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Factors leading to replacement of bolus in cattle with electronic ear tags and farmers' views on the electronic ear tag system in three extension areas of North East District, Botswana

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Abstract This study was carried out in three extension areas of North East District (*i.e.*, Tati East, Tati West and Masunga) in December 2012 to evaluate the performance of bolus system and to compare benefits of bolus system with electronic ear tag system. Data on gender and educational levels of respondents, cattle breeds, factors affecting Livestock Identification and Traceability System (LITS) implementation and the role of extension service in LITS implementation were collected using a structured questionnaire that was administered to 75 randomly selected respondents in Tati East (10), Tati West (15) and Masunga (50). Key informants were also interviewed and secondary sources of data reviewed. Data were analyzed using Statistical Analysis System (version 9.2). There was a significant difference ($P<0.0001$) between the cattle breeds reared in the study area except for Brahman which showed no significant difference ($P>0.4189$). The most preferred cattle breeds were *Tswana* (76%), Brahman (45.3%), Brahman/*Tswana* cross (29.3%) and Simmental (20%). The three major challenges of LITS implementation were: shortage of equipment and transport; equipment and network failure and shortage of skilled extension staff. Factors that led to the phasing out of bolus were frequent equipment breakdowns, data inconsistencies, omission of bolus insertion dates resulting in low bolus insertions (33%); the high expense of LITS to government (24%); inadequacy of extension staff (19%); and the labour intensity of LITS, poor recycling of boluses and the ability of thieves to detect the boluses leading to increased stock theft (15%). About 70% of the respondents said that bolus was tamper-proof unlike electronic ear tags which can be easily tampered with or lost resulting to increased stock theft. Only 30% of respondents said that the bolus system was acceptable. These results suggested that cattle farmers in North East District preferred bolus than electronic ear tags and that extension service was inadequate.

Key words: Animal identification, bolus, Botswana, cattle, electronic ear tag, stock theft, traceability

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Introduction

Traditionally, livestock identification has consisted of word description or graphic sketch of the animal (horn formation, colour or some other uniqueness), ear notching and hot iron branding which have been the most reliable means of identification. However, the need for permanent, easily proven livestock identification has become apparent as markets for beef open up (European Union (EU), 2000). Reliable livestock identification is critical in emergency situations such as disease outbreaks, disease control and stock theft, where lack of individual animal identification leads to theft and confusion over ownership when livestock stray and as officials seek to ascertain which livestock travelled where, as well as to identify livestock that may have been exposed to disease (Department of Veterinary Services (DVS) Report, 2010).

Traceability of meat to the farm of origin is becoming increasingly important to consumers and producers (Fallon, 2001). In Botswana, Livestock Identification and Traceability System, 2000 (LITS), was introduced for individual identification of cattle following the outbreak of Bovine Spongiform Encephalopathy in Europe and the demand by consumers for safe food that can be traced to their place of origin (DVS Report, 2010). The LITS system uses bolus, which is a Radio Frequency Identification Device (RFID) with a micro-chip embedded in a ceramic capsule to capture data which are then computerized (Ministry of Agriculture (MoA), 2002). Livestock Identification and Trace-back System allows cattle in Botswana to be identified from three months of age onwards. According to DVS Report (2011), bolus was chosen over other identification methods because it is tamper-proof and recyclable.

Livestock Identification and Trace-back System are experiencing implementation challenges (Ndubo and Moreki, 2012). Because of these challenges, government resolved to replace reticular bolus with electronic ear tag coupled with an analogue ear tag which took effect on 1st January 2013 (DVS Report, 2012). Therefore, a study was undertaken to evaluate the performance of the bolus system in three extension areas of North East District as compared to the ear tag system.

Materials and methods

Description of the study areas

A survey was carried out in three extension areas of North East District: Masunga, Tati East and Tati West in December 2012. Masunga is located about 120 km west of Francistown, while Tati East and Tati West are 18 and 60 km north-west of Francistown, respectively. The extension areas were chosen on

the basis of their proximity to Francistown with Tati East the nearest and Masunga being the farthest. A questionnaire was pre-tested in Oodi in Kgatleng District and thereafter finalized.

Sampling strategy

A total of 75 respondents were randomly selected in Tati East (10), Tati West (15) and Masunga (50).

Data collection and management

Quantitative data were collected by administering a structured questionnaire to individual farmers to collect data on socio-economic characteristics (*i.e.*, age, gender marital status and education), factors affecting LITS implementation, challenges to LITS implementation, and the role of extension service in LITS implementation. Interviews with key informant such as traditional leaders, police officers and extension agents were also performed using questionnaires that were different from that of farmers.

Qualitative data were collected using focus group discussions using various participatory rural appraisal methods (Odoch *et al.*, 2011). These data included LITS analysis, gender analysis, bolus insertion risk factor analysis and ranking of relative burden of using bolus system to using electronic ear tag system. Qualitative data were coded and grouped according to study themes. Analysis was conducted using a master sheet along the main themes of the study. Key concepts per theme were synthesized and the number of focus group discussions and key informants who reported each concept was noted and the major responses identified. Deductions from the synthesized data were made and *verbatim* key quotations from participants and respondents were incorporated to enrich the analysis, after which, discussions followed (Odoch *et al.*, 2011). In addition, secondary sources of data were obtained from DVS in North East District and MoA Headquarters in Gaborone and evaluated. These included bolus insertion reports, district annual reports, LITS annual reports, equipment fault report sheets and LITS database reports.

Data analysis

Quantitative data were entered in Microsoft Office Excel. Thereafter, data were cleaned and analyzed using Statistical Analysis System (SAS) version 9.2 (SAS Institute, 2002-2008). The differences between means were declared significantly different at $P<0.05$.

Results and discussion

Socio-economic characteristics

Data on socio-economic status of respondents are given in Table 1. Sex was statistically significant (P< 0.0018) with male respondents exhibiting a higher percentage frequency (68%) compared to females. This finding is in agreement with Oladele (2011) and Ndubo and Moreki (2012) who reported that men dominate cattle rearing and have been influential in the development of agricultural sector in Botswana. This could possibly be influenced by culture, educational level and government and bank loan policies that restrict or encourage females to opt for smallstock (sheep and goats) as it is perceived to be up to their managing capabilities.

In the present study, age did not show any significant difference (P>0.0595). One third of the respondents were aged between 31 and 40 years. On the contrary, the study by Ndubo and Moreki (2012) found that 96% of the respondents were aged >40 years. Previous study by Oladele and Jood (2010) in Kgalagadi District of Botswana showed that 47.6% of farmers were aged ≥50 years. In the current study, 19% of the respondents were aged ≥60 years; at this age, respondents may not be enthusiastic to try new technologies whose benefits are not immediate.

As shown in Table 1, there was a significant difference (P<0.05) in marital status and educational level of the respondents. An equal number of respondents were married (44.6% and single (44.6%). This finding correlates with the age group of 31-40 years as most people at this age have attained some education and are employed making it possible for them to acquire and care for livestock. High literacy rate of 98.6% in this study indicates that the respondents are likely to understand extension messages and/or adopt technologies with ease. However, the fact that 1.4% of the respondents never attended school challenges the extension services to develop methods of communicating messages to this recommendation domain.

Livestock rearing in the study sites

Data on livestock reared by respondents are presented in Tables 2 and 3. It is evident that cattle (90.2) were the most common livestock species reared followed by goats (38), chickens (27), sheep (11), and donkeys (3.4) while horses were the least reared livestock species (0.6).

Cattle breeds reared in the study areas are shown in Table 2. There is a significant difference between the breeds reared in the three extension areas (P<0.0001) except for the Brahman which showed no significant difference

(P>0.4189), indicating that it could be evenly distributed across the study areas. This could be ascribed to the fact that Brahman is a popular breed that has been in Botswana for many years. According to Table 2, the most preferred cattle breeds were *Tswana* (76%), Brahman (45.3%), Brahman/*Tswana* cross (29.3%) and Simmental (20%). The respondents mentioned that they preferred *Tswana* breed because it is tolerant to the local conditions. Brahman/*Tswana* cross was preferred because it combines the good characteristics of the two breeds, which are well adapted to the harsh climatic conditions of Botswana. Ndubo and Moreki (2012) reported that Brahman/*Tswana* cross (48%), *Tswana* (17%), Simmental/Brahman cross (Simbrah) (14%), Simmental/*Tswana* cross (6%), Brahman (6%), Bonsmara (1.5%) and Afrikaner (1.5%) were the preferred cattle breeds in the three villages of Kweneng District.

Table 1. Socio-economic status of respondents in the study area

Variable	% Frequency	Total	DF	P-value
Age		100	4	0.0595
≤30	16.0			
31 to 40	33.3			
41 to 50	18.7			
51 to 60	13.3			
>60	18.7			
Sex		100	1	0.0018
Male	68.0			
Female	32.0			
Marital Status		100	3	0.0001
Single	44.6			
Married	44.6			
Divorced	2.7			
Widowed	8.1			
Educational Level		100	3	0.0001
Primary	15.5			
Secondary	45.1			
Tertiary	38.0			
Other (No formal Education)	1.4			

DF= Degrees of freedom

Some breeds such as Simbrah and Limousine were not commonly reared in North East District as respondents (22%) mentioned that they were sceptical to try new breeds they were not familiar with; hence their unequal distribution (P<0.0001). This finding is in agreement with Moreki *et al.* (2012) who reported that one of the major challenges in LITS implementation is that most farmers are conservative and are lacking in introducing innovations. Trail and Gregory (1981) reported that Simbrah has higher reproductive performance,

faster growth rate and is viable. Simbrah combines the strengths of Brahman and Simmental, the two most popular cattle breeds in the world (Cundiff, 2005; American Simmental Association, 2010). The fertility, milking ability and rapid growth of the Simmental is complimented by the heat tolerance and hardiness of the Brahman (American Simmental Association, 2010).

A significant (P<0.0001) difference in the distribution of other livestock (goats, sheep, donkeys and horses) across the study sites was observed (Table 3). The current results showed that sheep, donkeys and horses (P<0.0001) are the most unequally distributed livestock species followed by goats (P<0.0082). The respondents attributed unequal distribution of livestock to the fact that smallstock market is still growing at a subtle pace resulting to little income generated compared to the beef industry. Chicken population in the present study did not show any significant difference (P>0.4602), indicating that chickens were evenly distributed across the study area. This could be due to the fact that chickens (especially family chickens) are easy to take care of compared to other livestock.

Table 2. Cattle breeds reared in the study area

Variable	Mean	% Frequency	Total	DF	P-value
Cattle Number	90.2		100	2	0.0001
≤30		54.7			
31 to 90		30.7			
≥91		14.7			
Cattle breeds					
Tswana			100	1	0.0001
Nil		24.0			
Present		76.0			
Brahman			100	1	0.4189
Nil		54.7			
Present		45.3			
Charolais			100	1	0.0001
Nil		88.0			
Present		12.0			
Simmental			100	1	0.0001
Nil		80.0			
Present		20.0			
Afrikaans			100	1	0.0001
Nil		93.3			
Present		6.7			
Limousine			100	1	0.0001
Nil		94.7			
Present		5.3			
Tuli			100	1	0.0001
Nil		93.3			

Present	6.7			
Simbrah		100	1	0.0001
Nil	94.7			
Present	5.3			
Cross Tswana + Simmental		100	1	0.0001
Nil	89.3			
Present	10.7			
Cross Tswana + Brahman	70.7	100	1	0.0003
Nil	29.3			
Present				

DF= Degrees of freedom

Table 3. Other livestock reared in the study area

Variable	Mean	%Frequency	Total	DF	P-value
Goats	38		100	4	0.0082
≤10		33.3			
11 to 20		24.0			
21 to 30		14.7			
31 to 60		8.0			
>61		20.0			
Sheep	11		100	3	0.0001
≤5		60.0			
6 to 10		12.0			
11 to 20		17.3			
≥21		10.7			
Chickens			100	5	0.4602
≤5		21.6			
6 to 10		12.2			
11 to 20		21.6			
21 to 30		13.5			
31 to 50		18.9			
≥51		12.2			
Donkeys	3		100	3	0.0001
≤3		60.0			
4 Up to 6		16.0			
7 up to 9		12.0			
≥10		12.0			
Horses	1		100	2	0.0001
Nil		83.6			
1 to 3		11.0			
≥4		5.4			

DF = Degrees of freedom

Bolus insertion

The current study showed that there was unequal distribution of cattles inserted with bolus (P<0.0001). For instance, 93% of respondents said that their cattle were inserted with bolus while only seven percent that none of their cattles were inserted with bolus due to a shortage of bolus. Oladele and Jood (2010) reported that 98% of the cattle farmers in Kgalagadi District had adopted LITS through insertion of bolus in their animals. On the other hand, Ndubo and Moreki (2012) reported lower bolus insertions of 48% in the three villages of Kweneng District.

About 67% of the respondents in this study said that all eligible cattles were inserted with bolus, whereas the remainder said that not all eligible cattles were inserted. Additionally, 70.3% of the respondents said that they were aware that cattles should be inserted with bolus at three months of age while the remainder said that they had no idea. This finding indicates the need for the extension to intensify educating farmers on LITS. About 60.1% (P<0.0712) of the respondents said that they first heard about LITS through extension agents during their farm visits and 58.9% (P<0.1281) from the radio. About 36% (P<0.0140) of farmers said that they heard about LITS from television, 19.2% (P<0.0001) at a *kgotla* (traditional meeting place) meeting addressed by extension staff and 20.1% from the newspapers. This result suggests that extension messages on LITS are not effectively communicated to farmers.

Extension service provision

The frequency of visits by extension agents to farmers was unequally distributed (P<0.0001). Seventy-three percent of the respondents mentioned that they only saw extension agents during the annual vaccination campaigns and when they requested extension agents to attend to their sick animals or to issue movement permits. In addition, 73% of the respondents said that they received visits from extension agents twice a year, 21% once a month, 5% weekly, whereas 73% said that they never received visits from extension agents. The current results show that extension service/support is inadequate. Ndubo and Moreki (2012) reported that low rate of extension services resulted in weak farmer participation and lack of responsiveness.

Extension agents identified challenges encountered during bolus insertion which include animals being presented with multiple brands without any affidavit resulting to verification being difficult; presentation of expired brand certificates leading to cattle not being inserted with bolus; introduction of animals into the district without movement permits and not inserted with bolus; and shortage of support staff at the crushes during bolus insertions. These challenges suggest that there is a need to intensify farmer education on LITS in

order to enhance its implementation. It also appears that there is a need to employ additional staff during bolus insertions.

The respondents said that the extension services provided by DVS were significantly visible (P<0.0001). These services included services provided by Livestock Advisory Centre (37.8%, P<0.0364) such as sale of veterinary requisites, livestock feeds and equipment; annual free vaccinations against anthrax, foot and mouth disease, blackleg, contagious abortion (37.3%, P<0.0282) and issuance of animal movement permits (29.7%, P<0.0005). On the other hand, 10.7% of the respondents (P<0.0001) said that they did not receive any assistance from DVS. Furthermore, 36% (P<0.0153) of the respondents mentioned that DVS assisted them in dipping, deworming and attended to their sick animals (30.6%, P<0.0001). These responses indicate the inadequacy of extension service.

Improvement of Livestock Identification and Traceback System

Responses on improvement of LITS are presented in Table 4. The five most important things that the respondents wanted to be done to improve performance of LITS included reducing technical challenges by proper handling of equipment (19%), provision of adequate resources to enable purchase of new equipment (15%), separate campaigns (*i.e.*, bolus insertion campaign should not be combined with vaccination campaign) (13%), employing additional skilled personnel (*i.e.*, extension agents and revenue collectors) and increasing call centres to improve service delivery (11%) and that bolus insertions should be carried out annually (10%).

In this study, 36% of the respondents said that they wanted DVS to replace the current field equipment and to improve record keeping. This finding is in agreement with Food and Agriculture Organization (2010) which reported that field data acquisition system in Botswana is faced with recurrent failures due to ageing equipment. Failure of equipment has contributed to an increase in the use of hand written permits and parallel manual recording systems of other animal events such as official vaccinations. In addition, the use of manual permits leads to long delays in the notification of animal movements and other animal events, as well as, general failure of the system. In agreement with the current results, information from the LITS central database revealed that LITS system needs to be reviewed as it has challenges of poor data quality and consistency.

Table 4. Respondents views on how LITS could be improved

Improvement of LITS	Percentage response
Reduce technical problems, proper handling of equipment	19
Buy new equipment / provide adequate resources	15
Separate campaigns	13
Hire skilled personnel and increase help centres	11
Carryout annual bolus insertion	10
Change in extension agents' insurance clause	8
Better protocols, clarified to farmers	7
Reduce brand certificates renewal/ collection dates to same day	6
Good record keeping	5
Improve /upgrade LITS system monthly	4
New management in DVS	2
Total	100

LITS = Livestock Identification and Traceback System

Factors affecting LITS implementation

About 69% ($P<0.0011$) of the respondents said that they experienced some challenges during bolus insertions relating to the issuance of permits (29.7%, $P<0.0005$), ownership transfers (24%, $P<0.0001$) and collection and renewal of brand certificates (20.3%, $P<0.0001$). The respondents attributed these challenges to frequent technical failures and data mismatches. Furthermore, extension agents mentioned that DVS was experiencing some challenges, which they ascribed to failure or poor turn up of farmers during bolus insertions, failure to submit proper documents such as valid brand certificates during bolus insertions and bringing cattles for bolus insertion with wrong brands.

The main factors affecting implementation of LITS in order of importance were: shortage of equipment and transport, equipment and network failure, shortage of staff and skilled extension agents, failure to involve extension agents in policy-making and failure by management to oversee correction of system failures (Figure 1). Consult IT (2010) identified challenges to LITS implementation in Botswana to be equipment being too old, equipment freezing during bolus insertions, limited bandwidth for remote data transfer, non-functioning up/download and increased use of manual permits. The majority of equipment failures result in little or few bolus insertions in the field. Motseta (2011) argued that since the introduction of LITS in 2002, most of the information technology equipment have not been replaced resulting to frequent breakdowns. Similarly, Gaotlhobogwe (2011) reported that over the past 10 years, LITS equipment experienced fundamental technical challenges such as

freezing of personal computers and failure of the equipment to communicate with the reader.

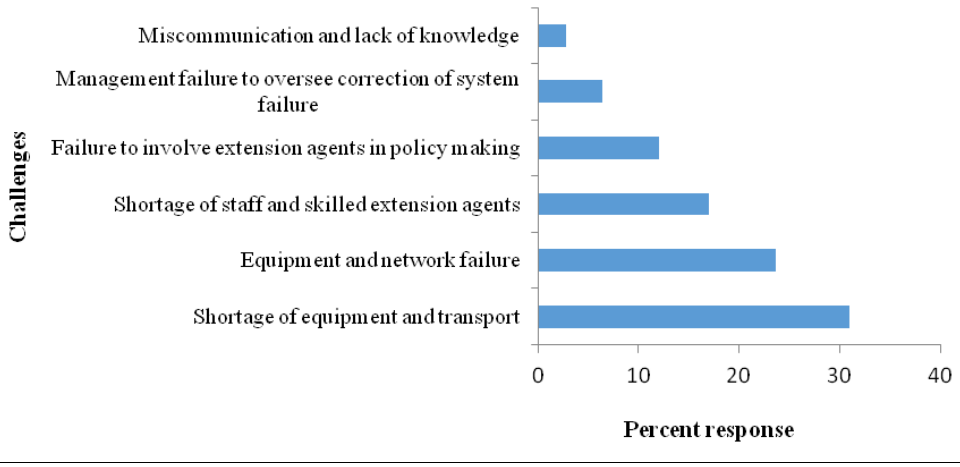

Fig. 1. Some challenges to LITS implementation

Inadequacy of transport for extension agents in the current study was an impediment to bolus insertions as it hampered execution of extension activities. This finding is in agreement with Ndubo and Moreki (2012) who pointed out that when LITS programme was rolled out, transport and logistics issues were never considered. According to Moreki *et al.* (2012), the other challenge to LITS implementation is limited suppliers of LITS equipment and boluses in the country as most LITS equipment that were designed for the programme are not easily available in the market. The system is mainly public sector driven and there is poor support from the private service providers. Despite these challenges, 50% of the respondents in this study said that bolus was reliable ($P<0.0029$) and useful as it enabled them to sell their cattle, change ownership and obtain animal movement permits. About 32.4% of the respondents said that bolus was not reliable while 17.6% said that it was partially reliable due to frequent equipment breakdowns.

Factors leading to the phasing out of bolus system

Thirty-three percent of the respondents identified factors that led to the phasing out of bolus to include frequent equipment breakdowns, data inconsistencies and omission of bolus insertion dates thereby resulting in the number of cattle inserted with bolus being low. In addition, 24% of the respondents said that the bolus system was too costly for the government, whereas 19% said that it was an overload for MoA resulting in government not

able to sustain it due to shortage of resources (19%) such as manpower. Furthermore, 15% of the respondents said that the bolus system was labour intensive, boluses were poorly recycled and that thieves could detect it resulting in increased cases of stock theft.

Farmers' views on bolus system

About 70% of respondents said that the bolus system was good because it was retained in the reticular-rumen and hence could not be easily tampered with. They also mentioned that reticular-bolus helps to reduce stock theft cases as it has information of the cattle owner. This finding is in agreement with Peace Bulletin (2004) that reported that the use of bolus has significantly reduced incidences of cattle theft by 60%, as well as, disagreements over claims of ownership by farmers. Similarly, Ndubo and Moreki (2012) reported that stock theft cases reported annually were low per year compared with before the introduction of bolus. In the current study, only 30.2% of the respondents said that the bolus system was a bad option, as it depends entirely on government for operational costs with little or no farmer contribution. The respondents said that delays in bolus insertions contributed to stock theft and low coverage. Furthermore, respondents said that the bolus system was lagging behind in development, thus rendering it ineffective in maintaining traceability. The current results indicate that bolus system does not reach farmers in time to enable them to benefit for rearing cattle.

Forty-five percent of the respondents mentioned that bolus was a good system that was not nurtured to the fullest. Furthermore, the respondents said that the bolus system could have been the best system for the livestock industry if its implementation was thoroughly planned and properly executed. Nine percent of the respondents that the performance of bolus system has never been evaluated leading to technical failures experienced.

Farmers' views on the electronic ear tag system

Eighty seven percent of respondents perceived electronic ear tag system to be a bad option compared to the bolus system. The respondents mentioned that although electronic ear tag has a visible tag number, it does not state the owner's details resulting to difficulties in animal identification and traceability. In addition, the respondents mentioned that DVS has not done enough to explain how the electronic ear tag system will work. The respondents contended that ear tags are likely to be lost, removed or tampered with, as most of their cattle are extensively reared, thereby rendering the system ineffective. Furthermore, the respondents said that the ear tag system will be costly to

smallholder farmers who own a few cattle. In addition, the respondents mentioned that smallholder farmers have no knowledge of record keeping and are unlikely to operate and/or maintain the system. The respondents argued that it was too soon to introduce a new system that is inconsistent with Botswana's terrain and that does not take into consideration stock theft.

Only 13% of respondents in this study said that the electronic ear tag system was a good initiative that will work better than the bolus system; as it will provide clear identification by being visible and will result in farmers being responsible for the identification and traceability of their cattle. The respondents argued that the electronic ear tag system will create less work for extension agents enabling them to focus on other extension activities. Forty-four percent of the respondents said that they do not think that the use of electronic ear tags will reduce stock theft.

Extension agents also had divergent views on the ear tag system. For instance, while 43% mentioned that it was a user-friendly system that will increase the number of EU compliant animals because the tags will be applied by farmers at their convenient time, the remainder said that electronic ear tags will be costly to farmers due to their possible loss. The respondents said that replacing lost ear tags could be expensive to smallholder farmers resulting in increased stock theft as some cattle will not be identified.

Expectations from the electronic ear tag system

Seventy-one percent of the respondents said that using electronic ear tags will lead to high stock theft cases; high ear tag losses and tampering; and increased number of unidentified cattle, as well as, poor record keeping as most farmers are old, reside in remote areas and are unable to read and write. Furthermo re, 75% of the respondents anticipated challenges in data capturing, slow data flow between MoA and farmers, as well as drawbacks in cattle identification system due to possible low insertions (coverage). Only 29% of the respondents said that the use of electronic ear tag system would result in farmers taking good care of their cattle, easy identification of cattle, high insertion rates, good record keeping, ease of cattle movement with proof of ownership, less labour and fewer technical faults. Furthermore, the respondents said that they expected many farmers to welcome and use the electronic ear tag technology. The extension agents also mentioned that they expected electronic ear tag implementation to be faster compared to bolus because of involvement of farmers, reduced expenses for government and reduced labour in inserting the ear tags. In agreement with farmers, the extension agents also mentioned that the use of electronic ear tags could contribute to increased stock theft through tampering.

Conclusion

Ninety-three percent of cattles in this study were inserted with bolus. Seventy percent of the respondents preferred bolus system over electronic ear tags which they believed would bring setbacks due to ear tag losses resulting in increased stock theft. According to the respondents, factors that led to the phasing out of bolus were frequent equipment breakdowns, data inconsistencies, high operational costs and omission of insertion dates resulting in difficulties in animal identification. The current results showed that respondents preferred bolus compared to electronic ear tags and that extension service was inadequate. The inadequacy of extension service has a bearing on the performance of LITS.

Recommendations

The following recommendations are made: An effective maintenance schedule for the equipment and long term replacement plan should be developed and implemented. In addition, new equipment should be purchased to replace the ageing equipment. Livestock Identification and Traceback System database should be re-designed to address technical challenges of poor data quality and inconsistencies experienced in bolus. In order to improve staff efficiency, skills transfer plan for DVS field teams should be developed and implemented. Implementation of the electronic ear tag system should be thoroughly planned with all logistics considered and executed prudently to minimize failures. Extensive consultation prior to and during implementation stages are required if the electronic ear tag system is to be successfully adopted by farmers.

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References

American Simmental Association. (2010). Guidelines for breeding Simbrah cattle. Available online at http://simbrahworld.com/images/index/2010/aug/guidelines_simbrah.pdf

Consult IT. (2010). Project Scope Definition for Livestock Identification and Trace-Back System, Ministry of Agriculture, Gaborone. Botswana.

Cundiff, L.V. (2005). Beef: Breeds and Genetics. Encyclopaedia of Animal Science, Marcel Dekker. Inc. USA., pp. 74-76. DOI:10.1081/E EAS 120019452

Department of Veterinary Services. (2010). North East District Annual Report. Ministry of Agriculture, Gaborone, Botswana.

Department of Veterinary Services. (2011). North East District Annual Report. Ministry of Agriculture, Gaborone, Botswana.

Department of Veterinary Services. (2012). North East District Annual Report. Ministry of Agriculture, Gaborone, Botswana.

European Union. (2000). Establishing a system for the identification and registration of bovine animals and regarding the labelling of beef and beef products and repealing Council Regulation No.820/97 no.1760/2000. Retrieved on 11/08/12 from http://www.fsai.ie/legislation/food/eudocs/MeatFresh/Reg1760 2000.pdf

Fallon, R.J. (2001). The development and use of electronic ruminal boluses as a vehicle for bovine identification. Revue Scientifique technologie Office International des Epizootics 20(2): 480-490.

Food and Agriculture Organization. (2010). Review of Botswana Livestock Identification and Trace-back Systems.

Gaotlhobogwe, M. (2011). Bolus program starts again despite hitches. Mmegi Newspaper Volume 28, No. 09.

Livestock Identification and Trace-back System (LITS). (2000). Statement of user requirement. Department of Animal Health and Production, Ministry of Agriculture, Gaborone, Botswana. Retrieved on 15/08/12 from www.moa.gov.bw

Ministry of Agriculture. (2002). Livestock Identification and Trace-back System: Omang wa Dikgomo. Frequently Asked Questions. An Information Publication by the Department of Animal Health and Production, Ministry of Agriculture, Gaborone, Botswana. Retrieved on 15/08/12 from www.moa.gov.bw

Moreki, J.C., Ndubo, N.S, Ditshupo, T., Ntesang, J.B. (2012). Cattle Identification and Traceability in Botswana. Journal of Animal Science Advances 2(12):925-933

Motseta, S. (2011). Ministry of Agriculture bolus bungle. Botswana Gazette Newspaper 27(42).

Ndubo, N.S. and Moreki, J.C. (2012). Evaluation of Livestock Identification and Trace-Back System (LITS) in Three Villages of Kweneng District, Botswana. African Journal of Livestock Extension 10:48-55.

Odoch, T.A., Kankya, C., Kyomugisha, E., Schwabenbauer, K., Nicole, D. and Byarugaba, D. (2011). Survey on the current poultry disease control practices in free range and smallholder poultry production systems in Uganda, pp. 1-18.

Oladele, O.I. and Jood, M. (2010). Factors affecting adoption of livestock identification and trace-back system among cattle farmers in Kgalagadi District, Botswana. Livestock Research for Rural Development 23(10). Retrieved on 27/08/2012 from http://www.Irrd.org/Irrd22/8/olad2247.htm

Oladele, O.I. (2011). Determinants of constraints to livestock Identification and Trace-back System use for Disease monitoring among cattle farmers in Botswana. International Journal of Applied Research in Veterinary Medicine 9(2):143.

Peace Bulletin. (2004). Cattle tracking in Botswana: Botswana using digital bolus to trace stolen cattle. Practical Action-EA Peace Bulletin –September 2004. Retrieved on 03/04/2013 from http://practicalaction.org/peace5_cattle_tracking_botswana

SAS Institute. (2000-2008). User's guide, SAS version 9.2. Statistical Analysis System Institute, Inc. Cary NC, USA.

Trail, J.C.M. and Gregory, K.E. (1981). Sahiwal cattle: An evaluation of their potential contribution to milk and beef production in Africa. International Centre for Africa, ILCA Monograph. 3. Addis Ababa, Ethiopia. Retrieved on 26/03/2013 on http://www.ilri.org/InfoServ/Webpub/fulldocs/x5538E/x5538E00.HTM.

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