomiasis control are public health programmes in Ghana, but sustainable control has not yet been achieved. Several unsuccessful attempts have been made in the past to control the disease (Stewart, 1937, 1946, 1954; Nowosielki-Slepowron, 1962; Ghana Ministry of Food and Agriculture, 1996) but currently some 60 % of the country is still infested with various species of tsetse flies (Ghana Ministry of Food and Agriculture, 2009).

The control of the disease is a complex (and multifaceted) and requires investigation into several aspects for a holistic approach. This study is one such example adapting several methods to arrive at a coherent result for targeting and control.

RESEARCH METHODS AND RESULTS

Rationale for Research Approach and Methodology

This research, combines qualitative and quantitative design as the most appropriate method of analysis. In support of the mixed methodology design in procedure and data analysis, Morse (1991) stated, "a project must be either theoretically driven by the qualitative methods incorporating a complementary quantitative component, or theoretically driven by the quantitative method, incorporating a complementary qualitative component".

The main purpose of this research was to explore the views of cattle farmers on the importance of trypanosomiasis in relation to their production objectives and to find out how farmers controlled cattle trypanosomiasis in the area. This research was to develop a model that could identify the constraints affecting control of trypanosomiasis by farmers in the study area as well as predictions of the disease. Therefore a mixed-methodology design of both qualitative and quantitative approaches was adopted. As qualitative research occurs in natural settings where human behaviour and events occur, it was rightly used for certain aspects of the study although supplemented occasionally with quantitative tools.

In certain aspects of the research, the qualitative suggestions of (Marshall and Rossman, 1989) and the Participatory Rural Appraisal (PRA) Techniques (Grandin and Young 1994; Hadgu, Yisehak, and Tekle 1992; Kirsopp-Reed and Hinchcliffe, 1994) were adopted. This is because the focus of this research was on respondents' perception and experiences (Locke, Spiriduso, and Silverman, 1987, Fraenkel and Wallen, 1990; Merriam, 1988; IAEA, 1998) especially of major animal health problems (Catley, 1997), and to assess the success of disease control measures (Catley, 1997;

Ghirotti, 1993; McCracken, Pretty, and Conway, 1988). This approach is appropriate for understanding multiple facts, characteristics and constraints of trypanosomiasis control, livestock diseases and the development of a forecasting tool. Therefore the purpose of this methodology design was to seek convergence (triangulation) by examining different aspects of the research and adding breadth and scope to the project (Greene, Caracelli, and Graham, 1989).

The quantitative method of this research are concerned with measurements and evaluation of the use of Berenil® and the prevalence of trypanosomiasis (lab studies) as well as the use of satellite data for prediction and control. Therefore, the emphasis is on numerical data and measurable variables. It was appropriate to use multivariate analysis and GIS (ArcView) to analyse certain aspects of the data to develop epidemiological models. Hence a multi-method approach was adopted for this research as a strategy for validation.

Population and sample

The respondents consisted of 250 herdsmen representing 15.14% of the total population of herdsmen in the study area. The number of cattle farms owned in the study area is 1651 (Ghana, 2009). They were grouped into various districts as follows:

In the central region there are 112 farms at Awutu-Efutu-Senya (AES) district and 139 in Gomoa District. In the Greater Accra Region, there are 20 in the Accra Metropolitan Assembly (AMA); 185 in Dangme East 429 in Dangme West and 205 in Tema District. In the Volta region, 198 in Akatsi district 33 in Keta district 46 in Ketu and 119 in Sogakope (South Tongu) district. Of this total number of farms, 250 were selected for the study and the respective herdsmen were identified as respondents and interviewed. In a survey design, a sample of 10 to 20% of the accessible population is enough to generate confidence in the data collected and the subsequent generalization (Ary, Jacob, and Razavieh 1979). It was noted that 30 cases is minimum for statistical data analysis (Bailey, 1982), and some techniques can be used with fewer than 30 cases (Champion, 1970). For the Participatory Rural Appraisal (PRA) technique, 850 farmers comprising drovers, herdsmen and owners were interviewed for matrix-scoring of the production objectives and the effect of animal diseases on livestock and their products.

For the purpose of trypanosomiasis prevalence studies a current cattle population census of the various districts was obtained from records of the respective Veterinary Offices. A minimum sample size of all herds (kraals) was chosen at a 95% confidence level, an assumed (estimated) prevalence of 20% (Ghana, 1999) and within a precision (margin of error) of 5% (Lemeshow *et al.,* 1990; Lwanga and Lemeshow, 1991).

In each herd (within the kraals) the required number of animals was selected by simple random sampling so as to ensure that each animal had an equal chance of being selected.

In this survey, 1,830 cattle were sampled. But the research also adopted a total of 6,902 samples for analysis as secondary data from the Tsetse Control Unit (Veterinary Department of the Ministry of Food and Agriculture) to strengthen the validity of the research findings.

Procedure

Participatory Rural Appraisal Surveys (PRA)

The PRA survey relied on a technique known as preference ranking of variables within a matrix (Kirsopp-Reed and Hinchcliffe, 1994). Participants were asked to rank the importance of different cattle production parameters and also their perceptions of the importance of livestock diseases. Parameters included hide, beef, milk, manure as well as customary and ceremonial uses. The criteria were listed in the rows of a matrix with the classes of livestock in columns. Within each cell of the matrix, participants could specify the relative importance of every category by placing between zero and ten maize seeds within the matrix. The production objectives,

farmer's perceptions of the importance of livestock diseases, livestock disease types in relation to trypanosomiasis and cattle diseases affecting productivity (i.e. the rows of a matrix) were determined after discussion and pre-testing with farmers.

The survey was carried out in 75 villages within 11 districts (Figure 1) as follows: five districts in the Greater Accra Region, four districts in the Volta Region and two districts in the Central Region.

In each village, participants were asked to divide themselves into groups according to their ethnic origin and wealth relative to cattle herd size: small < 50 herds, medium 50-99 herds and large > 99 herds (Ghana, 2009). Each completed the matrix separately. Contract herdsmen completed the matrices as groups separate to the owners of the herd. Herders were also asked to complete the matrices according to herder types and the type of ownership (sole ownership, family ownership and communal ownership). Prioritization process was followed by informal discussions to clarify issues relating to the matrices, cattle disease, treatment and constraints for each type of livestock.

Ground Surveys:

Glossina spp. Tsetse fly sampling was done in the study area (where PRA surveys and parasitological studies were conducted) using 20 unbaited biconical traps (Challier and Laveissiere, 1973) in each area for 24 hours. The species, sex and numbers of tsetse were identified (Geoffoy *et al.,* 1993; WHO, 1988) and photographed, recorded and stored in the database as flies per trap per day. The data were supplemented with those of the National Livestock Survey Project. The Global Positioning System (GPS) was used to locate the longitudes, latitudes and altitudes of the study sites.

Land use and climatological data

It is important to examine the interaction between trypanosomiasis risks and agricultural activities such as crop and livestock production. To achieve this, digitized land use maps of the study area were obtained from the Department of Geography and Resource Development (University of Ghana, Legon), while Climatological data were obtained from the Ghana Meteorological Headquarters (Accra) for analysis.

Satellite data

Normalised Difference Vegetation Indices (NDVI) (Rouse *et al.,* 1974) derived from the Advanced Very High Resolution Radiation (AVHRR) on board the National Oceanic and Atmospheric Administration (NOAA) satellites were used for the period 1999. The indices were simplest and most convenient way to monitor vegetation cover, and allowed rapid estimation of vegetation cover properties from remotely sensed data.

The significant ($p < 0.05$) Normalised Difference Vegetation Index (NDVI) band affecting tsetse distribution was RANGEDVI and the equation could be represented as,

$$TSETSE_{Distribution} = -3.097 + 0.33\ RANGEDVI \ldots\ldots (1)$$

Equation (1) shows that for a unit (1.0 %) increase in RANGEDVI, the tsetse density increased by 0.0033. The relationship between NDVI and tsetse was represented by,

$$[\log TRYPSR]_{Risks\ areas} = 0.993 + 1.186\ RANGEDVI - 1.364\ MINNDVI \ldots (2)$$

Equation (2) shows relationships between RANGEDVI, MINNDVI and trypanosomiasis prevalence. A unit increase (1.0 %) of RANGEDVI increases trypanosomiasis risk by 0.0186 and with a 1.0 % decrease in MINNDVI decreases Trypanosomiasis risk by 0.01364. Thus the distribution of tsetseflies *Glossina palpalis* and trypanosomiasis risks were influenced by changes in RANGEDVI and MINNDVI bands respectively.

The indices were simplest and most convenient way to monitor vegetation cover, and allowed rapid estimation of vegetation cover properties from remotely sensed data.

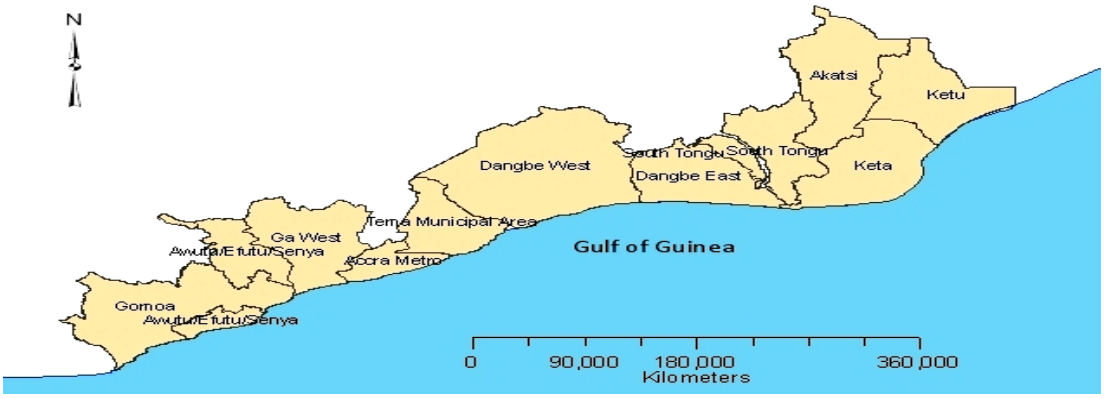

Fig 1. The study area showing Gomoa, AES, Ga, AMA, Tema, Dangbe West, Dangbe East, Sogakope (Tongu) Akatsi, Keta and Denu (Ketu) Districts in Ghana

Trypanosome identification in cattle

The techniques adopted (Murray *et al.,* 1983) are based on the premise that following blood centrifugation, trypanosomes are concentrated mainly in the buffy coat zone. Each animal was bled from the jugular vein into a herparinized vacutainer tube (10 mls) and from the ear vein into a haematocrit capillary tube which were transported to the laboratory on ice at 4° C. The capillary tubes containing blood were microscopically examined for trypanosomes using the Buffy Coat Technique, BCT [Woo method] (Woo, 1969). The buffy coat prepared in a microhaematocrit capillary tube and centrifuged as for measurement of Packed Cell Volume (PCV) was examined for trypanosomes as follows:

The capillary tube was cut with a diamond pointed pen 1mm below the buffy coat to include the upper layer of the red blood cells, and 3cm above to include the plasma. Using a microhaematocrit capillary tube holder, the contents of the capillary tube were gently expressed on a slide, mixed and covered with a cover slip (22 x 22 mm). The preparation was then examined using the following microscopic set up: A Leitz SM microscope, periplan GF x 10 eyepieces, P.V. 25/0.50m objective and Heine phase contrast condenser. The entire coverslip area was then examined for about five minutes.

The identification of trypanosome species were made on morphology of the parasites (Hoare, 1972; Itard, 1989) the behavioural pattern observed in the buffy coat dark ground illuminated preparations, and mensural characteristics: The species identified were: *Trypanosoma congolense*, *T. vivax and T. brucei*.

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

Knowledge of diagnosis and treatment procedures of trypanosomiasis by herdsmen was assessed by questionnaire and results presented in Figure 2. Respondents, were interviewed 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 Services, Veterinary Technical officers (Community Animal Health Officers/Frontline Staffs), District veterinary doctors and the National Head of Tsetse and Trypanosomiasis Control Unit.

Quality of care of Veterinary drug services

Farmers were asked to rank quality of drug services using Likert scale. The farmers' view of drug services were presented in tabular form and ranked as follows: excellent [5], good [4], fair [3], undecided [2] and poor [1]. The variables used were: general satisfaction, coverage of needs, satisfaction of needs,

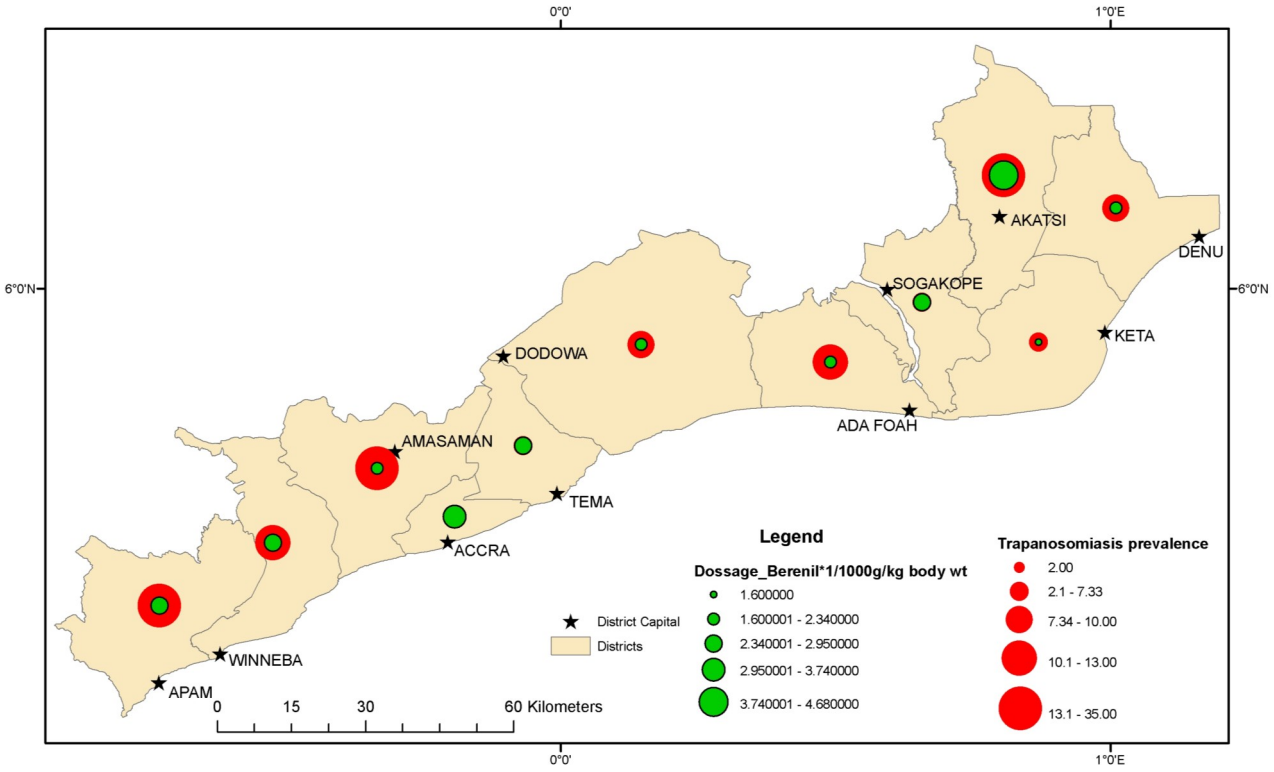

Fig 2. Trypanocide (Berenil®) usage in relation to Trypanosomiasis prevalence in Ghana's coastal savannah

presentation of treatment methods, effectiveness of treatment, information given, understanding of drugs, language gap, seller's follow up and regularity of follow up.

Data processing and analysis

Participatory Rural Assessment (PRA)

The data were analyzed using a linear-mixed-model that included the effects of regions, districts, villages within districts, ethnic groups, herd size and whether the respondents were cattle owners or herdsmen, business-ownership of cattle (sole, family, communal) and vegetation type of each study site.

$$Y_{ijklmno} = Region_i + district_j + village_k + ethnic\ group_l + herd\ size_m + ownership_n + vegetation_o + e_{ijklmno}$$

regions, districts, ethnic group, herd size and vegetation were regarded as fixed factors, whereas village within district was regarded as a random factor. The data were standardized to ensure that relative ranking of objectives and disease type by different groups of respondents was similar. For example, one group of farmers might only use a range of zero to five maize seeds, whereas another group the full range of zero to 10. In the first group, a trait with a score of five is the most important, although it will be an intermediate score in the second group. The data for each herd and animal group were transformed using the formula:

$$Y_{std} = Y_{org}/(n/\sum Y_{org}$$

Where Y_{org} = original score of trait

n = number of recorded traits

Thus the standardized trait measures the importance of this trait relative to all scored traits within each herd. An F-test was used to test the significance of the various factors and the LSD-test to investigate the differences of levels within a factor. The results are presened in Table 1 and clearly shows that among herdsmen, the production objectives were ranked as milk, acquisition of cattle, beef, manure and hides. The importance attached to milk by herdsmen might be

Table 1: Farmer Perceptions of Cattle Production Objectives and the Importance of Hide, Beef, Milk, Manure and Ceremonial Uses

Products	Drovers				Herdsman				Owner			
	Cash	Own Consumption	Ceremonial Use	Mean Rank	Cash	Own Consumption	Ceremonial Use	Mean rank	Cash	Own Consumption	Ceremonial Use	Mean rank
Hide	0.47	0.36	0	0.28	1.68	0.95	0	0.88	1.09	0.81	0	0.63
Beef	4.59	1.27	0	1.95	6.08	2.32	0	2.80	6.73	2.15	0	2.96
Milk	7.85	1.96	0	3.27	9.61	4.49	0	4.70	4.19	1.76	0	1.98
Manure	2.08	0.74	0	0.94	1.27	2.64	0	1.30	0.65	1.87	0	0.84
Whole Cow	4.26	0	1.38	1.88	6.89	0	2.41	3.10	8.97	0	2.17	3.71
Mean Usage	**3.85**	**0.87**	**0.28**	**1.66**	**5.11**	**2.08**	**0.48**	**2.56**	**4.33**	**1.32**	**0.43**	**2.03**

motivating factor to control trypanosomiasis without technical guidance.

Constraints associated with the control of trypanosomiasis by herdsmen

To empirically estimate the marginal effect of constraints affecting the control of trypanosomiasis, multiple regression equations were run on the PC-SPSS programme by the Ordinary Least Squares (OLS) analysis. In this analysis, the "general to specific" approach of Hendry (Johnston and DiNardo, 1997; Kennedy, 1998; Koutsoyiannis, 1977; Thomas, 1993; Zar, 1984) was adopted in order to arrive at coherent regression results. The results as presented in Table 2 shows the factors and relative impacts.

Quality of care of drug services

The data were transformed semi-quantitatively by assigning values to the variables. The qualities of the likert-scale were assigned values as follows: excellent = 5, good = 4, fair = 3, undecided = 2 and poor = 1. The PC Programme SPSS was used to run multiple regression to test the significance of the impact of the farmers' view of the qualities of drug services.

Furthermore, the Spearman's rho (ρ) was used for a two-tailed test for possible correlations between the variables. The results showed that although cattle farmers were generally satisfied with the "effectiveness of treatment" using trypanocide drugs purchased, yet their perception on drug effectiveness is not very satisfactory. In some districts, the cattle farmers ranked drug services as "poor" or "undecided".

Tsetse and Trypanosomiasis surveys

The GIS ArcView and ArcInfo Programmes were used to map the current distribution of the flies (Figure 3) and trypanosomiasis (Figure 4) in the study area. *Glossina palpalis* was the only species found in the area *Trypanosomiasis vivax* was found in 61% of cattle.

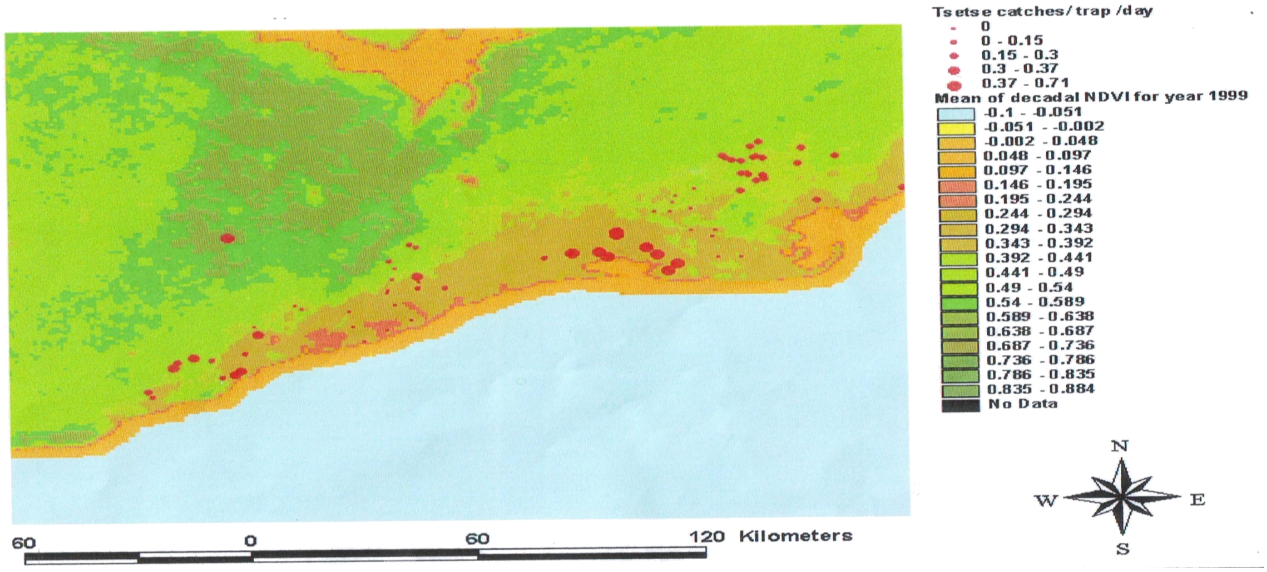

Fig 3. *Glossina palpalis* distribution (catches/trap/day) in relation to mean for decadal NDVI for year 1999 in the Coastal savannah;

Table 2: Re-estimated profit model of herdsmen

Variables	Beta	t-value	p-value
Constant (K)	2.342	24.219	0.001
Farm size	0.176	7.488	0.001
Management experience	0.264	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

Cryopreservation of Trypanosome-infected blood samples for future drug (trypanosome) susceptibility analysis

This section was conducted at The Noguchi Memorial Institute of Medical Research (Legon-Accra, Ghana) as follows:

Trypanosome-infected blood samples from cattle in selected areas were treated with anticoagulant, heparin (0.005%). One volume of dimethylsulfoxide (DMSO) sterilized stock (20%) solution was added to three volumes of blood, to give a final concentration of 5% and mixed well. The samples were aliquoted in 0.8 mls [8 x 10^{-3} litres] cryotubes, screwcapped, labelled with stabilate codes and frozen in liquid nitrogen by progressively sinking the tubes in the vapourphase of the liquid nitrogen container.

DISCUSSION AND POLICY IMPLICATION OF STUDY

Multimethod approach, convergence of results and tests for validity and reliability

The various mixed-method of techniques comprising data sources, methods, analysis theory and instruments generated a rich and comprehensive picture of trypanosomiasis prevalence in the study area. It is a range of quantitative and qualitative perceptions designed to converge results. The output of the analysis were presented as maps, tables, graphs, statistical analysis, and models then tested for validity and reliability.

In seeking explanations for diverse results, the researcher may come out with unexpected findings. For example the Participatory Rural Appraisal [PRA] data in this research helped to explore the reason for indiscriminate use of trypanocides by herdsmen: they were rewarded mainly with milk (by cattle owners) as the main source of remuneration. The ground surveys

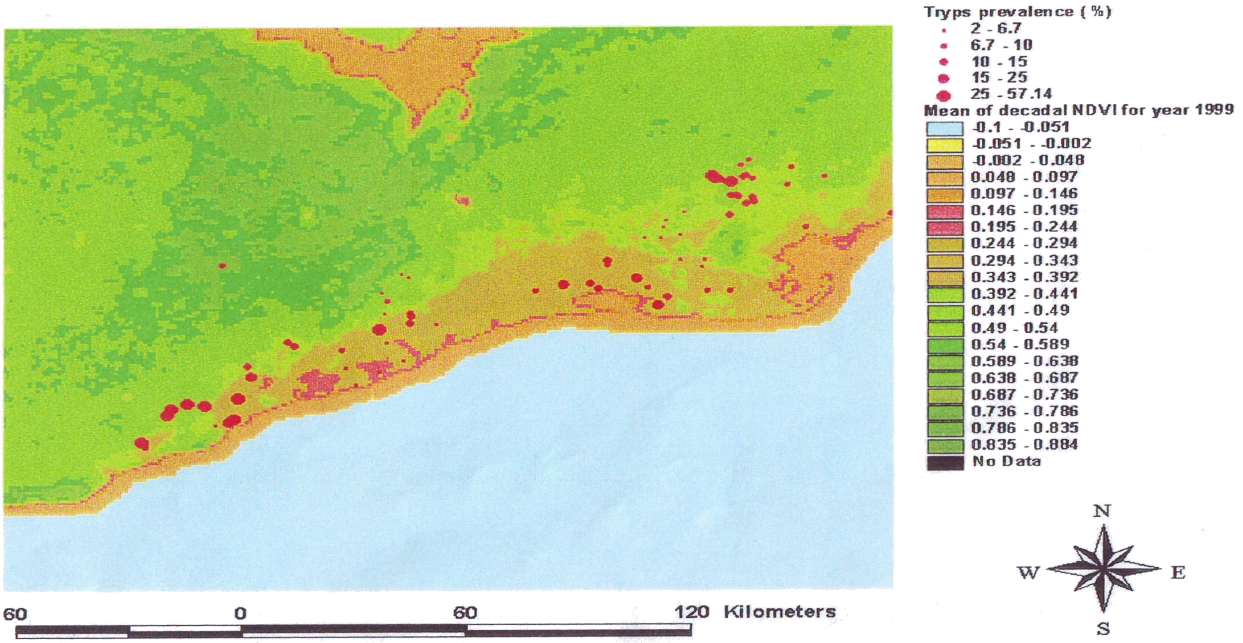

Fig. 4 Trypanosomiasis prevalence (%) in relation to mean of decadal NDVI for year 1999 in the study area

together with satellite data made it possible to accurately map areas most affected by trypanosomiasis for predictions, it was also a relevant information for land use patterns. The cryopreservation of Trypanosome-infected samples was for future drug susceptibility analysis and to test for probable identifications of resistant strains associated with the control procedures. In effect, multi-method approach gives a holistic view of the disease and identifies the appropriate strategies for targeting control.

In effect, the triangulation seeks a logical pattern in results and to test for validity and reliability of the findings. The belief is that once the researcher merges qualitative and quantitative methodologies, the internal validity of the research is strengthened (Bowen, 1996). It has been argued that one can rely on the use of only two methods for maximizing the credibility of research findings (Bowen, 1996), But expanding on this notion, some researchers have suggested the need to statistically test the validity and reliability of research findings (Schmidt, Hunter, and Urry, 1976).

Validity and Reliability

The issue of validity is to draw attention to the extent that the findings really measure the concept that it purports to measure and reliability (repeatability) measures the accuracy and consistency of the tests. All approaches to investigate validity have been designed to establish convergent validity (Campbell and Fiske (1959). But this notion of validity is currently controversial (Trochim, 2002) and has been argued as *the best available approximation* to the truth of a given proposition, inference or conclusion (Trochim, 2002). But the concept of validity and reliability should be seen as a collective whole (comprising all components) with the view to ensuring consistencies. This paper therefore examines the tests and accuracies of these measurements.

In this research, the reliability of the tests (internal validity) were calculated using Crobanch's alpha (a) for possible split-half reliability (Bryman and Cramer, 1997) and found to be 0.81. For convergent validity of this research the maximum possible validity coefficient test (French and Michael, 1966) was used to test for the internal validity of the samples. The result was 0.78 and indicates a good validity.

Residual (difference between the observed and expected) probability plots followed a normal distribution; the data were found to fit the assumptions of the research model. Residual analysis was used to identify individual subjects whose values on the outcome variable do not fit with other subjects (outliers). With large samples, (250 as in this research) multivariate models are sufficiently robust (Katz, 1999) and therefore the results can be generalized to another situation in the new situation.

In this study, econometric model was developed to explore the views of herdsmen on the quality of drug use and the impact of control procedures on profit margins. In this model, the test of significance of parameter estimates was carried out by the use of the student t-test. In econometric applications, researchers (Koutsoyiannis, 1977) test the null hypothesis for each parameter against the alternative hypothesis. 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 and are retained in the model. While the t-values determine the significance of the respective independent variables, the F-values determine the overall significance of the independent variables of the results. In this study, only certain variables turned out as expected in the equations. Apart from variables that were dropped by the computer itself (probably due to collinearity) variables with very low t-values (p 0.05) were also dropped from the subsequent equation to re-estimate the model.

Findings of the PRA indicate that milk is the most dominant production objective of farmers (normally sold for cash or savings) and were most affected by trypanosomiasis. Some of the constraints identified as associated with the use of trypanocide were inappropriate dosage of Berenil® and "pour-on" techniques, the lack of extension training and wrong dilution methods of trypanocide drugs. Others were inappropriate criteria for treatment and wrong treatment intervals. Constraints associated with quality of drug services were inadequate information given to farmers, language gap, and inability of drug sellers to follow up and the lack of presentation of treatment methods.

An aspect of this research focused on the quality of drug services among the 250 farmers. Some of the variables were: general satisfaction of services, coverage of needs, presentation of methods and effectiveness of treatment. Others were: information given, understanding of drugs, language gap, seller's follow up and regularity of follow up.

Contrary to the relevance of validity and reliability for ensuring the strengths of researches, some writers (Trochim, 2002) have criticized the notion of validity as *measures*, and that samples and designs don't have validity; only propositions, inference or conclusions can "have" validity. Instead, Trochim (2002) subdivided validity into four types as (external, construct, internal, conclusion) that build on one another. The external validity relates the ability to generalize to other persons, places and time; the construct validity concerns the ability to generalize to other constructs and the internal validity concerns the causal relationships.

SUMMARY AND CONCLUSION

This article has discussed the need for multiple triangulation methods and exemplified the theory of triangulation and analysis to enhance the quality and validity of research findings. Each taps a different dimension of a problem and captures a more complete and holistic view of research. An illustration of a mixed-methodological triangulation involved the use of Participatory Rural Appraisal technique (PRA) to explore farmer's production objectives and their perceptions of the importance of diseases in relation to trypanocide use. Ground surveys (using unbaited Challier-Laveissier biconical traps) determined the distribution and density of *Glossina palpalis* and

trypanosomiasis prevalence obtained from cattle. Econometric model assisted in identifying the constraints associated with drug use by cattle farmers while The Geographical Information System (GIS) – ArcView programme was used to map the risk areas for accurate targeting and control. All these multi-method approach helped to give a holistic view of cattle trypanosomiasis in the study area and convergence of information on trypanosomiasis risk areas for predictions, monitoring and planning of policy and control.

It is evident from this research that, the multi-method approach is the most appropriate strategy for disease control because it enhances the validity and reliability of the findings. Furthermore, it gives all-round information to inform decision in planning and appropriate policy for integrated disease control programmes.

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