Determinants of Constraints to Livestock Identification and Trace-back System Use for Disease Monitoring Among Cattle Farmers in Botswana

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ABSTRACT

This paper examines the Determinants of Constraints to Livestock Identification and Trace-back System use for disease monitoring among cattle farmers in the Kgalagadi district, Botswana. A descriptive survey design using a multi-stage sampling technique was applied to select 58 cattle farmers as sample size for the study. A structured questionnaire was designed based on the review of related literature and objectives of the study and comprised personal characteristics and determinants of constraints to Livestock Identification and Trace-back System (LITS) use for disease monitoring. Data were analyzed with the Statistical Package for Social Sciences (SPSS) using frequencies, percentages, mean, and regression analysis. The results showed that majority of the farmers were more than 30 years of age, males, married, having secondary school education, having less than 100 cattle as herd size, use LITS, having unfavorable attitude towards LITS, unfavorable attitude towards LITS, and experiencing high constraints in the use of LITS. Signifiant determinants of constraints to Livestock Identification and Trace-back System use for disease monitoring were age (t = -2.46), educational level (t = 2.57), farming experience (t = 2.65), sources of information (t= 2.93), ownership status (t = 2.15), herd composition (t = -2.80), attitude towards LITS (t = -3.51), and time taken to crushes (t = -2.04).

INTRODUCTION

The livestock industry is extremely important to the economy of Botswana, and includes not only commercial producers of meat or milk, but also purebred breeders and small producers with a few animals. Botswana has a cattle population of about 3 million, and an arid climate that favours livestock farming beyond crop farming. Eighty percent of the national herd are owned by people with 1-20 cattle in extensively managed open grazing areas. Botswana beef is primarily produced for export, with 70-75% going to the EU countries and 15% and 10% going to South Africa and Norway respec-

tively.[1] According to Oladele and Rantseo,[2] identification is one of the several livestock management practices that are routinely carried out among others such as castration, deworming, and hoof trimming.

The success of any type of livestock operation is closely related to the disease level of the animals[3]. A number of complex diseases has emerged, difficult to diagnose and induced by a multiplicity of pathogenic agents causing an apparent or "clinical diseases." They are more likely that the effect will be less obvious and may only reduce the overall productivity of the livestock. Animals may not die or even show any symptoms at all so that the farmers may be unaware of what is happening unless they keep very careful records and use them with more than the usual degree of skill. It is also a very common phenomenon that intensive production on a livestock unit may start efficiently and effectively, but deteriorate in time so gradually that it is not noticed until the consequences have become very serious and control becomes extremely difficult. The nature of these infections is of special interest and concern because the environmental and housing conditions have a profound effect on their severity[4].

Livestock Identification and Trace-back System

In late 1997 and early 1998, the outbreak of Bovine Spongiform Encephalopathy (BSE) struck the global beef market with devastating consequences. Subsequently, a series of increasingly stringent regulatory measures pertaining to food trace-ability were introduced over the following 3 years. These regulations had a bearing on Botswana's beef export to its main market, the European Union (EU). A total of 1,808,045 out of 2 million cattle have been inserted with the bolus countrywide so far, and can be individually identified.

After inserting the bolus into the cattle, the bolus number is read by a reader and is transmitted through radio frequency link to extension officer personal computer. This is then linked with the following information:

- Owner's name
- Omang (PID) number,
- Brand
- Brand position
- Sex
- Color Location
- Date

The information is up/downloaded to the extension officer's personal computer at the District office through a docking station via the Government Data Network. The docking station communicates with the Central database in Gaborone. The Central database comprises the primary server at the Ministry of Agriculture and duplicate cluster server at the Department of Information Technology Districts. That allows access to the Central database through computer terminals where querying and reporting of the system is carried out. Online brands registration and renewals are performed at district level and brand certificate printed at Gaborone for manual signature by the designated officer.[5] Digital movement permits are issued through the extension officer personal computer for movement of livestock to export abattoirs and municipal abattoirs, as well as movement within the country.

According to Kedikilwe,[5] the Government of Botswana introduced the Livestock Identification and Trace-back System (LITS) for the computerized individual identification and registration of cattle and origin-based labeling system, permitting monitoring, or traceability of beef products to the farm. This was in partial fulfillment of EU export requirements. A bolus is about the size of a 'baby' carrot, and has a ceramic coating that covers a microchip with unique number. Bolus inserted only in branded cattle 3 months old and above. Bolus number linked to the animal owner, crush of insertion, zone of residence of the animal, and the animal itself. A new bolus costs about U S $2.50 and a recycled bolus costs U S $1.45. The implementation of LITS include:

- Purchase and installation of cattle identification devices (boluses, reading

devices,

- Extension Officer's Personal Computers, etc.)
- Purchase and installation of computer hardware

peripherals and related software;

- Commissioning of a Central Database (both primary and duplicate servers) and Application
- Implementation of LITS at the regional and district Offices and connection to the Government Data Network Infrastructure (GDN) in order to support and service the farming community
- Consolidation of all other systems such as Brands Registration into a single system in order to synchronize data and offer one-stop service to the farming community
- Maintain and trace the movement and health status of cattle from birth to slaughter within Botswana.

According to Burger,[6] LITS employs radio frequency identification (RFID) technology to capture data on individual cattle, which is transmitted directly, error-free, to a central database. The database enables Botswana's meat export agency to obtain EU certification for its beef exports, and is a key repository of information for livestock farmers, as well as for state veterinary services and health authorities.

In Botswana's southern Kweneng and Kgatleng districts, they are found in the stomachs of more than 135,000 cattle. LITS is being implemented by AST Botswana and Inala Identification and Control (South Africa). The first phase, completed in 2001, involved the development of the database and the identification of all cattle in two pilot districts. In the second phase, the system is being extended, and will eventually be the world's largest livestock tracking, monitoring and management system using RFID technology, involving an estimated 3 million head of cattle. MOA,[7] reported that the advantages of the use of LITS for cattle owners include:

- Computerized brands certificates and herd cards are available on demand from district officers
- Computerized Movement permits and new change of ownership forms can be printed on the spot at the kraals and cattle posts
- Farmers having an easy on the spot access to detailed management information about their cattle from DVS staff
- Reduced likelihood of cattle theft because of easy and tamper-free identification of stolen cattle and easy identification of stray cattle.

On the part of the government, the advantages of the use of LITS for cattle owners include:

- Provision of accurate information on the demographics of the national cattle herd
- Provision of accurate disease information to assist Department of Veterinary Services (DVS) in livestock disease management, a simple, tamper – proof identity system available to the police, DVS and other Government organizations with an interest in cattle ownership
- Linkage between cattle ownership records and the Omang National Registration System[7].

The convenience, speed, and accuracy of the LITS system have brought many benefits for Botswana's livestock farmers, veterinary officers, and health authorities. It can be used to locate lost or stolen cattle, and to monitor and manage disease outbreaks. The stomach bolus is safe for the animals.There are few field losses, criminal tampering is not possible, and it is easy to read because it is always in the same place. Also, the bolus is retrieved at the slaughterhouse and can be recycled, keeping costs low. It is a vast improvement on passive livestock identification systems such as ear tags, which require animals to be checked manually until the correct one is found.[6] LITS has encouraged

everyone involved in livestock management to be more thorough and to be creative in finding new ways of working and monitoring performance. Veterinary officers, can:

- Rapidly isolate animals for treatment
- Update health records at the point of treatment
- Track weight gain in selected animals
- Correlate feeding programes with yield
- Select specific bulls for breeding programes
- Track animal family trees.

Despite the aforementioned benefits and requirements of the government offices, some of the cattle farmers are yet to adopt the LITS technology. Anecdotal information suggests that most farmers expressed fears that bolus insertion could suffocate or strangle and kill their cattle, the bolus is too heavy for the animals digestive tract, and that bolus might be corrosive and cause digestive disorders. Several authors have reported that farmers and technology characteristics are important factors that affect the decision to adopt a technology or not. It is therefore important that factors affecting the adoption of LITS technology be examined within the particular scenario within which farmers operate in Botswana. Several factors have been advanced in literature as determinants of the adoption of livestock technologies by farmers, and they have been categorized as farm, farmer, and technology characteristics among others. It was hypothesized that a farmers' adoption behaviour is, however, motivated by a number of factors pertaining to the farmer and the farm, including the human capital (age, sex), financial (profits, non-farm income), farm structure (size, ownership), and social characteristics (distance, population pressure). The objective of this study is to examine the determinants of constraints to Livestock Identification and Trace-back System (LITS) use for disease monitoring among cattle farmers in Botswana. Specifically, demographic characteristics were identified, and constraints to use LITS ascertained.

MATERIALS AND METHODS

A descriptive survey design using a multistage sampling technique was applied in the study. From the target population of the study which was 4,041 cattle farmers, the Kgalagadi district was selected, and out of the 24 extension areas in the selected district, six extension areas were selected--Bokspits, Werda, Hukuntsi, Kang, Tsabong. and Middlepits. From each of the selected extension areas, at least 10 cattle farmers were selected to give a total sample size of 60 cattle farmers. However, 58 questionnaires were found analyzable.

A structured questionnaire was designed based on the review of related literature and objectives of the study and comprised personal, determinants of constraints to Livestock Identification, and Trace-back System (LITS) use for disease monitoring among cattle farmers. The scale measuring constraints consisted of 15 items which were rated on a 2-point scale of Yes (2) and No (1). Reliability of the instrument was established by conducting a pilot test with a similar sample group in Mochudi; a split half test gave 0.98 coefficients. Data were analyzed with Statistical Package for Social Sciences (SPSS) using frequencies, percentages, mean and multiple regressions.

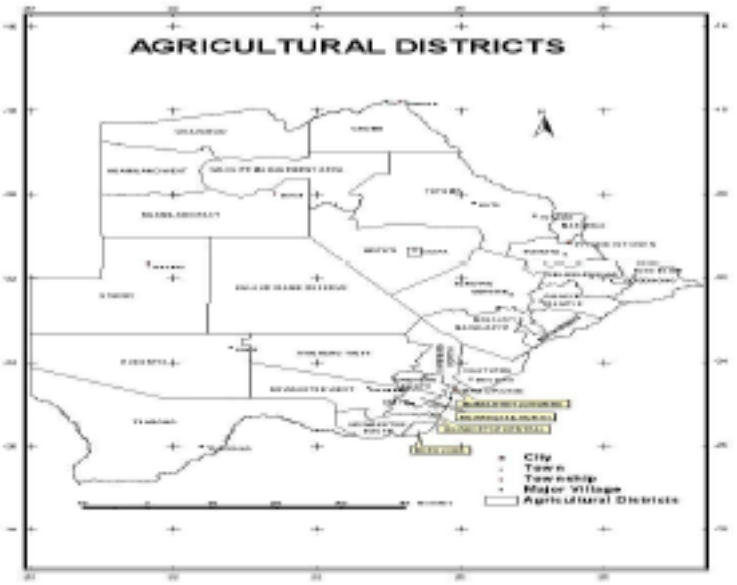
RESULTS

Table 2 presents the personal and farm characteristics of cattle farmers in Kgalagadi district of Botswana. Table 3 shows the percentage distribution of respondents according to constraints to Livestock Identification and Trace-back System (LITS) use for disease monitoring. Table 4 presents the determinants of constraints to Livestock Identification and Trace-back System (LITS) use for disease monitoring

DISCUSSIONS

From Table 1, the demographic characteristics covered by the study included age, gender, marital status, educational level, farming experience, number of dependants, source of information, ownership status, income, herd size and composition, time

***Figure 1**. Map of Botswana showing agricultural districts*



spent on farm membership of organization, distance to crushes, and time taken to crushes. The household head is the final decision-maker in terms of the allocation of resources for a new technology and, therefore, age may enhance adoption. However, age may constrain adoption because older farmers may not be enthusiastic to try new technologies whose benefits are not immediate, whereas younger farmers might be more willing to try out new technologies.[8]

Table 1 shows that (47.6%) of cattle farmers are above the age of 50 more so that those less than 50 years are employed in other institutions rather doing farming, 23.8% farmers fall within the age range of 30 - 40 years. This scenario demonstrates the fact that older people are the ones responsible for the management of livestock especially in communal areas. This finding is consistent with those found by[9] which indicated that mostof the herds were managed by older, married men whose main occupation was farming, and whose families tended to be large. Table 1 reveals that the majority of the cattle farmers are males (72.9%) compared to their female (27.1%) counterparts. Accordingly, the results agree with the males dominancy by stating[7] that men have been influential in the development of Botswana's agricultural sector, hence this gives them an advantage over women in number. It is also[8] reported that women-headed households may respond less favourably to new technology than men because the traditional power structure and control over household productive resources are less favorable to women, ie, negative effect on adoption.

Table 1 further shows that married farmers constitute (50.8%) and single parents (25.4%). Half of the respondents were married, which shows that they could help each other with cost sharing . With reference to the level of education of the respondents ,the table shows that (35.6%) had primary education, (52.5%) had secondary education ,(11.9%) had tertiary education ,thus most farmers pursued secondary education. Thus, most farmers pursued secondary education. Human capital is an important asset for adoption, and an educated farmer is more likely accept new farm technologies. The level of formal education attained was used as a proxy for farmer's ability to acquire and

effectively use information.

According to the results respondents with farming experience that ranges between 10-20 years constituted about (52.7%) whilst those with less than 10 years constituted about (37.4%) and above 20 years constituted (10.2%). The results in Table 1 reveals that the number of dependants who were less than 10 contributed about (79.8%) this may be due to proper family planning and those above 10 dependants contributed (20.4%). This variable determines the availability of household labour supply in order to be able to implement the new technology.[8]

The findings indicate that radio and veterinary officers constituted the most prominent sources of information(35.6%) by farmers followed by newspapers with (3.4%), since it's hard to obtain newspapers in the area, while with reference to ownership most cattle farmers were owners with (61.0%) whilst (39.0%) were managers with a monthly income that ranges from (Botswana Pula, BWP) BWP1000-BWP6000 (91.8%). The results has also shown that the respondents has a herd size that ranges between 100-400 cattle (68%) , those with less than 100 cattle constituted (22.1%), and those with cattle above 400 constituted about (10.2%).The most reared breed according to the results was the Friesian(57.6%), Tswana (10.2%), Brahman(5.1%), and lastly Simmental with (3.4%). The results further shows that 88.1% of the farmers were always on the farm, while 94.9% were members of framers organization

The study showed that (71.4%) farmers had cattle posts within a trekking distance of above 10 kilometers, followed by those with a trekking distance from 5 kilometers to 10 kilometers with (17%). About (86.5%) reached their destinations within a range of 1-5 hours while (13.6%) reached their cattle posts above 5 hours. The findings further showed that (98.3%) of the respondents have inserted bolus while (1.7%) did not inserta bolus. The highest proportion of animals inserted with bolus was (47.4%) This is closely related to herd size, which is an indicator of wealth in most communal areas. Wealth enhances risk-taking and the probability that a farmer will invest in a new technology, i e, positive relationship. The influence of wealth may therefore a priori be either positive or negative.[8] Fifty-one percent of the farmers indicated unfavorable attitude towards the use of use of Livestock Identification and Trace-back System, while about 57% specified that they experience high level of constraints in the use of Livestock Identification and Trace-back System.

Constraints to the Use of Livestock Identification and Trace-back System

Table 3 shows the constraints to the adoption of bolus insertion. The respondents were asked to indicate their level of agreement with the given constraint by indicating Yes or No. TThe most prominent constraint is shortage of boluses during insertion (89.8%), thus leading to delays in the insertion operation, which result in failure in adopting new technologies . This is followed by poor infrastructure support such as metal crushes with (86.4%). According to10 the hand or static reader sends electronic signals to the bolus, thus the bolus is charged and replies with the stored information, so incase where there are metal crushes they tend to interfere with the electronic signals thus not allowing response. Another major constraint is tracking cattle to crushes as per schedule (74.6%). Trekking cattle to crushes for long distances such as over 20 kilometers is tedious as per schedule which has resulted in calves dying on the way to crushes or others getting lost whilst on track.

Other constraints with high percentage among cattle farmers was most farmers are conservative and void of introducing innovations (67.8%). According to[11] the educational level of a community is the most important indicator of social change and for this reason, it is known that the education level is effective in adopting and practicing innovations in rural areas. but according to the results most cattle farmers had only secondary education which is the second lowest in the education system thus

Table 1: *Personal and farm characteristics of cattle farmers*

Variable	Frequency	Percentages
Age		
Less than 30	5	8.5
30-40	14	23.8
41-50	12	20.4
Above 50	28	47.6
Gender		
Female	16	27.1
Male	43	72.9
Marital status		
Single	15	25.4
Married	30	50.8
Divorced	11	18.6
Widowed	3	3.4
Educational level		
Primary	21	35.6
Secondary	31	52.5
Tertiary	7	11.9
Farming Experience		
Less than 10 years	22	37.4
10-20 years	31	52.7
Above 20 years	6	10.2
Number of dependants		
Less than 10	47	79.8
Above 10	12	20.4
Source of information		
Radio	5	8.5
Newspapers	2	3.4
Veterinary	14	23.7
Radio + Veterinary Officers	21	35.6
Newspapers + Veterinary Officers	9	15.3
All	8	13.6
Ownership status		
Owner	36	61.0
Manager	23	39.0
Income		
Less than 1000	4	6.8
1000-6000	54	91.8
Above 6000	1	1.7
Herd Size		

Less than 100	13	22.1
100-400	40	68
Above	6	10.2
Herd Composition		
Brahman	3	5.1
Simmental	2	3.4
Tswana	6	10.2
Friesian	34	57.6
Simmental + Tswana	3	3.4
Simmental +Tswana + Brahman	11	18.6
Time on the Farm		
Always	52	88.1
Sometimes	3	5.1
Weekly	2	3.4
Weekends	2	3.4
Membership of Organization		
Yes	56	94.9
No	3	5.1
Distance to crushes		
Less than 5km	7	11.9
5-10km	10	17
Above 10	42	71.4
Time taken to crushes		
1-5 hours	51	86.4
Above 5 hours	8	13.6
Bolus Insertion		
Yes	58	98.3
No	1	1.7
Proportion of Animals inserted with bolus		
50-51	2	3.4
73-79	7	11.9
80-89	17	28.9
90-98	28	47.4
100	5	8.5
Attitude		
Favorable	29	49.3
Unfavorable	30	51
Constraints		
High	34	57.7
Low	25	42.4

Table 2 *Constraints to the use of Livestock Identification and Trace-back System*

Constraints	YES	NO	Mean	Standard deviation
Shortage of boluses during insertion	53(89.8)	6(10.2)	1.90	0.30
Breakdown of equipment during insertion	33(55.9)	26(44.1)	1.56	0.50
Tracking cattle to crushes as per schedule.	44(74.6)	15(25.4)	1.75	0.44
Profitability of cattle business	39(66.1)	20(33.9)	1.66	0.48
Lack of collaboration and communication.	21(35.6)	38(64.4)	1.36	O.48
Inadequate information	26(44.1)	33(55.9)	1.44	0.50
Lack of knowledge in some technical areas.	36(61.0)	23(39.0)	1.61	0.49
Lack of staff.	40(67.8)	19(32.2)	1.68	0.47
Relatively poor support infrastructure e.g. metal crushes.	51(86.4)	8(13.6)	1.86	0.34
Most farmers are conservative and void of introducing innovations.	40(67.8)	19(32.2)	1.68	0.47
Poor health status of cattle	35(59.3)	24(40.7)	1.59	0.49
Injury/death of animal in the process	34(57.3)	25(42.4)	1.58	0.50
Inadequate planning by farmers	21(35.6)	38(64.4)	1.36	0.48
Cost of bolus insertion is high.	27(45.8)	32(54.2	1.46	0.50
Keeping cattle without brands nor ear marks	26(44.1)	33(55.9)	1.44	0.50

most farmers are so conservative because of the little knowledge they have. Most of the cattle farmers did not believe there is lack of collaboration and communication because the constraint recorded the lowest percentage of farmers (35.6%).

Determinants of Constraints to Livestock Identification and Trace-back System (LITS) Use for Disease Monitoring

The result of multiple regression analysis of relationships between cattle farmers' personal characteristics and constraints to Livestock Identification and Trace-back System (LITS) use for disease monitoring were presented in Table 3. The independent variables were significantly related to constraints to Livestock Identification and Trace-back System (LITS) use for disease monitoring with F value of 2.38, $p < 0.05$. Also, R value of 0.67 showed that there was a strong correlation between independent variables and constraints to Livestock Identification and Trace-back System (LITS) use for disease monitoring. The result further predicted 45 % of the variation in constraints to Livestock Identification and Trace-back System (LITS) use for disease monitoring by farmers.

Significant determinants were age ($t = -2.46$), educational level ($t = 2.57$), farming experience ($t = 2.65$), sources of information ($t = 2.93$), ownership status ($t = 2.15$), herd composition ($t = -2.80$), attitude towards LITS ($t = -3.51$), and time taken to crushes ($t = -2.04$). It implies that as farmers' educational level, farming experiences increases, the more the number of information sources farmers were exposed, increases and ownership status remains as farm manager; constraints to Livestock Identification and Trace-back System (LITS) use for disease monitoring would increase. However, increase in cattle farmers' age, variation in the herd composition, favourable attitude towards LITS, and reduction in time taken to crushes the lower the constraints to Livestock Identification and Trace-back

Table 4. *Determinants of constraints to Livestock Identification and Trace-back System (LITS) use for disease monitoring*

	Reg. Coeff(SE)	t
(Constant)	92.0(15.4)	5.96**
Age	-0.92(0.37)	-2.46**
Gender	-5.13(5.93)	-0.86
Marital status	4.90(3.91)	1.254
Educational level	10.5(4.11)	2.57**
Farming experience	1.13(0.42)	2.65**
Number of dependants	1.26(0.90)	1.40
Sources of information	5.36(1.83)	2.93**
Ownership status	5.68(2.64)	2.15**
Income	1.9-04(0.00)	0.50
Herd size	8.9-030(.07)	0.11
Herd composition	-3.78(1.35)	-2.80*
Time spent on farm	-4.23(2.69)	-1.57
Organisation membership	5.80(4.10)	1.41
Attitude towards LITS	-4.78 (1.36)	-3.51
Distance to crushes	-1.6-03(0.01)	-0.08
Time to crushes	-0.62(0.30)	-2.04**
Visit to veterinary office	-4.16(4.39)	-0.94
Attendance of health workshop	4.38(3.49)	1.25
R	0.67	
R Square	0.45	
F	2.38	
P	0.009	

System (LITS) use for disease monitoring. Non significant variables were gender, marital status, number of dependants, income, herd size, time spent on farm, organisation membership, distance to crushes, visit to veterinary office, and attendance of health workshop. The non significance of these variables may be related to the prevailing socio-cultural milieu in the study area such as majority of women do not own cattle rather goats and sheep.[12] The practice of serial monogamy and incidence of low family sizes and dependants are significant factors, and many farm owners are absentee farmers, weak farmers' group and the classification of LITS services as public good by the government to cattle farmers[2].

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