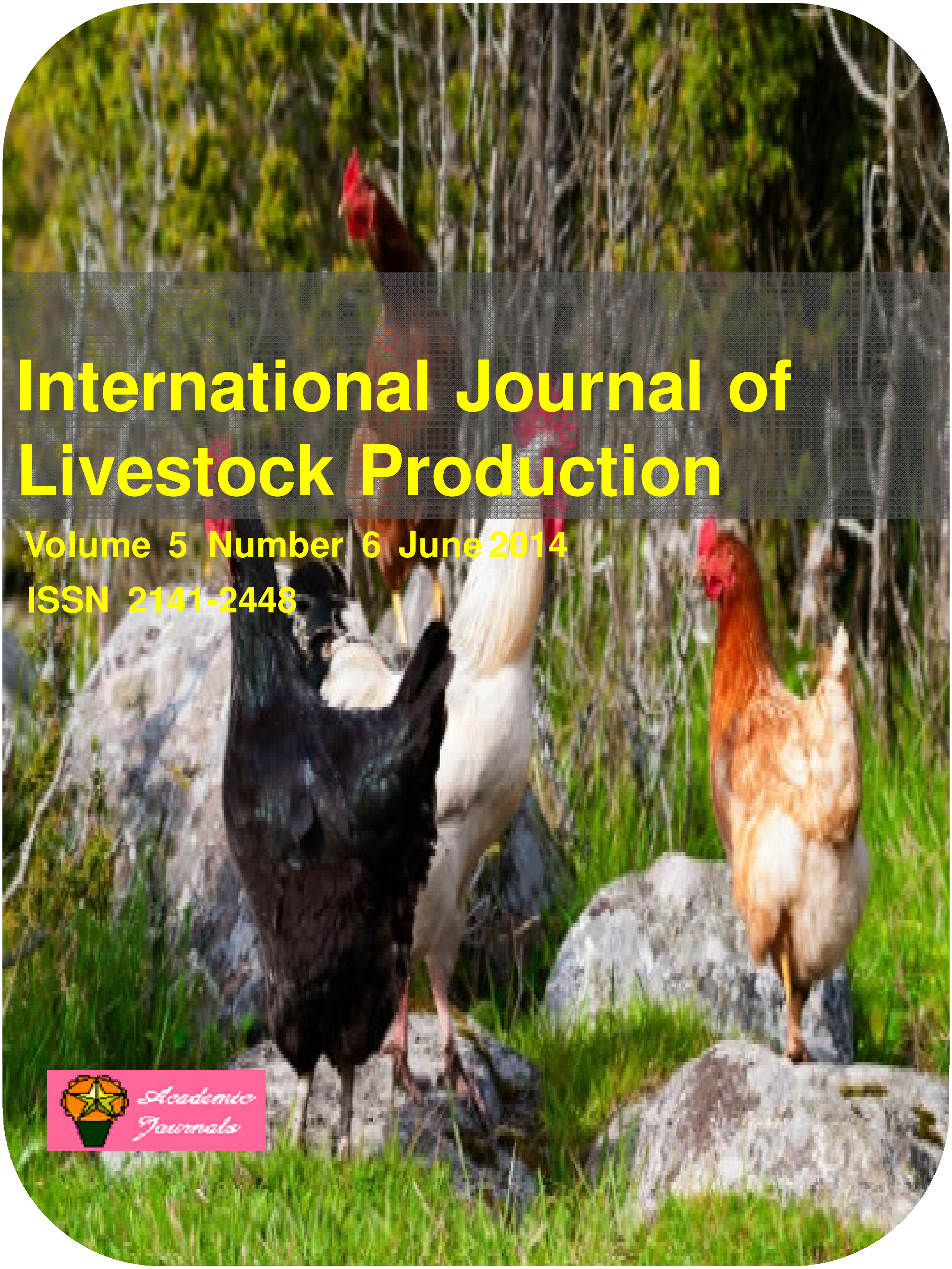
International Journal of Livestock Production

Volume 5 Number 6 June 2014

ISSN 2141-2448



Academic Journals

ABOUT IJLP

The **International Journal of Livestock Production (IJLP)** is an open access journal that provides rapid publication (monthly) of articles in all areas of the subject such as Selective breeding in animal husbandry, the health effects of animal cruelty, fishery in terms of ecosystem health, Fisheries acoustics etc.
The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published shortly after acceptance. All articles published in the IJLP are peer-reviewed.

International Journal of Livestock Production (IJLP) (ISSN 2141-2448) is monthly (one volume per year) by Academic Journals.

Contact Us

Editorial Office: ijlp@academicjournals.org

Help Desk: helpdesk@academicjournals.org

Website: http://www.academicjournals.org/journal/IJLP

Submit manuscript online http://ms.academicjournals.me/

Editors

Editorial Board

International Journal of Livestock Production

Table of Contents: Volume 5 Number 5 May 2014

ARTICLES

Research Articles

academicJournals

Vol. 5(6), pp. 97-102, June, 2014
DOI: 10.5897/IJLP2013.0198
Article Number: 7AFE20145318
ISSN 2141-2448

http://www.academicjournals.org/IJLP

International Journal of Livestock Production

Full Length Research Paper

Alternative remedies and approaches used by resources-challenged farmers in the management of cattle black-leg disease in Umzingwane district, Matabeleland South, Zimbabwe

B. Moyo[1]*, S. L. Ndlovu[1], S. Moyo[1], P. J. Masika[2], V. Muchenje[3], D. N. Ndhlovu[4] and V. Maphosa[3]

[1]Department of Agribusiness, Faculty of Science and Technology, Solusi University P. O. Solusi, Bulawayo, Zimbabwe.
[2]Agriculture and Rural Development Research Institute, Faculty of Science and Agriculture, University of Fort Hare, P/Bag X1314, Alice 5700, South Africa.
[3]Department of Livestock and Pasture Sciences, Faculty of Science and Agriculture, University of Fort Hare, P/Bag X1314, Alice 5700, South Africa.
[4]Department of Clinical Veterinary Studies, Faculty of Veterinary Science, University of Zimbabwe. P. O. Box MP 167, Harare, Zimbabwe.

Received December 13, 2013; Accepted April 28, 2014

Cattle productivity has been minimized by the occurrence of diseases such as blackleg. This study was conducted to determine and document how resource-challenged farmers of Umzingwane district of Zimbabwe use alternative remedies to manage cattle blackleg cases. Random sampling was used to select 90 beef cattle farmers who were interviewed using a structured questionnaire. Results of the study revealed that cattle owners (86%) reported blackleg disease to be the most important disease followed by ehrlichiosis (23%) and lumpy skin disease (5%). Almost 71% of the respondents reported having experienced cases of blackleg in their herd in the past three years. Few farmers (22%) used conventional vaccines, whereas the majority (78%) used alternative remedies to manage the disease, which included; hot water (80%), hot iron (78%), Potassium permanganate (10%), *Ihlwili* (60%), *Ricinis communis* (5%), *Pterocarpus angolensis* (7%), *Sclerocarya birrea* (8%), *Diospyros mespiliformis* (3%), *Gardenia spatulifolia* (2%). Some of these remedies (*P. angolensis*, *S. birrea*, *D. mespiliforms*, *G. spatulifolia*) were believed to prevent the occurrence of the diseases, while hot water and hot iron were used for treatment of infected animals. The study revealed that most resource-challenged farmers in Umzingwane district of Zimbabwe used alternative remedies to manage blackleg infections in cattle.

Key words: Alternative remedies, blackleg, cattle, *Clostridium chauvoei*

INTRODUCTION

In Zimbabwe, cattle play an important role in the livestock industry through provision of meat, milk, manure and raw materials for the processing industries (Neumann et al., 2002). Despite its importance, cattle production is failing the local beef market demand (Chawatama et al., 2005). The demand for beef is on the rise throughout the world, especially in developing countries due to increased human population and growth in income. To meet this demand, there is need to improve the productivity of cattle, which is relatively low at the moment (Neumann et al., 2002). Regardless of other positive attributes, the productivity of cattle in many tropical countries is low and has been related to diseases, nutrition, genotype and management (Neumann et al., 2002). Diseases such as blackleg and tick-borne are the most endemic in Zimbabwe (Chatikobo et al., 2013). Blackleg (Black quarter, Quarter evil) is a disease affecting cattle and other ruminants and it is caused by the bacteria *Clostridium chauvoei.* Infective spores of *C. chauvoei* were ingested during grazing lodge in the gastrointestinal tract, livers and spleens of healthy cattle and remain latent until their germination is triggered by punctured wounds or injury to muscles (Useh et al., 2010). During the multiplication of *C. chauvoei* in the anaerobic environment they produce lethal toxin which contains hyaluronidases, deoxyribonucleases and oxygen labile hemolysins (Moussa, 1958). The toxins affect the muscles, cause congestion, haemorrhagic and degenerative lesions in the liver and kidneys. In addition, the toxins cause the destruction of leucocytes and platelets (Useh et al., 2003).

According to Scoones (1992), cattle production by resource-challenged farmers is associated with sub-optimal management of diseases and parasites. This is attributed to a low income base to purchase drugs and vaccines. In addition, resource-challenged farmers have limited knowledge on the use and handling of drugs and vaccines. Ideally cattle diseases are controlled using commercial remedies; however, these are expensive, out of reach for resource-challenged farmers because of distance and the unwanted residual effects of drugs in meat (Ndhlovu and Masika, 2013).

In addition, inefficient veterinary service delivery systems due to inadequate staffing, force farmers to resort to the use of alternative remedies and approaches in the management of cattle diseases such as blackleg. There is therefore a need to determine, document and validate the alternative remedies that resource-challenged farmers use to manage blackleg within their cattle herds. Alternative remedies are reportedly cheap, locally available and culturally acceptable in communities (Lans et al., 2008).

However, there is little, if any documentation of the different alternative remedies that resource-challenged farmers use to manage blackleg in the Matabeleland South Province of Zimbabwe. Hence the objective of this study was to determine and document the various alternative remedies that resource-challenged farmers use to control and manage blackleg in their cattle herds.

MATERIALS AND METHODS

Study site

A baseline questionnaire survey was conducted in two villages Nswazi (20° 49′46.67″ S and 28° 57′46.22″ E; Elevation 926 m above sea level) and Dula (20° 37′ 26.99″ S and 28° 48′ 52.28″ E; Elevation 1196 m) in Umzingwane district which is in Matabeleland South Province of Zimbabwe. This area is characterised by rainfall which is received during spring to summer (November to March) (300 to 500 mm/annum). The average summer minimum temperatures range from 19 to 23°C and the maximum range is 28 to 31°C. In winter, the average minimum temperature is 7°C while the maximum temperature is 21°C.

Sampling procedure

Stratified random sampling technique was used to select 90 households that were to be interviewed. The households were chosen by the researcher with the help of the local extension officers. Umzingwane district was stratified into wards and villages from which whence households were randomly selected. Two wards (ward 7 and ward 12) were selected at random and from each of these wards, four villages, Sibambene, Thandabantu, Dula and Mazhowe were subsequently selected randomly. The four chosen villages had significant number of households rearing cattle. Inclusion of farmers (both male and female) in the survey was on condition that they owned cattle.

Data collection

A total of 90 structured questionnaires were administered to 90 randomly selected cattle owners from the four villages during the month of August 2012. Informal and formal interviews were conducted with 28 and 26 farmers in Nswazi and Dula area respectively, and four key informants from each village were also interviewed. The key informants were; the village head, councilors and two herbalists. The data collected from cattle farmers included; household demography, livestock inventory, role of cattle, occurrence of blackleg, perceived challenges caused by blackleg and blackleg disease management practices. Further data on blackleg disease management practices included the types, preparations and applications of remedies used to treat and prevent the occurrence of blackleg disease in cattle.

Statistical analysis

The collected data were analysed using the Statistical Package for the Social Sciences (SPSS, 2010). Descriptive statistics and cross tabulation were computed.

RESULTS

Household demographics

Many households heads (69.3%; n=90) were over 56

*Corresponding author. E-mail: busamoyo@gmail.com, Tel: +263 777727249.

years of age while 17.3 and 9.6% were in the age range of 46 to 55 and 35 to 45 years, respectively. The majority of households were male headed (63.4%; n=90). Although the majority (74.8%) of the household heads were not employed, they were literate. Their education background ranged from primary, Zimbabwe junior certificate to ordinary level. The daily management of cattle was performed mainly by boys (62%) followed by fathers (20%). A few households had mothers (2%) and girls (16%) managing cattle. Households owned an average of 8 cattle (±3 S.E.M). In addition to cattle, farmers owned chickens (87%), goats (30%). The majority of farmers (86%) reported blackleg to be the most important disease followed by ehrlichiosis (23%) and lumpy skin disease (5%). Almost 71% of the respondents reported having experienced cases of blackleg disease in their herd in the past three years. Blackleg disease was perceived to be an important contributor to cattle mortality (52.2%) in the last three years. The mortality due to blackleg disease ranges from 0.4 to 12.5%. About 96.1% of the respondents in the study area reported that blackleg disease was prevalent during summer while 3.9% reported blackleg cases in winter. The majority of the respondents (72.5%) acknowledged that blackleg disease frequently affected cattle that are 1 to 3½ years age range. About 23.5% of the respondents reported that blackleg disease affected cattle that were older than five years. The community had various ways of disposing dead carcasses. Almost 66% of the respondents cut the affected portion and fed it to dogs while the rest of the carcass was used for human consumption. The rest of the respondents disposed carcasses by burning (23.7%) and burying (8.2%).

Farmers got information on how to manage blackleg disease from different sources. The majority got the knowledge from elders (62%), neighbours (11.8%), extension officers (4.5%) and friends (3.9%). A range of alternative remedies and approaches were used to manage blackleg disease. These included conventional vaccines (22%) and alternative remedies (78%). Tables 1 and 2 shows the alternative remedies and management approaches used by the respondents to manage black leg disease. The majority of farmers (80%) claimed that hot water was the mostly used remedy in managing black leg disease. Some remedies; *Pterocarpus angolensis*, *Sclerocarya birrea*, *Diospyros* me*spiliforms, Gardenia spatulifolia* and *"ihlwili"* were believed to prevent the occurrence of the disease. Respondents using traditional remedies administered these by drenching animals with an infusion of the plant powder and water prepared to volumes of 300, 500 and 750 ml (Table 3).

Methods used to prevent blackleg disease put it at the right place

Farmers got information on how to manage blackleg disease from different sources. The majority got the knowledge from elders (62%), neighbours (11.8%), extension officers (4.5%) and friends (3.9%). The respondents varied in the methods and frequency of use of the commercial and alternative remedies. Of the farmers using the conventional blackleg vaccine, 92.3% annually vaccinated their cattle while 7.7% of the respondents had no regular vaccination programme, they only vaccinated when there was an outbreak. All the traditional remedies which the respondents used had no clear program that was followed.

All the farmers who used blackleg vaccine reported that the dosage was 2 ml per animal as prescribed in the bottle. Also they reported that they first communicated with the veterinary officer before buying the vaccine so that the officer would keep the vaccine in their office refrigerator until use.

DISCUSSION

The study revealed that blackleg disease was the most important disease affecting cattle and it was more prevalent in summer which was in agreement with reports by Useh et al. (2010) who found positive correlation between heavy rainfall and outbreaks of blackleg disease in Nigeria. High rainfall may give rise to water-saturated soils and anaerobiosis in the soil, which favours the multiplication of *C. chauvei*. The soil becomes the source of infection and cattle will ingest *C. chauvei* together with grass (Useh, 2002). Useh et al. (2006) affirmed that high rainfall assisted in the dissemination of spores to a wider area. The control of blackleg in the study area was complicated by the way the farmers dispose the cattle carcasses suspected to have died of blackleg. Skinning and throwing away the affected muscles, exposes and spreads the *C. chauvoei* spores. This serves as a source of infection to other supposedly healthy herds (Useh et al., 2006). As such farmers need to be trained on proper carcass disposal methods such as burning of the carcasses.

In this study, there were few farmers who used conventional vaccines. This was attributed to inadequate veterinary skills and lack of money to buy the vaccine by the farmers. The finding in this study was in agreement with Useh et al. (2010) who reported that ineffective vaccination policy and lack of adequate facilities to maintain the cold chain for vaccine storage limits blackleg disease control. Conventional vaccines and services are expensive and they require veterinary technology in the storage and administration of the vaccine (Sori et al., 2004; Harun-or-Rashid et al., 2010). Most respondents were resource-challenged farmers and unemployed and they could not afford to purchase conventional vaccines, a finding which is supported by Useh et al. (2006). In addition, farmers had inadequate resources to purchase syringes and needles and as a result they depend on equipment from the Department of Veterinary Services.

Table 1. Alternative remedies and approaches (non plant material) used by Umzingwane farmers to manage blackleg disease in cattle.

Name of the alternative remedy	Farmers using alternative remedies (%)	Part used	Preparation method	Administration route
Hot water	80		It is sprinkled on the affected part of the animal	Topical
Hot iron	78	Hot surface	Heat the metal or iron to cherry then apply on the affected part for 5 s.	Topical
Potassium permanganate	10		1 g is mixed with 5 L of water. Cattle are drenched with 750 ml in cases of outbreak.	Drenching

Table 2. Alternative remedies and approaches (plant materials) used by Umzingwane farmers to manage blackleg disease in cattle.

Scientific name	Common name	Ndebele name	Farmers using alternative remedies (%)	Part of the plant used	Preparation method	Administration route
Pterocarpus angolensis	Mukwa	uMvagazi	7	log	It is horizontally laid at the foot of kraal for the animals to jump over it daily.	Crossing over the log
			8	Bark	The bark is chopped, soaked in cold water for 6 h or when water has changed reddish colour. Mainly drenched twice annual. 750 ml are drenched per animal.	Drenching
Ricinus communis	Castor oil plant	Mhlafutho	5	leaves	They are ground on the wound that susceptible to blackleg disease.	Topical
Diospyros mespiliformis	Jackal berry	uMdlawuzo	3	log	Put together with *Gardenia spatulifolia* at the foot of the kraal for animal to jump over them daily.	Crossing over the log
Gardenia spatulifolia	Bushveld gardenia	uMvalasangwana	6	log	It is horizontally laid at the foot of kraal for the animals to jump over it daily.	Crossing over the log
		iHlwili	60	bulb	Chop the bulb, soak in cold water or hot for 6 h or water has turned reddish in colour. Drench with 750 ml when suspected to be ill. Sometimes it can be drenched prophylactic.	Drenching

In this study, farmers had an average of 8 cattle per household, while the vaccine vials had 50 doses which was large compared to the small herds reared by the household. As such farmers had to first mobilise themselves so that the numbers of cattle reached close to 50. However, farmers expressed some challenges in mobilising themselves. As a result some farmers discarded the unused doses, and this was a waste of the resources which is unacceptable to financially challenged farmers. Furthermore, the farmers' challenge was compounded by the fact that veterinary livestock technicians cover huge areas without mobility which made it difficult for the farmers to access their services. Some of the farmers travelled more than 20 km to get the services from the Department of Veterinary Services. This contributed to low vaccine usage. Another factor that contributed to low usage of the vaccine is lack of refrigerators and electricity supply to maintain the cold chain while farmers were mobilising themselves. Most of the rural homes were not electrified making it difficult for farmers to have cold mediums such as cold rooms or refrigerators.

Farmers perceived that the Department of Veterinary Services was indifferent to the utilisation of alternative remedies; this could be ascribed to the fact that the veterinary officers were not trained in the use of these alternative remedies during their academic training at colleges and universities. As such they were not keen to promote the use of alternative remedies

Table 3. Dosage of the alternative remedies used by Umzingwane farmers.

Traditional herb	Dosage (ml)
Ihlwili	750
Gardenia spatulifolia	750
Diospyro smespiliformis	500
Sclerocarya birrea	300
Pterocarpus angolensis	750
Ricinus communis	300

which they were not knowledgeable about (Mwale and Masika, 2009).Majority of farmers were reported to be using alternative remedies, a finding consistent with Fullas (2010) and Yirga et al. (2012) which could be ascribed to local availability, accessibility and their cheapness. Alternative remedies were perceived to be effective, easy to use by resource-challenged farmers. Most respondents were resource-challenged farmers and unemployed and they could not afford to purchase conventional vaccines, a finding which is supported by Moreki (2013). Use of hot water by farmers was perceived to be effective in the management of blackleg disease, however its mode of action was unknown. Topical application of hot water or hot iron on the affected portion was believed to increase the muscle temperature which could be lethal to the bacteria in its vegetative form. It has also been speculated that temperatures above 40˚C may inhibit the neuraminidase activity for the *C. chauvoei* (Singh et al., 1993).

Farmers in this current study reported that they drenched their cattle with potassium permanganate. Potassium permanganate is an inorganic substance that has various uses. It is an oxidizing agent that has broad antimicrobial properties against bacteria, algae, fungi and viruses (Khan, 2005). However, Khan (2005) reported that potassium permanganate should be used at low concentration to avoid irritation of tissues. Farmers dissolve a pinch of potassium permanganate (1 g) to 5 L of water; however, cattle are drenched with 750 ml. In this current study, farmers used it before and during outbreaks. Moreki (2013) reported the use of potassium permanganate in the control and treatment of poultry disease especially Newcastle disease. As potassium permanganate has antimicrobial properties, it is speculated that it destroys the ingested *C. chauvoei* which is localised in the intestines and muscles before they cause damage to the muscles.

The plant materials were used as single decoctions or infusions for drenching or topical applications. This was in contrast to traditional healers who frequently use complex mixtures (Luseba and Van der Merwe, 2006). Plant materials were collected when needed from the bush with the exception of *ihlwili* which was kept and perceived to be an essential remedy for a livestock farmer. The mode of action of the plant material was not well explained by the farmers. Farmers perceived that the remedies stimulate the blood circulation and would clean the blood. Furthermore, farmers believed that the reddish colour of the mixture would cleanse the blood from infection with blackleg disease.

The concentrations of the remedies were determined by the qualitative means such as colour changes of the liquid after being soaked in water. The use of *P. angolensis* in the current study was consistent with findings by Luseba and Van der Merwe (2006) who reported that farmers used the plant in the control and treatment of blackleg. According to Ndhlovu and Masika (2013) and Luseba and Tshisikhawe (2013), *P. angolensis* has been used for treatment of Bovine dermatophilosis and cattle anorexia respectively. In addition, Luseba et al. (2007) reported that *P. angolensis* had antibacterial activities. It was speculated that drenching cattle with plant decoctions or infusions inhibited *C. chauvoei* neuramidase (Useh et al., 2003). This might be the pharmacological action by which they ameliorate clinical blackleg infections (Useh et al., 2003).Farmers reported that they put log of *P. angolensis*, *D. mespiliforms* and *G. spatulifolia* across the entrance of the cattle pen so that cattle will step over them when they enter or exit the pen. They changed the logs after a year of its use or when the logs lost their barks. Farmers perceived that these log prevent the occurrence of the blackleg disease. However, they were divergent views on the efficacy of the log in the prevention of blackleg. For instance, some farmers doubted their efficacy; as such they used the logs in conjunction with other remedies.

Conclusions

The use of alternative remedies used in the control and management of blackleg disease, needs to be scientifically explored. Considering the fact that Zimbabweans have a wide range of alternative remedies, research should be directed to explore their potential. The poor accessibility of modern veterinary healthcare services by resource-challenged farmers makes the use of alternative remedies a viable option. In addition to being cheaper and more accessible, alternative remedies can be a viable therapeutic option, if properly investigated and standardized.

Conflict of Interests

None of the authors of this paper has a financial or personal relationship with people or organisations that could inappropriately influence or bias the content of the article.

ACKNOWLEDGEMENTS

The authors are grateful to the communities for sharing their knowledge and experiences in controlling and managing blackleg disease in their cattle. They also wish to thank Solusi University for financial support.

REFERENCES

Chatikobo P, Choga T, Ncube C, Mutambara J (2013). Participatory diagnosis and prioritization of constraints to cattle production in some smallholder farming areas of Zimbabwe. Prev. Vet. Med. 109:327 33.

Chawatama S, Mutisi C, Mupawaenda AC (2005). The socio-economic status of smallholder livestock production in Zimbabwe: A diagnostic study. Livest. Res. Rural Dev. 17:12.

Fullas F (2010). Ethiopian medicinal plants in veterinary healthcare: A Mini-Review. Ethiopian e-J. Res. Innov. Foresight 1(2):48-58.

Harun-or-Rashid MD, Tanzain R, Ghosh KC, Jahan R, Khatan A, Rahmatullah M (2010). An ethnoveterinary survey of medicinal plants used to treat cattle diseases in Birishiri area, Netrakona district, Bangladesh. Adv. Nat. Appl. Sci. 4(1):10-13.

Khan CM (2005). Potassium permanganate. The Veterinary Merck Manual, Merck and Co. Inc. USA, P. 2155.

Lans C, Nancy T, Tonya K (2008). Medicinal plant treatments for fleas and ear problems of cats and dogs in British Columbia, Canada. Parasitol. Res. 103:889-898. http://dx.doi.org/10.1007/s00436-008-1073-6

Luseba D, Van der Merwe D (2006). Ethnoveterinary medicine practices among Tsonga speaking people of South Africa. Ondersterpoort J. Vet. Res. 73:115-122. http://dx.doi.org/10.4102/ojvr.v73i2.156

Luseba D, Van Staden J, Elgorashi EE, Ntloedibe DT (2007). Antibacterial, anti-inflammatory and cyto-toxicity study of medicinal plants used in treatment of wounds and retained placenta in animals. S. Afr. J. Bot. 73:378-383. http://dx.doi.org/10.1016/j.sajb.2007.03.003

Luseba D, Tshisikhawe MP (2013). Medicinal plants used in the treatment of livestock diseases in Vhembe region, Limpopo province, S. Afr. J. Med. Plant Res. 7(10):593-601.

Moreki JC (2013). Documentation of ethnoveterinary practices used in family poultry in Botswana. Vet. World 6(1):18-21. http://dx.doi.org/10.5455/vetworld.2013.18-21

Moussa RS (1958). Complexity of toxins from *Clostridium chauvoei* and *Clostridium septicum*. J. Bacteriol. 76:538-545. PMid:13598715 PMCid:PMC290235

Mwale M, Masika PJ (2009). Ethnoveterinary control of parasites, management and role of village chickens in rural households of Centane district in the Eastern Cape, South Africa. Trop. Anim. Health Prod. 41:1685-1693. http://dx.doi.org/10.1007/s11250-009-9366-z

Ndhlovu DN, Masika PJ (2013). Ethno-veterinary control of bovine dermatophilosis and ticks in Zhombe, Njelele and Shamrock resettlement in Zimbabwe. Trop. Anim. Health Prod. 45(2):525-532. http://dx.doi.org/10.1007/s11250-012-0253-7

Neumann C, Harris DM, Rogers LM (2002). Contribution of animal sourcefoods in improving diet quality and function in children in the developing world. Nutr. Res. 22(1):193-220. http://dx.doi.org/10.1016/S0271-5317(01)00374-8

Scoones I (1992). 'The economic value of livestock in the communal areas of southern Zimbabwe'. Agric. Syst. 39:339-59. http://dx.doi.org/10.1016/0308-521X(92)90074-X

Singh KP, Parihar NS, Tripath BN (1993). Pathology and pathogenesis of experimental *Clostridium chauvoei* infection in hill bulls. Indian Vet. J. 70:511-514.

Sori T, Bekana M, Adugna G, Kelbessa E (2004). Medicinal plants in the ethnoveterinary practices of Borana pastoralists, Southern Ethiopia. Int. J. Appl. Res. Vet. Med. 2(3):220-225.

SPSS (2010). The Statistical Package for Social Sciences (SPSS). 2010. Base 18.0 for Windows, SPSS Inc, Chicago IL.

Useh NM, Ajanusi OJ, Nok AJ, Esievo K (2006). Effect of some inhibitors on *Clostridium chauvoei* (Jakari strain) neuraminidase. J. Anim. Vet. Adv. 5:778-781.

Useh NM (2002). The production and characterization neuraminidase (sialidase) from *Clostridium chauvoei* (Jakari strain). Master of Science Thesis, Ahmadu Bello University, Zaria, Nigeria.

Useh NM, Nok AJ, Esievo K (2003). Pathogenesis and pathology of blackleg in ruminants: The role of toxins and neuraminidase. Vet. Quart. 25(4):155-159. http://dx.doi.org/10.1080/01652176.2003.9695158

Useh NM, Adam S, Ibrahim NDG, Nok AJ, Esievo K (2010). Outbreaks of blackleg of cattle in northern Nigeria (1964-2003). Slovenia Vet. Res. 47: 39-40.

Yirga G, Teferi M, Brhane G, Amare S (2012). Plants used in ethnoveterinary practices in Medebay-Zana District, Northern Ethiopia. J. Med. Plant. 6(3):433-438.

academicJournals

Vol. 5(6), pp 103-112, June 2014
DOI: 10.5897/IJLP2013.0178
Article Number: 7AFE20145318
ISSN 2141-2448

http://www.academicjournals.org/IJLP

International Journal of Livestock Production

Full Length Research Paper

Non-genetic factors affecting fitness traits in the grasscutter (*Thryonomys swinderianus)*

S. Y. Annor[1,2,4]*, B. K. Ahunu[2], G. S. Aboagye[2], K. Boa-Amponsem[3] and J. P. Cassady[4]

[1]Department of Animal Science Education, College of Agriculture Education, University of Education, Winneba, P. O. Box 40, Mampong-Ashanti, Ghana.
[2]Department of Animal Science, College of Agriculture and Consumer Sciences, University of Ghana, P. O. Box LG 571, Legon, Accra, Ghana.
[3]Animal Research Institute, Council for Scientific and Industrial Research, P. O. Box AH 20, Achimota, Accra, Ghana.
[4]Department of Animal Science, College of Agriculture and Life Sciences, North Carolina State University, Campus Box 7621/232B Polk Hall, Raleigh NC 27695-7621, North Carolina, USA.

Received 30 August, 2013; Accepted 13 May, 2014

This study was conducted at the grasscutter section of the University of Education, Winneba, Ghana, to estimate non-genetic effects on reproductive and survival traits. Data consisted of records on 136 does from 2006 to 2010. Litter size at weaning, litter weight and lactation weight loss all increased (P < 0.01) with increasing litter size at birth. Litter weight and lactation weight loss increased (P < 0.05) at weaning, whilst days of joining decreased (P < 0.01), with increasing years. Minor rainy season was found to be the most suitable mating season. Dams that kidded in dry season took fewer (P < 0.05) days to conceive than in other seasons. Nursing dams lost more (P < 0.05) weight in dry and minor rainy seasons than in major rainy season. Increasing parity led to decreasing (P < 0.05) pre-weaning survival of offspring. Post-weaning survival of offspring decreased (P < 0.01) with increasing years. Kids conceived in the minor rainy and dry seasons had significantly higher (P < 0.05) post-weaning survival rates than those conceived in the major rainy season. Post-weaning survival rates of kids born in the minor rainy season were lower (P < 0.05) than those born in other seasons. It was concluded that non-genetic factors influenced fitness traits and must therefore be considered when designing grasscutter breeding programmes.

Key words: Domestication, environmental factors, reproduction, rodent.

INTRODUCTION

Fitness traits measure survival and reproductive rates (Goddard, 2009). Heritability estimates are generally low for these traits, suggesting that response to artificial selection will be slower than that of growth traits (Hohenboken, 1985; Nicholas, 1987; van Vleck et al., 1987). For these reasons, some breeders normally do not include these traits in the breeding objective and selection index, or do not include them in the recording

*Corresponding author. E-mail: sayannor@yahoo.com.

scheme (Haile-Mariam et al., 2007). Therefore, these traits sometimes show a negative genetic trend in livestock populations, despite their importance to profitability (Goddard, 2009). This negative trend may also arise from inbreeding depression (Cassell et al., 2003; Wall et al., 2005). The most important recommendation to overcome this problem is to include fitness traits in the breeding objective, recording scheme and selection index (Goddard, 2009). The low heritability of fitness traits also suggests that environmental or non-genetic factors, which may or may not be controllable by producers, account for substantial variation in these traits (Annor et al., 2012a).

The influence of non-genetic factors on reproductive and survival performance of domestic livestock is very well documented in traditional livestock species reared in tropical environments e.g. cattle (Osei and Effah-Baah, 1989; Osei et al., 1991) and pigs (Darko and Buadu, 1998; Baffour-Awuah et al., 2005). There is however, scanty information in the literature about effects of non-genetic factors on fitness traits of the grasscutter.

The objective of this work was to estimate effects of non-genetic factors on reproductive and survival traits of the grasscutter.

MATERIALS AND METHODS

Location, animals and experimental protocol have been described in a companion paper (Annor et al., 2012c). Essentially, the study was carried out at the grasscutter section of the Department of Animal Science Education, University of Education, Winneba, Ghana, from 2006 to 2010. Mampong-Ashanti is located in the transitional zone between the Guinea savanna zone of the north and tropical rain forest of the south of Ghana. It lies between latitude 07° 04' north and longitude 01° 24' west with an altitude of 457 m above sea level. Maximum and minimum annual temperatures recorded during the study period were 30.6 and 21.2°C, respectively (MSD, 2010). Rainfall in the district is bimodal, occurring from April to July (major rainy season) and again August to November (minor rainy season), and is about 122 cm per annum. The dry season occurs from December to March. The vegetation is transitional savanna woodland. The common fodder species that are routinely fed to grasscutters, *Pennisetum purpureum* (elephant grass) and *Panicum maximum* (guinea grass) are readily available in this zone.

Data consisted of records of 136 does over a 5-year period (2006 - 2010). Dams gave birth up to their third parity. They were fed a basal diet of elephant grass (*P. purpureum*) and a supplementary ration of concentrate which contained 14% crude protein and 1845.6 kcal/kg ME. Composition of concentrate supplement was maize (44%), wheat bran (41%), soybean (9%), oyster shell (5%), common salt (0.5%) and vitamin-mineral-premix (0.5%). Dams were reared and housed in concrete (for mating) and wooden (birth to pre-weaning) cages placed in a large animal house. Animals were reared in wooden cages during the post-weaning period. Kids were weaned at 2 months of age. Animals were identified by metal ear tags at the pre-weaning stage (Hauptner, Germany). The following traits were recorded:

Reproduction

Litter size at birth (LS), litter size at weaning (LSW), litter birth weight (LBWT), litter weaning weight (LWWT), days from joining (introduction of male to female) to conception (DJC), age at first parturition (AFP) and lactation weight loss at weaning of dam (LWTL).

Survival

Survival was defined in two ways, as trait of dam and as trait of offspring: Pre-weaning survival as a trait of dam (PRS_d): Percentage of kids surviving from birth to weaning. Pre-weaning survival as a trait of offspring (PRS_o): Survival from birth to weaning = 1; died = 0. Post-weaning survival as a trait of dam ($POWS_d$): Percentage of kids surviving from weaning to maturity (8 months). Post-weaning survival as a trait of offspring ($POWS_d$): Survival from weaning to maturity = 1; died = 0.

Data on reproduction (except age at first parturition) and survival as a trait of dam were analyzed using Linear mixed models (LMM) with MIXED procedure of SAS (2008). Data on survival as a trait of offspring were analyzed using Generalized linear mixed models (GLMM) with GLIMMIX procedure of SAS (2008). Model used for both situations was:

$$y = X\beta + Zu + \varepsilon$$

Where, y represents vector of observations; X and Z are design, or regressor, matrices associated with fixed and random effects, respectively; β is a vector of fixed-effects (type of birth, parity of dam, year of birth, season of mating and season of birth) parameters; u represents the random effects (animal or dam) vector; and ε, is the vector of residuals.

Sex was included as a fixed effect in analysis of survival as trait of offspring. An account was made for repeatable observations of reproductive traits and survival as trait of dam in SAS analysis.

Data on age at first parturition were subjected to least squares analysis using Generalized linear models (GLM) Type III procedure of SAS (2008) on the following fixed models:

$$y = X\beta + \varepsilon$$

Where, y represents vector of observations, X is design, or regressor, matrix associated with fixed effects; β is a vector of fixed effects (type of birth, parity of dam, year of birth, season of mating and season of birth) parameters; and **ε**, is the vector of residuals.

All model equations included 2-way interactions of fixed effects. Three-way and higher level interactions were not considered important. Differences between means of significant effects were separated by the probability of difference (PDIFF) procedure of SAS (2008). The following coding was used for fixed factors:

Type of birth (litter size): Single = 1, twin = 2, triplet = 3, quadruplet = 4, quintuplet = 5, sextuplet = 6 and septuplet = 7;

Sex of kid: Females = 1 and males = 2.

Parity of dam: First birth = 1, second birth = 2 and third birth = 3.

Seasons: Major rains (April to July) = 1, minor rains (August to November) = 2 and dry season (December to March) = 3.

Year of birth: 2006, 2007, 2008, 2009 and 2010.

RESULTS AND DISCUSSION

Effect of non-genetic factors on reproductive traits

Least squares means of reproductive traits are shown in

Table 1. Least squares means and standard errors for the effect of fixed factors on LS, LSW, LBWT and LWWT.

Fixed factor	LS		LSW		LBWT		LWWT	
	No.[x]	Units	No.	Units	No.	g	No.	g
Type of birth[y]				< 0.0001		< 0.0001		< 0.0001
1	-	-	7	1.0 ± 0.35[a]	8	158.5 ± 25.40[a]	7	844.4 ± 231.00[a]
2	-	-	7	1.4 ± 0.35[a]	7	296.2 ± 27.11[b]	7	1031.6 ± 231.00[ab]
3	-	-	31	2.6 ± 0.16[b]	33	390.2 ± 12.53[c]	31	1482.8 ± 109.77[b]
4	-	-	46	3.7 ± 0.14[c]	47	505.4 ± 10.71[d]	46	2143.1 ± 91.11[c]
5	-	-	30	4.3 ± 0.17[d]	32	566.0 ± 12.71[e]	30	2153.9 ± 111.59[c]
6	-	-	4	6.0 ± 0.47[e]	4	673.2 ± 35.83[f]	4	2988.1 ± 305.59[d]
7	-	-	5	5.4 ± 0.42[e]	5	710.7 ± 32.16[f]	5	2295.4 ± 275.33[cd]
Parity[y]		0.4438		0.4438		0.3036		0.1843
1	57	3.7 ± 0.17	56	3.3 ± 0.19	57	450.7 ± 18.62	56	1782.4 ± 101.73
2	61	4.0 ± 0.16	61	3.5 ± 0.18	61	489.3 ± 18.13	61	1884.5 ± 98.23
3	18	4.1 ± 0.31	16	3.6 ± 0.36	18	489.4 ± 33.12	16	2199.3 ± 194.40
Year of birth[y]		0.8718		< 0.001		0.0280		0.0202
2006	26	3.7 ± 0.26	26	3.0 ± 0.28[ac]	26	429.2 ± 27.04[a]	26	1503.1 ± 145.82[a]
2007	31	4.0 ± 0.24	31	3.9 ± 0.25[b]	31	462.6 ± 24.77[a]	31	1833.3 ± 130.97[ab]
2008	24	4.0 ± 0.27	24	3.6 ± 0.29[bc]	24	520.8 ± 28.13[b]	24	2023.0 ± 152.01[bc]
2009	35	4.0 ± 0.22	35	3.6 ± 0.25[bc]	35	509.5 ± 24.45[b]	35	2200.3 ± 127.79[c]
2010	20	3.7 ± 0.29	17	2.6 ± 0.34[a]	20	427.0 ± 30.90[a]	17	1702.7 ± 182.09[b]
Mating season[y]		0.0329		0.4860		0.0496		0.0001
Major rains	51	3.7 ± 0.18[a]	51	3.3 ± 0.20	51	453.2 ± 19.38[a]	51	1728.5 ± 106.53[a]
Minor rains	42	4.3 ± 0.20[b]	42	3.7 ± 0.23	42	520.3 ± 21.61[b]	42	2082.8 ± 119.56[b]
Dry season	43	3.6 ± 0.19[a]	40	3.4 ± 0.23	43	452.0 ± 21.11[a]	40	1846.8 ± 120.10[a]
Season of birth[y]		0.1842		0.1612		0.7870		0.5425
Major rains	37	3.8 ± 0.21	34	3.5 ± 0.25	37	460.2 ± 23.31	34	1874.1 ± 130.45
Minor rains	29	3.6 ± 0.24	29	3.0 ± 0.27	29	472.1 ± 26.37	29	1730.0 ± 147.94
Dry season	70	4.1 ± 0.16	70	3.6 ± 0.17	70	480.2 ± 17.13	70	1925.2 ± 93.79
Overall	136	3.9 ± 0.11	133	3.4 ± 0.13	136	473.2 ± 12.06	133	1888.2 ± 66.58

[x]Number of animals; [y]Probability value of test of main effects; [abc]Means in the same column and within the same effect, with different superscripts are significantly different; LS, Litter size at birth; LSW, litter size at weaning; LBWT, litter birth weight; LWWT, litter weaning weight.

Tables 1 and 2. Mean values of kidding interval and number of parturitions per doe per year were 8.2 months and 1.8, respectively. Mean litter size at birth (3.9) and litter size at weaning (3.4) fall within ranges from the literature, 3.8 to 4.8 and 2.4 to 3.9, respectively (Adu et al., 1999; Jori and Chardonnet, 2001; Adu, 2003; Ikpeze and Ebenebe, 2004c; Addo et al., 2007). Mean litter birth weight (473.2 g) and litter weaning weight (1888.2 g) are also within ranges, 289.2 to 798.0 g and 1038.4 to 2242.5 g, respectively (Schrage and Yewadan, 1999; Adu et al., 2000; Ikpeze and Ebenebe, 2004a; Ikpeze and Ebenebe, 2004b).

There is positive correlation between duration of male-female pairing (joining) and conception rates (Addo et al., 2003). Determination of optimal duration of pairing to achieve pregnancy is important for successful breeding. Mean days of joining to conception of 21 days observed in this study is far below the common practice in Ghana where most farmers pair males and females for no less than 45 days (Greater Accra Grasscutter Farmers Association, personal communication). Breeding males prey on pregnant does if duration of pairing is too long. There is also a common practice where farmers leave breeding pairs together until parturition. This practice results in breeding males preying on male kids in the litter (Asibey, 1974; Addo et al., 2003).

This study provides evidence that the period for which farmers commonly pair males and females for breeding is too long. Addo et al. (2003) observed 80% sexual receptivity and 79.3% resultant pregnancies within the first 3 days of male-female pairing. Addo et al. (2007) reported a conception rate of 87.1% when males and

Table 2. Least squares means and standard errors for the effect of fixed factors on DJC, ADB and LWTL.

Fixed factor	DJC		AFP		LWTL	
	No.[x]	Days	No.	Months	No.	g
Type of birth[y]		0.3988		0.1696		0.0006
1	8	22.0 ± 3.98	5	12.3 ± 0.33	7	122.7 ± 93.33[a]
2	7	29.3 ± 4.22	1	12.0 ± 0.71	7	-119.0 ± 93.33[ab]
3	33	20.1 ± 1.98	16	11.6 ± 0.19	31	-254.1 ± 45.08[b]
4	47	21.8 ± 1.70	23	11.8 ± 0.17	46	-267.7 ± 36.81[b]
5	32	20.1 ± 2.00	9	12.6 ± 0.30	30	-452.3 ± 45.08[c]
6	4	28.6 ± 5.57	1	11.6 ± 0.71	4	-360.0 ± 123.46[bc]
7	5	18.7 ± 5.05	2	12.1 ± 0.52	5	-588.0 ± 110.42[cd]
Parity[y]		0.5136				0.0558
1	57	22.1 ± 1.51	-	-	56	-251.4 ± 38.02
2	61	20.0 ± 1.47	-	-	61	-301.0 ± 36.38
3	18	22.7 ± 2.68	-	-	16	-317.0 ± 72.14
Year of birth[y]		0.0019		0.0461		0.0255
2006	26	18.8 ± 2.08[a]	18	11.6 ± 0.26[a]	26	-193.6 ± 55.13[a]
2007	31	28.2 ± 1.91[b]	9	12.0 ± 0.31[ab]	31	-227.7 ± 49.51[a]
2008	24	22.4 ± 2.17[a]	11	12.0 ± 0.28[ab]	24	-311.9 ± 58.77[b]
2009	35	19.1 ± 1.82[a]	16	12.4 ± 0.22[b]	35	-370.4 ± 47.27[b]
2010	20	14.5 ± 2.38[c]	3	12.0 ± 0.45[ab]	17	-389.8 ± 68.91[b]
Mating season[y]		0.0239		0.2107		0.0259
Major rains	51	24.6 ± 1.56[a]	23	12.3 ± 0.28	51	-272.6 ± 40.12[a]
Minor rains	42	17.9 ± 1.74[b]	19	12.0 ± 0.27	42	-355.6 ± 44.40[b]
Dry season	43	20.0 ± 1.70[c]	15	11.7 ± 0.27	40	-256.7 ± 44.97[a]
Season of birth[y]		0.0482		0.1445		0.0233
Major rains	37	20.1 ± 1.85[a]	14	12.3 ± 0.30	34	-220.9 ± 48.12[a]
Minor rains	29	23.6 ± 2.12[b]	12	12.2 ± 0.30	29	-313.9 ± 55.03[b]
Dry season	70	18.8 ± 1.39[c]	31	11.6 ± 0.22	70	-322.4 ± 34.02[b]
Overall	136	21.0 ± 0.98	57	11.9 ± 0.10	133	-293.7 ± 24.91

[x]Number of animals; [abc]Means in the same column and within the same effect, with different superscripts are significantly different; [y]Probability value of test of main effects; DJC, Days of joining to conception; AFP, age at first parturition; LWTL, lactation weight loss.

females were paired for 14 days, and recommended that mates be paired for 2 to 4 weeks for mating purposes. In this study, only 60.0% of females were pregnant at the mean 21 pairing days (3 weeks), with 75.0 and 91.2% of females pregnant at the end of the 4[th] and 5[th] week of pairing, respectively. It is therefore being suggested that mates (males and females) should be paired for a maximum of 5 weeks (35 days) for mating purposes. This recommendation is based on the optimum pregnancy rate of 90.0% reported for the grasscutter (Schrage and Yewadan, 1999; Addo et al., 2007), and an observation in this study that males begin preying on pregnant females after about 40 days of pairing. One suggestion for producers is to only retain replacement females from those that get pregnant early. For example, farmers may keep replacements out of females that get pregnant in the first 21 days.

Mean age at first parturition of 11.9 months observed in this study is similar to 11.0 months reported by Schrage and Yewadan (1999). It is also close to 10 to 11 months calculated from data presented by Mensah and Okeyo (2006). Kidding around 11 to 12 months is ideal because age at first mating is around 6 to 7 months, and gestation is approximately 5 months (Schrage and Yewadan, 1999; Adu et al., 1999).

Mean lactation weight loss of dam (-293.7 g) was approximately 10% of the dam's body weight at birth, despite being given supplementary feed. A similar observation was made by Mattingly and Mcclure (1985) in cotton rats. They reported that even with ample food, lactating cotton rats lost 11% of their body weight at weaning.

Mean kidding interval of 8.2 months obtained in the study is similar to 7.5 months reported by Adu et al. (1999). It is however longer than the 6.9 and 6 to 7 months reported by Schrage and Yewadan (1999) and Mensah and Okeyo (2006), respectively. Shorter kidding intervals are desirable to increase number of litters per doe per year. Kidding interval is variable and depends greatly on weaning period. Weaning age can be reduced to increase number of litters per doe per year. In this study, weaning was done at 2 months, but it could be reduced to about 1 month, which would reduce kidding interval to 7.2 months to improve upon number of litters per doe per year. This is supported by the work of Adu (2003). In his study of patterns of parturition and mortality in weaned grasscutters, he concluded that it is practical to wean kids at 4 weeks of age with proper post-weaning management. Based on the results of this study and experience from the field and in the literature farmers are advised to wean kids at the age of 2 months.

Litter size at weaning, litter birth weight, litter weaning weight and lactation weight loss all increased ($P < 0.01$) with increasing litter size at birth (Tables 1 and 2). However, kids of various litter size groups had similar ($P > 0.05$) days of joining to conception and age at first parturition, indicating that the effect of litter size on these two traits was not important. Litter size at birth explained 57.0, 72.8, 30.7 and 22.9% of the variation in litter size at weaning, litter birth weight, litter weaning weight and lactation weight loss, respectively.

As litter size at birth increases, litter size at weaning will increase due to a high positive genetic correlation between the two traits (Annor et al., 2012b). In mammals, litter weight is positively correlated with litter size (Millar, 1981). Therefore, if litter size at birth increases, litter birth weight and litter weaning weight will increase. Large litters consume more milk than small litters (Epstein, 1978); therefore, increasing litter size will also increase lactation weight loss. In some instances, dams of litter size of 6 to 7 became very emaciated during suckling, sometimes resulting in alopecia and death. Emaciated condition of nursing female reflected the physiological stress resulting from raising an extraordinary large litter over the pre-weaning period (Cameron, 1973). These results should stimulate experimental inquiry into role of nutrition as an ultimate factor in family size determination. There was no influence ($P > 0.05$) of parity on any reproductive trait. Parity was relatively not important in explaining variation in reproductive traits, possibly because of the few parity levels (1, 2 and 3) involved in the study or the few observations made for Parity 3, compared to Parity 1 and 2.

Year of birth had an effect ($P < 0.05$) on all reproductive traits, except, litter size at birth (Tables 1 and 2). Mean litter size at birth was similar in all years. There was no trend of the effect of year on reproductive traits. However, litter weaning weight and lactation weight loss increased whilst days of joining to conception decreased with increasing years. Year of birth explained 3.7, 4.3 and 7.1% of the variation in litter weight at weaning, days of joining to conception and lactation weight loss, respectively.

It was observed by Addo et al. (2007) that increasing years of the dam had an effect of increasing weaning weight. In that study, increasing year by 1 unit increased weaning weight by 39.6 g. Observed increase in weight with increasing years led to recorded increases in litter birth weight and litter weaning weight with years. Days of joining to conception decreased with years because multiparous dams with bigger body size conceived earlier than primiparous dams with smaller body size. Increasing years has the effect of producing bigger dams and also bringing many multiparous dams into play. Lactation weight loss increased with increasing years because heavier offspring were produced with increasing years. The demand for milk from heavier offspring is higher than that of lighter ones (Epstein, 1978), therefore, physiological stress resulting from suckling from heavier offspring is also higher than that of lighter ones (Cameron, 1973; Vaughan et al., 2009).

Season of mating affected ($P < 0.05$) litter size at birth, litter birth weight ($P < 0.05$), litter weaning weight ($P < 0.01$), days of joining to conception ($P < 0.05$) and lactation weight loss ($P < 0.05$) but had little effect ($P > 0.05$) on litter size at weaning and age at first parturition. Mean litter size at weaning and age at first parturition of dams that conceived in all seasons were similar. However, dams that conceived in the minor rainy season had higher ($P < 0.05$) litter size at birth, litter birth weight ($P < 0.05$), litter weaning weight, lactation weight loss and fewer ($P < 0.05$) days of joining to conception than those conceiving in major rainy and dry seasons.

Mean litter size at birth, litter size at weaning, litter birth weight, litter weaning weight and age at first parturition did not differ ($P > 0.05$) between seasons of birth. However, dams that kidded in dry season took fewer ($P < 0.05$) days to conceive than those kidding in the other seasons. Dams that kidded in dry and minor rainy seasons lost more ($P < 0.05$) weight than those kidding in major rainy season.

The best reproductive performance of females was exhibited by those mated in the minor rainy season. Litter size at birth, litter birth weight and litter weaning weight were significantly higher for females mated in the minor rainy season than the other two seasons. Lactation weight loss at weaning was also higher for females mated in the minor rainy season. The shortest days of joining to conception was also observed in the minor rainy season. The minor rainy season, August to November, coincides with the natural breeding season of grasscutters in the wild, as the major rains had encouraged the growth of fresh vegetation with abundant food supply (GNA, 2009). The abundance of food provides good nutrition, which is important for adequate and good ovulation (Bronson, 2009). This probably led to the highest litter size in dams mated in the minor rainy season. An increase in litter size at birth also led to an increase in litter weight at birth because in mammals litter weight is positively correlated with litter size (Millar, 1981).

Dams that were mated in the minor rainy season took the shortest days to get pregnant, probably because that is their natural breeding season. The minor rainy season is therefore the best breeding period for domesticated grasscutters, although the animals are known to breed throughout the year (Asibey, 1974; Adu, 2003; Addo et al., 2007). Lactation weight loss was highest among does mated in the minor rainy season because these females gave birth in the dry season, and produced the largest litters that also had the highest litter birth weight. Poor grass quality, in addition to increased litter size and litter birth weight, in the dry season adversely affected lactation weight loss. Despite providing supplementary feeding, the effect of season was still significant. This is relevant when it is recognized that feeding standards used to provide supplementary feed for nursing mothers were based on those of growing grasscutters.

Dams that gave birth in the dry season had the shortest days of joining to conception because they were mated in the minor rainy season which is the best or natural mating period (GNA, 2009). Dams that gave birth in the dry season also lost more weight than those that gave birth in the major rains because the former had the largest litter size at birth and highest litter birth weight, though the difference between the means of season of birth was not significant. It is concluded that farmers could mate their animals in any season of the year but should make sure to provide animals with adequate nutrition.

Effect of non-genetic factors on survival traits

Least squares means of survival traits are shown in Table 3. Post-weaning survival was higher than pre-weaning survival. There is wide variation in survival rates of grasscutter in the literature, most likely due to wide variations in environmental and management conditions. Both pre- and post-weaning survival rates range from 75 to 100% (Mensah, 2000; Adu, 2003; Ikpeze and Ebenebe, 2004b; Addo et al., 2007). Mean survival rates (as trait of dam and offspring) are higher than 75% observed in Nigeria (Ikpeze and Ebenebe, 2004c) and Benin (Mensah, 2000), respectively. They are however lower than 100% reported by Addo et al. (2007) in Ghana.

Pre- and post-weaning survival rates did not differ ($P > 0.05$) between litter sizes (Table 3). The results do not follow general observation in rodents that survival of kids decreases with increasing litter size (Cameron, 1973; Myers and Master, 1983), probably because the husbandry was congenial for survival in this study. Both grass and concentrate supplement were provided to nursing dams to enable them provide sufficient milk for kids. Based on the present results it is suggested that it will be advantageous to select animals from larger litters at weaning, on account of their survival, for breeding.

Survival did not differ ($P > 0.05$) between the sexes. Thus, sex had no influence on pre- and post-weaning survival. There is little information in the literature on survival rates in the sexes. However, a study in wild birds also observed no differences in survival between the sexes (Fisher and Wiebe, 2006).

Year of birth had an effect ($P < 0.05$) on all survival traits (Table 3). Nevertheless, there was no trend of the effect of year on survival traits. However, post-weaning survival rate as a trait of offspring decreased with increasing years. Year of birth explained 2.7% of the variation in this trait. The reduction in post-weaning survival as the years progressed was attributed to an increase in population of animals with increasing years. The annual population growth rate of the study animals on the farm was 108.5%. Increase in population facilitates the spread of infectious diseases in grasscutter herds (Annor et al., 2009). This probably led to reduced survival. In domestic animals, survival depends not only on diseases and their characteristics but also on husbandry practices (Thrusfield, 2007). Animals may die from negligence of farm workers or from the absence of farm inputs. It is concluded that most year effects were due to variation in management practices, knowledge and/experience of the farmer and farm workers, and facilities available on the farm.

Season of mating affected ($P < 0.01$) post-weaning survival but had little effect ($P > 0.05$) on pre-weaning survival rates. Kids conceived in all seasons had similar pre-weaning survival rates. Kids conceived in minor rainy and dry seasons had higher ($P < 0.01$) post-weaning survival rates than those conceiving in major rainy season (Table 3). Mean pre-weaning survival rate as trait of dam and offspring did not differ ($P > 0.05$) between seasons of birth. Post-weaning survival rates of kids born in minor rainy season were lower ($P < 0.05$) than those born in other seasons.

Animals that were conceived in the major rainy season had significantly lower post-weaning survival rates than those conceived in other seasons. Post-weaning here refers to age of 2 to 8 months. Effect of season on survival is known to be mediated through quantity and quality of food available to rodents (Cittadino et al., 1994). Most dams that conceived in the major rainy season (April to July) gave birth and weaned kids in the minor rainy season (August to November). These weaned kids had to spend the first part (4 months) of their adult life (post-weaning) in the dry season (December to March) when grass quality was poor (Annor et al., 2012c). Poor nutrition is probably

Table 3. Least squares means and standard errors for the effect of fixed factors on survival traits.

Fixed factor	PRS_d		$POWS_d$		PRS_O		$POWS_O$	
	No.[x]	%	No.	%	No.	%	No.	%
Type of birth[y]		0.1534		0. 6236		0.1934		0.2514
1	8	99.9 ± 8.55	6	99.9 ± 11.58	8	97.6 ± 0.11	6	97.9 ± 0.12
2	7	99.9 ± 8.55	7	99.7 ± 10.70	14	97.2 ± 0.09	11	93.3 ± 0.11
3	33	85.9 ± 3.94	27	87.8 ± 5.46	96	79.1 ± 0.04	73	88.4 ± 0.06
4	47	93.3 ± 3.37	39	82.1 ± 4.63	179	87.3 ± 0.04	145	83.1 ± 0.05
5	32	86.29 ± 4.06	23	90.7 ± 5.91	157	81.9 ± 0.04	111	80.2 ± 0.06
6	4	71.4 ± 11.31	3	92.1 ± 16.36	24	91.5 ± 0.10	18	79.4 ± 0.13
7	5	77.2 ± 10.11	5	79.3 ± 12.67	24	77.6 ± 0.10	20	77.4 ± 0.12
Sex[y]						*0.1633*		*0. 6630*
Male	-	-	-	-	245	84.9 ± 0.04	187	83.9 ± 0.05
Female	-	-	-	-	257	81.5 ± 0.04	197	85.1 ± 0.04
Parity[y]		P = 0.3472		P = 0.5731		0.0444		0.4236
1	57	90.1 ± 3.07	47	86.7 ± 4.12	224	88.0 ± 0.04[a]	177	83.9 ± 0.05
2	61	89.4 ± 2.97	50	86.3 ± 4.04	203	86.7 ± 0.04[a]	160	80.9 ± 0.05
3	18	80.6 ± 5.75	13	85.5 ± 7.84	75	74.8 ± 0.06[b]	47	88.7 ± 0.07
Year of birth[y]		0.0058		0.0170		0.0098		0.0031
2006	26	81.8 ± 4.26[a]	25	92.2 ± 5.22[a]	79	78.9 ± 0.06[ab]	70	91.3 ± 0.07[a]
2007	31	96.8 ± 3.90[b]	31	98.1 ± 4.69[a]	117	91.3 ± 0.05[b]	116	99.9 ± 0.05[a]
2008	24	91.0 ± 4.44[b]	23	66.3 ± 5.45[b]	91	88.3 ± 0.05[b]	82	79.2 ± 0.06[b]
2009	35	93.5 ± 3.73[b]	24	87.6 ± 5.45[a]	148	88.4 ± 0.04[b]	94	75.1 ± 0.06[b]
2010	20	71.0 ± 5.27[a]	7	94.3 ± 9.87[a]	67	79.0 ± 0.07[a]	22	75.8 ± 0.10[b]
Mating season[y]		0. 6126		0.0112		0.2340		< 0.0001
Major rains	51	89.1 ± 3.24	36	74.3 ± 4.47[a]	188	80.8 ± 0.05	124	72.3 ± 0.07[a]
Minor rains	42	85.8 ± 3.61	35	92.4 ± 4.66[b]	165	78.4 ± 0.05	129	91.0 ± 0.06[b]
Dry season	43	90.9 ± 3.65	39	96.0 ± 4.28[b]	149	90.3 ± 0.05	131	99.9 ± 0.05[b]
Season of birth[y]		0.3456		0.0076		0.1177		0.0233
Major rains	37	92.6 ± 3.95	32	96.3 ± 4.69[a]	133	86.3 ± 0.06	111	85.5 ± 0.06[a]
Minor rains	29	83.9 ± 4.27	23	76.7 ± 5.53[b]	98	82.8 ± 0.06	68	73.7 ± 0.07[b]
Dry season	70	88.6 ± 2.77	55	90.5 ± 3.61[a]	271	90.5 ± 0.04	205	94.3 ± 0.05[a]
Overall	136	86.5 ± 2.26	110	87.4 ± 2.70	502	84.4±0.04	384	85.0±0.05

[x]Number of animals; [y]Probability value of test of main effects; [abc]Means in the same column and within the same effect, with different superscripts are significantly different; PRS_d, pre-weaning survival as trait of dam; $POWS_d$, post-weaning survival as trait of dam; PRS_o, pre-weaning survival as trait of offspring; $POWS_o$, post-weaning survival as trait of offspring.

responsible for the poor post-weaning survival of animals conceived in the major rainy season.

Post-weaning survival of animals born in the minor rainy season was significantly poorer than those born in other seasons. Kids born in the minor rainy season were weaned in the same season. Similar explanation given above also applies to this situation because these weaned kids had to spend the first part (4 months) of their adult life (post-weaning) in the dry season (December to March).

Interaction effects of fixed factors on traits

Interaction effects of type of birth with all other fixed factors on litter size at weaning, litter birth weight, litter weaning weight and post-weaning survival as a trait of offspring were important (Table 4). Year × season of mating interaction was important for litter size at birth, litter size at weaning, litter birth weight, litter weaning weight and days of joining to conception. Year × seasons and season of mating × season of birth interactions were

Table 4. Interaction effects of fixed factors on fitness traits.

Type of interaction	LS	LSW	LBWT	LWWT	DJC	AFP	LWTL	PRS_d	$POWS_d$	PRS_o	$POWS_d$
TOB*Sex	-	-	-	-	-	-	-	-	-	ns	ns
TOB*Parity	-	**	**	**	ns	-	ns	ns	ns	ns	**
TOB*YOB	-	**	**	*	ns	ns	ns	ns	ns	ns	**
TOB*SOM	-	**	**	**	ns	ns	ns	ns	ns	ns	**
TOB*SOB	-	**	**	**	ns	ns	ns	ns	ns	ns	*
Sex*Parity	-	-	-	-	-	-	-	-	-	ns	ns
Sex*YOB	-	-	-	-	-	-	-	-	-	ns	ns
Sex*SOM	-	-	-	-	-	-	-	-	-	ns	ns
Sex*SOB	-	-	-	-	-	-	-	-	-	ns	ns
Parity*YOB	ns	ns	ns	ns	ns	-	ns	ns	ns	ns	*
Parity*SOM	ns	ns	ns	ns	ns	-	ns	ns	ns	ns	ns
Parity*SOB	ns	ns	ns	ns	ns	-	ns	ns	ns	ns	**
YOB*SOM	*	*	*	*	**	ns	ns	ns	ns	ns	ns
YOB*SOB	ns	ns	ns	ns	**	ns	ns	ns	*	**	*
SOM*SOB	ns	ns	ns	ns	**	ns	ns	ns	*	ns	ns

* = $P < 0.05$; ** = $P < 0.01$; LS, Litter size at birth; LSW, litter size at weaning; LBWT, litter birth weight; LWWT, litter weaning weight; DJC, days from joining to conception; AFP, age at first parturition; LWTL, lactation weight loss; PRS_d, pre-weaning survival as trait of dam; $POWS_d$, post-weaning survival as trait of dam; PRS_o, pre-weaning survival as trait of offspring; $POWS_o$, post-weaning survival as trait of offspring; TOB, type of birth; YOB, year of birth; SOM, season of mating; SOB, season of birth.

important for joining to conception. Year × season of birth and season of mating × season of birth interactions were important for post-weaning survival as a trait of dam.

The significant first order interactions observed in this study for both reproductive and survival traits indicate that the ranking of levels of the same factor do not hold when combined with sets of levels of two factors are considered. There are no previous studies on interactions of fixed factors in the grasscutter. However, studies in rodents and other farm animal species have confirmed the existence of some of the above interactions. Significant parity × season interactions on litter size and litter weight in rabbits were reported by Tuma et al. (2010). Chineke (2005) also reported significant interactions of parity × season on litter weight in rabbits. Significant year × season of birth interactions on litter size has been reported in pigs (Gaugler et al., 1984) and goats (Hamed et al., 2009). The importance of interactions of fixed factors has been recognized in farm animal genetic improvement and evaluation programmes (Diop, 1997; Lee and Pollak, 1997; Lee et al., 2000; Meyer, 2003).

Conclusion

The mean values of traits obtained in this study were compared favourably with similar studies conducted in sub-Saharan Africa on the grasscutter. In most cases, the study showed that non-genetic effects influenced reproductive and survival traits. It is important that the extent to which these environmental factors influence traits under study be evaluated for appropriate adjustments to be made when estimating genetic values for a breeding programme in grasscutter. Interaction effects were important in the grasscutter and must be considered in genetic improvement and evaluation programmes. There is also a need to find the nutrient requirements for pregnant and lactating grasscutters.

Conflict of interests

The author(s) have not declared any conflict of interests.

ACKNOWLEDGEMENT

The authors are grateful to the Teaching and Learning Innovative Fund (TALIF), Ghana for providing grasscutter facilities for this research.

REFERENCES

Addo PG, Dodoo A, Adjei S, Awumbila B (2003). Optimal duration of male-female exposure to optimize conception in the grasscutter (Thryonomys swinderianus). Livest. Res. Rural Dev. 15: 1. http://www.lrrd.org/lrrd15/1/addo151.htm

Addo PG, Awumbila B, Awotwi E, Ankrah N-A (2007). Reproductive characteristics of the female grasscutter (Thryonomys swinderianus) and formulation of colony breeding strategies. Livest. Res. Rural Dev. 19: 59. http://www.cipav.org.co/lrrd/lrrd19/4/addo19059.htm.

Adu EK, Alhassan WS, Nelson FS (1999). Smallholder farming of the cane rat, Thryonomys swinderianus, Temmink, in Southern Ghana: A baseline survey of management practices. Trop. Anim. Health Prod. 31: 223-232. http://dx.doi.org/10.1023/A:1005267110830

Adu EK, Aning KG, Wallace PA, Ocloo TO (2000). Reproduction and mortality in a colony of captive greater cane rats, Thryonomys swinderianus, Temminck. Trop. Anim. Health Prod. 32:11-17. http://dx.doi.org/10.1023/A:1005284817764

Adu EK (2003). Patterns of parturition and mortality in weaned greater crane rats (Thryonomys swinderianus, Temminck). Trop. Anim. Health Prod. 35(5):425-431.
http://dx.doi.org/10.1023/A:1025815528916

Annor SY, Adu EK, Donkor J, Otsyina H, Ahiaba J (2009). In: Grasscutter Production: A Handbook. Qualitype Ltd. Accra, Ghana, 109 pp.

Annor SY, Ahunu BK, Aboagye GS, Boa-Amponsem K, Cassady JP (2012a). Phenotypic and genetic parameter estimates for grasscutter production traits. 1. Co(variance) and heritability. Global Adv. Res. J. Agric. Sci. 1(6):148-155.

Annor SY, Ahunu BK, Aboagye GS, Boa-Amponsem K, Cassady JP (2012b). Phenotypic and genetic parameter estimates for grasscutter production traits. 2. Global Adv. Res. J. Agric. Sci. 1(6) 156-162.

Annor SY, Ahunu BK, Aboagye GS, Boa-Amponsem K, Cassady JP (2012c). Non-genetic effects on traits of the grasscutter. 1. Growth traits. World Appl. Sci. J. 18(10) 1412-1424.

Asibey EOA (1974). Wildlife as a source of protein in Africa, South of Sahara. Biol. Conserv. 6(1):32-39.
http://dx.doi.org/10.1016/0006-3207(74)90039-1

Baffour-Awuah O, Kewuribi CS, Etse DB (2005). The performance of Ashanti Black pigs under intensive management system. Ghanaian J. Anim. Sci. 1(1):7-13.

Bronson FH (2009). Climate change and seasonal reproduction in mammals. Philos. Trans. R. Soc. London [Biol] 354(1534):3331-3340. http://dx.doi.org/10.1098/rstb.2009.0140

Cameron GN (1973). Effect of litter size on post-natal growth and survival in the desert wood rat. J. Mammal. 54(2):489-493. http://dx.doi.org/10.2307/1379133

Cassell BG, Adamec V, Pearson RE (2003). Maternal and fetal inbreeding depression for 70-Day non return and calving rate in Holsteins and Jerseys. J. Dairy Sci. 86:2977-2983.
http://dx.doi.org/10.3168/jds.S0022-0302(03)73895-8

Chineke CA (2005). Genetic and non-genetic effects on weaning weight and post-weaning traits in rabbit breeds and crosses. Pak. J. Biol. Sci. 8(10):1402-1410.
http://dx.doi.org/10.3923/pjbs.2005.1402.1410

Cittadino EA, de Carli P, Busch M, Kravetz FO (1994). Effects of food supplementation on rodents in winter. J. Mammal. 75(2):446-457. http://dx.doi.org/10.2307/1382566

Darko K, Buadu MK (1998). The performance of a herd of Ashanti dwarf pigs in the forest zone of Ghana. Proc. 24th Anim. Sci. Symp. Faculty of Agriculture, KNUST, Kumasi, August 26-29, 1998(2):88.

Diop M (1997). Design and analysis of open nucleus breeding systems for cattle in Senegal. ETD collection for University of Nebraska - Lincoln. Paper AAI9734613. http://digitalcommons.unl.edu/dissertations/AAI9734613.

Epstein HT (1978). The effect of litter size on weight gain in mice. J. Nutr. 108(1):120-123.

Fisher RJ, Wiebe KL (2006). Effect of sex and age on survival of northern flickers: A six-year field study. Condor 108:193-200. http://dx.doi.org/10.1650/0010-5422(2006)108[0193:EOSAAO]2.0.CO;2

Gaugler HR, Buchanan DS, Hintz RL, Johnson RK (1984). Sow productivity comparisons for four breeds of swine: Purebred and crossbred litters. J. Anim. Sci. 59(4):941-947.

Ghana News Agency (GNA) (2009). Annual ban on hunting begins. General News, Monday 3rd August 2009. http://www.ghanaweb.com/GhanaHomePage/NewsArchive/artikel.php?ID=166277.

Goddard M (2009). Fitness traits in animal breeding programmes. In: Adaptation and Fitness in Animal Populations: Evolution and Breeding Perspectives on Genetic Resource Management. Eds. J. van der Werf, H-U Graser, R. Frankham and C. Gondro, Springer Science+Business Media B.V., pp. 41-52.

Haile-Mariam M, Schelfhorst E, Goddard ME (2007). Effect of data collection methods on the availability of calving ease, fertility and herd health data for evaluating Australian dairy cattle. Aust. J. Exp. Agric. 47:664-671. http://dx.doi.org/10.1071/EA05267

Hamed A, Mabrouk MM, Shaat I, Bata S (2009). Estimation of genetic parameters and some non-genetic factors for litter size at birth and weaning and milk yield traits in Zaraibi goats. Egypt. J. Sheep Goats Sci. 4(2):55-64.

Hohenboken WD (1985). Heritability and repeatability. In: World Animal Science, General and Quantitative Genetics. Ed. Chapman A.B., Elsevier Science Publishers. pp. 77-119.

Ikpeze OO, Ebenebe CI (2004a). Factors affecting growth and body measurements of grasscutter (Rodentia: Thryonomyidae). Anim. Res. Int. 1(3):176-180.

Ikpeze OO, Ebenebe CI (2004b). Productive performance of the grasscutter (Rodentia: Thryonomyidae) reared under three different housing systems. Bio-Res. 2(2):19-21.

Ikpeze OO, Ebenebe CI (2004c). Productive performance of the grasscutter (Rodentia: Thryonomyidae) reared under three different housing systems. Bio-Res. 2(2):19-21.

Jori F, Chardonnet P (2001). Cane rat farming in Gabon: Status and perspectives. 5th International Wildlife Ranching Symposium Pretoria, South Africa. http://www.tdr.cesca.es/TESIS_UAB/AVAILABLE/TDX-0919101-122006/fjm5de10.pdf.

Lee C, Pollak EJ (1997). Relationship between sire × year interactions and direct-maternal genetic correlation for weaning weight of Simmental cattle. J. Anim. Sci. 75:68-75.

Lee JW, Choi SB, Jung YH, Keown JF, Van Vleck LD (2000). Parameter estimates for direct and maternal genetic effects on yearling, eighteen-month, and slaughter weights of Korean native cattle. J. Anim. Sci. 78:1414-1421.

Mattingly DK, Mcclure PA (1985). Energy allocation during lactation in cotton rats (Sigmodon hispidus) on a restricted diet. Ecology 66:928-937. http://dx.doi.org/10.2307/1940555

Mensah GA (2000). Présentation générale de l'élevage d'aulacodes, historique et état de la diffusion en Afrique. In Actes Séminaire international sur l'élevage intensif de gibier à but alimentaire à Libreville (Gabon), Projet GEG/VSF/ADIE/CARPE/UE, pp. 45-59.

Mensah GA, Okeyo AM (2006). Continued harvest of the diverse African animal genetic resources from the wild through domestication as a strategy for sustainable use: A case of the larger Grasscutter (Thryonomys swinderianus). In: Animal Genetics Training Resource, version 2, 2006. Eds. Ojango, J.M., Malmfors, B. and Okeyo, A.M. International Livestock Research Institute, Nairobi, Kenya, and Swedish University of Agricultural Sciences, Uppsala, Sweden.

Meyer K (2003). Estimates of variances due to sire x herd effects for weights of Hereford cattle. Proc. Assoc. Advmt. Anim. Breed. Genet. 15:131-134.

Millar JS (1981). Pre-partum reproductive characteristics of eutherian mammals. Evolution 35(6):1149-1163. http://dx.doi.org/10.2307/2408129

MSD (2010). Annual Reports. Meteorological Services Department Mampong Municipal Assembly, Mampong-Ashanti, Ashanti Region, Ghana.

Myers PM, Master LL (1983). Reproduction by Peromyscus maniculatus: size and compromise. J. Mammal. 64(1):1-18. http://dx.doi.org/10.2307/1380746

Nicholas FW (1987). Veterinary Genetics. Clarendon Press, Oxford, 580 pp.

Osei SA, Effah-Baah K (1989). Reproductive performance of N'dama and West African Shorthorn cattle in the humid forest zone of Ghana. Trop. Agric. (Trinidad) 66(3):256-258.

Osei SA, Effah-Baah K, Karikari P (1991). The reproductive performance of Friesian cattle in the hot humid forest zone of Ghana. World Anim. Rev. 68: 52-59.

SAS (2008). Statistical Analysis System. User's Guide. SAS/STAT® 9.2, Cary, NC: SAS Institute Inc.

Schrage R, Yewadan LT (1999). In: Raising Grasscutters, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Eschborn, Germany, 99 pp.

Thrusfield M (2007). In: Veterinary Epidemiology. 3rd ed., Blackwell Publishing, 593 pp.

Tuma J, Tumova E, Valasek V (2010). The effect of season and parity order on fertility of rabbit does and kit growth. Czech. J. Anim. Sci. 55(8):330-336.

Van Vleck LD, Pollak JE, Oltenacu EAB (1987). Genetics for the Animal Sciences. W.H. Freeman & Co., 391 pp.

Vaughan TA, Ryan JM, Czaplewski NJ (2009). In: Mammalogy. 5th ed.,

Jone and Bartletr Publishers, Sudbury, USA, 747 pp.
Wall E, Brotherstone S, Kearney JF, Woolliams JA, Coffey MP (2005). Impact of nonadditive genetic effects in the estimation of breeding values for fertility and correlated traits. J. Dairy Sci. 88:376-385. http://dx.doi.org/10.3168/jds.S0022-0302(05)72697-7

Related Journals Published by Academic Journals

- *Journal of Plant Breeding and Crop Science*
- *African Journal of Agricultural Research*
- *Journal of Horticulture and Forestry*
- *International Journal of Livestock Production*
- *International Journal of Fisheries and Aquaculture*
- *Journal of Cereals and Oilseeds*
- *Journal of Soil Science and Environmental Management*
- *Journal of Stored Products and Postharvest Research*