



**Animal Agriculture as a vehicle for
diversification of the economy**

**3rd Animal Agriculture Conference
of Animal Science and Production Department**

**25th – 27th July 2011
Centre for In-Service and Continuing Education
(CICE) Botswana College of Agriculture
Sebele Contetnt Farm, Gaborone, Botswana**

Animal Agriculture as a vehicle for diversification of
the economy

3rd Animal Agriculture Conference
of
Animal Science and Production Department (ASP)

Book of Abstracts

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Animal Nutrition

01. Anti-Nutritional factors in livestock feeds

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Anti-nutritional factors (ANF) are compounds which reduce the nutrient utilization and/or food intake of plants or plant products used as human foods or animal feeds. Hence they play a vital role in determining the use of plants by animals. The list is inexhaustible and some of these plant chemicals have been shown to be either deleterious to health or advantageous to human and animal health if consumed at appropriate amounts. They include saponins, tannins, flavonoids, alkaloids, trypsin (protease) inhibitors, oxalates, phytates, haemagglutinins (lectins), cyanogenic glycosides, cardiac glycosides, and gossypol. The anti-nutritional factors may be divided into two major categories. They are proteins (such as lectins and protease inhibitors) which are sensitive to normal processing temperatures. Other substances are stable under these temperatures and include polyphenolic compounds (mainly condensed tannins), non-protein amino acids and galacto-mannan gums. All available information, both qualitative and quantitative must be used in making judgments about the feed value of particular plant species.

Keywords: Condensed tannins, Feeds, Inhibitors, Proteins, Plant species,

02. Parasitic plants of woody species in ruminant diets

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Plants which parasitize trees are many and varied. In times past, these plants were considered to be a threat to the ecological balance and various attempts were made in some parts of the world to eradicate them. However, some studies have shown that these plants can play a crucial role in animal diets. This paper reviews work done on the role of parasitic plants of woody species in ruminant nutrition in Botswana. Studies on four parasitic plants (*Viscum verrucosum*, *V. rotundifolium*, *Tapinanthus lugardii*, and *Erianthenum ngamicum*) showed that they blossom during the dry winter months when forage from pasture is low in supply and quality. The crude protein (CP) content of parasitic plants varied from 10.1 – 16.6% while the *in vitro* dry matter digestibility (IVDMD) ranged from 41.3% to 52.8%. These amounts of CP and IVDMD are able to maintain animals without the need for supplements. The parasitic plants were also found to contain condensed tannins which are capable of forming complexes with protein. Such complexes protect protein from microbial degradation in the rumen when the concentration of tannins in the diet is less than 50 g/kg DM. Tannin concentrations in excess of 50 g/kg DM impede protein digestion. However, other studies have shown that *V. verrucosum* reduces the egg counts of intestinal parasites in goats due to the anti-helminthic effect of tannins in this parasitic plant. These studies indicate that parasitic plants of woody species are an important component of the ecosystem capable of furnishing significant nutrients and reducing the parasitic burden on ruminant animals.

Keywords: digestibility, nutrient content, parasitic plants, ruminants, tannins

Animal Products

03. Mapping the color stability and palatability of beef top sirloin butts (*gluteus medius*)

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The study was carried out to find interactive effect of United States Department of Agriculture quality and yield grades on the color stability and palatability of beef top sirloin butts (*gluteus medius*). *Gluteus medius* (GM) steaks (n=48) from quality and yield grades carcasses aged for 14 days at 2⁰C were fabricated, labeled, into eight (1-inch thick); which were then divided into nine subsections (pieces). Set steaks were vacuum-packed and frozen at -20⁰C for shear force determinations. The portions were anterior-lateral, anterior-central, anterior-medial, middle-lateral, middle-central, middle-medial, posterior-lateral, posterior-central, and posterior-medial. The instrumental color assessment was dominated (P < 0.05) by light (L*) color in all portions of the muscle on simulated steak x position interaction throughout the period of retail display. There was some significant difference (P < 0.05) for b* values on days two, three, four and six of simulated steak x position interactions display. The values for chroma were decreasing (P > 0.05) and the only difference was noticed (P < 0.05) in day two from retail display periods of steak x position interaction of the muscle color. The pH values were considerably moderate with small variations with the muscle; and had difference (P < 0.05) of interactions of steak x position indicating that muscle portions are lighter. Warner-Bratzler shear force values for instrumental tenderness were lower (P < 0.05) with anterior-central and higher (P < 0.05) in middle-medial portion, but cook loss showed significant (P ≤ 0.05) effect on the quality and yield grades.

Keywords: sirloin butts, *Gluteus medius*, colour stability, USDA grades, Instrumental assessment.

04. Carcass and meat quality traits of three strains of indigenous Tswana chickens raised under an intensive management system

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Carcass characteristics and meat quality traits of indigenous Tswana chickens (ITC) have not been evaluated. Carcass characteristics and meat quality traits of naked neck (NNS), dwarf (DS) and normal-feathered (NFS) strains of ITC, raised under deep litter management system were evaluated. A total of 19, 10 and 9 male chicks of the NFS, DS and NNS, respectively, were used. The chicks were fed starter mash from day old to 2 weeks of age and thereafter fed grower pellet until 21 weeks of age, then slaughtered for carcass evaluation and meat quality. There were no differences ($P > 0.05$) in live weight and in carcass weight at slaughter between the NNS and NFS. The DS had lower ($P < 0.05$) live weight and carcass weight compared to the other two strains. Significant differences ($P < 0.05$) in dressing percentage occurred, with the NNS exhibiting the highest while the DS had the lowest dressing percentage. There were no significant ($P > 0.05$) differences for shank weight, drumstick weight, breast weight, back weight, liver weight, gizzard weight and heart weight between the NNS and NFS. Significant differences ($P < 0.05$) between the naked neck and the normal-feathered strain occurred for neck weight and thigh weight. The DS had significantly lower ($P < 0.05$) shank weight, drumstick weight, thigh weight, wing weight, back weight, breast weight and liver weight compared to the NNS and the NFS. No significant ($P > 0.05$) differences between the DS and the NFS were observed for neck weight, heart weight and gizzard weight. The heaviest meat portions were from the NNS while those from the DS the lightest. There were no significant ($P > 0.05$) differences in breast meat pH, 45 minutes and 24 hrs post-slaughter and in drip loss 48 hrs post-slaughter between all the three strains.

Keywords: Chickens, meat quality, live weight, post-slaughter, carcass

Animal Production

05. Using factor analysis to characterise the body structure of male and female indigenous Tswana goat at the kid and grower ages

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The objectives of this study were to investigate the correlations among the seven body measurements and determine factors which could objectively describe the variability among the kids and growers of Tswana goat. The goats were sampled from six agricultural regions of Botswana except for Tsabong and Ghanzi districts in 2004. Fifteen farmers were randomly selected from each district and records taken on a random sample of 4-12 animals *per* farm depending on the 1999 CSO data on average district flock size. Seven body measurements namely body length (BL), shoulder width (SW), height at withers (HW), heart girth (HG), neck length (NL), tail length (TL) and ear length (EL) were recorded from 273 female kids, 277 male kids, 696 female growers and 283 male growers indigenous Tswana goats. The data were analysed to determine correlations and extract factors. The factors were then rotated using varimax method to simplify interpretation. Positive correlations among body measurements ranged from 0.37906 to 0.76112 and were statistically significant ($P < 0.05$). A maximum of three factors were found to be important in explaining the observed variability in this study. In female kids only one factor was retained explaining 54% variability; two factors explained 72.3% of the variability in male kids; three factors explained 58.3% of the total variability in female growers while two factors explained 61.3% of the total variability in male growers. In all age groups, the first factor explained most of the variability followed by the second. These factors were described and given a name. The study concluded that factor analysis is a useful tool to describe the body structure of the indigenous Tswana goat.

Keywords: Body measurements, factor analysis, Tswana goat, Principal Components, correlation

**06. Implications of the Weaner
Production System on Beef Industry of
Botswana**

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The beef cattle industry in Botswana has three main types of production systems being the cow-calf, purebred breeders and cattle feeders. A sustainable weaner beef production operation is dependent on a sustainable cow-calf operation. Successful cow-calf breeding activities ensure a sustainable supply of calves to be weaned. The weaned calves are destined for finishing at cattle feeder operations at different ages and subsequently to slaughter markets. Thus, in the variable period of a calf's life between weaning and finishing, it is usually classified as a stocker, feeder or a replacement heifer. The benefits and incomes generated from the disposal of weaners by different producers in the country are a topical issue that needs to be addressed if the whole beef value chain and the concept of value addition are to be understood by all the stakeholders involved. The objective of this paper is therefore to discuss the advantages and disadvantages of the weaner production system as practiced in Botswana.

Keywords: Beef industry, weaner, production, calf age, finishing

07. Mathematical modeling of animal population dynamics with a focus on smallholder pig breeding establishments

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Botswana government has made efforts to diversify agriculture and pig production is one alternative of diversification in the livestock industry. It is important that farmers are encouraged to raise pigs for the purposes of creation of employment, supply of essential animal protein and consequently poverty alleviation. A Government owned Pig Nucleus Farm was therefore established at Sebele to provide good quality parent breeding stock for farmers. Farmers have used financial support offered by programmes such as the Financial Assistance Policy (FAP), Citizen Entrepreneurial Development Agency (CEDA) and Young Farmers Fund to venture into pig production. These entrepreneurs require accurate production data to guide their investments in terms of expected pig numbers from their investments. Pig numbers were monitored for 5, 10, 15 and 30 sow unit farms over a period of 30 weeks. Pig numbers were plotted against time and a unique mathematical equation was generated for each farm size by fitting a line of best fit in the data and picking the equation for the line with the highest coefficient of determination. In all cases of 5, 15 and 30 sow unit farms, unique second order polynomial equations predicted the number of pigs on the farm with a coefficient of determination, $R^2 = 0.805$, 0.958 and 0.964 respectively. The 10 sow unit farm was predicted using a linear equation with a coefficient of determination of $R^2 = 0.916$. These mathematical equations for prediction of pig numbers are deemed accurate because the coefficient of determination is at least 80.5 % in all predictions with some going as high as 0.964 which means that the prediction model can explain at least 80.5 % of the variability.

Keywords: pigs, poverty alleviation, animal protein, sows, breeding

08. Cattle performance in a cattle-goat mixed grazing trial at Impala Research Station

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Cattle and goat grazing trial was carried out to determine the cattle to goat stocking ratio that will result in effective use of rangelands at Impala Research Station. Cattle to goat ratios were 0:0 (control), 0:1, 1:0, 1:1, 2:1, and 3:1 at a stocking rate of 12Ha/LSU. A total of 51 Tswana male cattle weaners (7- 12 months) and 18 months male and female Tswana goats were used. Only steers were weighed every 4 weeks after feed and water had been withheld overnight. The animals were left to graze continuous in the paddocks for 18 months then sold to Botswana Meat Commission and replaced by other weaners. Two batches of animals have been used so far. There was no significant ($P > 0.05$) difference in cattle growth between the cattle in different paddocks for the two batches of animals used. However, there was a significant ($P < 0.05$) difference in cattle growth between grazing ratios 1:0, 2:1 and 3:1 during the dry season for both batches. At cattle to goat ratio of 1:0 some cattle lost 10% of their body weight in one month. There was reduction in bare ground in all the paddocks with an increase in poor grass species during the dry season. There was no significant ($P > 0.05$) change in litter and good grass species. The crude protein was good (ranging from 4.5 – 12%) for all grasses in 2007 and 2009 compared to 2008 (0.3 – 5%). There were significant differences in CP, DM, ADF and IVTD in grasses comparing 2007 to 2008 which correlated with rainfall. So far the cattle to goat ratios 1:1, 2:1 and 3:1 have shown high weight gains compared to 1:0. The study shows that mixed grazing gives an advantage on complementary use of pasture resource by different livestock species especially during resource limitation.

Keywords: Mixed grazing, Tswana cattle, Tswana goat, animal performance

09. Assessment of the efficiency of treating dairy lagoon wastewater: A case of Notwane farm at Botswana College of Agriculture

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The purpose of this study was to assess wastewater treatment efficiency in the lagoon dairy at Botswana College of Agriculture (BCA), Notwane farm. Assessment was done by sampling both the influent and effluent from the lagoon on a weekly basis. Contaminant removal efficiency was assessed through the evaluation of NH_4^+ , NO_3^- and BOD5 concentrations for nitrogen and carbon respectively. BOD5 was reduced during residence time and there was an increase in NH_4^+ while NO_3^- was not detectable in the system. This contaminants trend was also observed to be associated to dissolve oxygen, temperature and pH status of the wastewater. However, the observed BOD5 and NH_4^+ effluent concentrations were higher than the discharge limits, that is, $<30\text{mg/l}$ for BOD5 and $<10\text{mg/l}$ for NH_4^+ , set by Botswana Bureau of Standards. Therefore, dairy lagoon wastewater treatment is not efficient and the water should not be disposed off onto the surrounding grounds as is currently the practice in order to mitigate high levels of nitrogen and dissolved carbon groundwater contamination.

Keywords: efficiency, effluent, contamination, oxygen, wastewater

10. Smallstock Innovation Platform; The case of Botswana

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Many Batswana derive their livelihood from the livestock sector especially those in the rural areas. Smallstock (sheep and goats) is owned and raised by most resource-poor households as compared to cattle. Smallstock is the single most important source of on-farm income and insurance in the low-input farming system of Botswana. Those tasked with developing the livestock industry have not done much to promote the smallstock sector as compared to the beef sector. A positive improvement in the productivity of the smallstock sector will enhance economic growth and alleviate poverty in resource-poor families. An Innovation Platform (IP) is an integrated programme for technology dissemination or a community of practice for stakeholders to regularly meet, share, learn and take away the knowledge acquired for use in their own private agricultural practices and businesses and for continued research. The IP facilitates dialogue between the main local players in the value chain and identifies bottlenecks and opportunities in production, marketing, policy environment and utilization of products resulting. This paper describes the attempts made through the SCARDA initiative to adopt the IP approach to facilitate improved smallstock production in the country such that it enhances the livelihoods of resource-poor households.

Keywords: smallstock, innovation platform, households, livelihoods

11. Chick mortality in indigenous chickens (*Gallus domesticus*) under free-range management in Sebele.

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People who keep indigenous chickens were visited and the indigenous chicks found were initially counted and the number of surviving chicks for a period of three months. A total of 125 out of 307 (41%) chicks belonging to the indigenous breed of chickens under free-range management died in the first three months of life. Most chicks were lost in the first month. The main cause of chick mortality was predation mostly by dogs but also as a result of inclement weather especially during the cold weather season. It is imperative that brooding should be provided to curb these chick losses and adequate housing should be provided for the hens so as to protect the young chicks from predation.

Keywords: Chickens, housing, free range, mortality

12. Ammonia Emissions of Laying-Hen Manure as Affected by Accumulation Time

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A study was conducted to investigate how ammonia (NH_3) emission of laying hen manure is affected by manure accumulation time (MAT). Three trials were conducted. For each trial, 108 W36 laying hens in their prime laying stage were housed in two calorimeter chambers (54 birds per chamber) that were maintained at a temperature of $24 \pm 1^\circ\text{C}$ and a concomitant relative humidity of 45 to 65%. Measurements were done continuously over a 5-week period. The environmental variables measured continuously in each chamber included NH_3 gas concentration, ambient temperature, dew-point temperature and air flow rate. On a daily basis, the eggs were collected, counted and weighed. The feed supplied to the birds was also weighed daily. Once a week, 18 hens per chamber were weighed. Ammonia emission rate was then calculated from the differences in NH_3 concentrations between the exhaust and inlet air and the corresponding airflow rate; and it was expressed as $\text{mg}\cdot\text{d}^{-1}\cdot\text{hen}^{-1}$, $\text{g}\cdot\text{d}^{-1}\cdot\text{AU}^{-1}$ (AU = animal unit, 500 kg live body weight), $\text{g}\cdot\text{d}^{-1}\cdot\text{kg egg}^{-1}$, and $\text{g}\cdot\text{d}^{-1}\cdot\text{kg feed N intake}^{-1}$. The results showed that NH_3 emission progressively increased from 101 ± 10 to $605 \pm 10 \text{ mg}\cdot\text{d}^{-1}\cdot\text{hen}^{-1}$ when MAT increased from 1 to 5 d. There was a linear relationship between NH_3 emission rate and MAT and the empirical relationship has been developed for the various emission units. The NH_3 emission rates measured in this study contributes to the U.S. national inventory on NH_3 emissions from laying hen operations.

Keywords: Ammonia emission, laying hen, manure accumulation time

13. Ammonia Emission and Performance of Laying Hens as Affected by Different Dosages of *Yucca schidigera* in the Diet

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A lab-scale study was conducted to determine the effect of feeding laying hens' standard commercial diet supplemented with different dosages of *Yucca schidigera* powder on ammonia (NH₃) emission rate (ER) and production performance. A total of 72 W36 laying hens at a starting age of 25 wk were used during the 12-wk study. The birds were equally divided into four groups and randomly allocated to four treatment diets supplemented, respectively, with 0, 50, 100, and 200 ppm (by weight) yucca powder. Each dietary group of 18 birds was further divided into 6 subgroups or replicates of 3 birds per cage housed in an environmentally-controlled chamber maintained at 24±1°C and a concomitant relative humidity of 45 to 65%. The weight of feed supplied and the number and weight of eggs produced were recorded daily. Manure was collected in the last 2 wk of the experiment and used in the comparative determination of NH₃ ER. The results showed that *Yucca schidigera* powder in the laying hen diet at 50, 100, or 200 ppm dosage did not affect the production performance of laying hens when compared to the 0 ppm dosage. The 100 ppm yucca inclusion rate significantly (p<0.05) reduced NH₃ emission in the first and second day of manure storage by 44% and 28%, respectively, when compared to the other yucca inclusion levels. On the third day, NH₃ reduction was 14% but was not significantly different from the other treatments. Adding 50 or 200 ppm yucca in the diet did not reduce NH₃ emission. Hence, adding 100 ppm of yucca in the laying hen diet coupled with frequent manure removal, such as once every 1 to 2 d, would be conducive to reducing NH₃ generation and emissions in laying hen barns.

Keywords: Ammonia emission, laying hen, *Yucca schidigera*

14. Production of adapted breeding animals by smallholder farmers: Experiences from the Zimnyama Community Beef Breeding Scheme of Mangwe District in Zimbabwe

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Previously in Zimbabwe, breeding of “improved” cattle was done under extensive management systems with regular dipping, strategic dosing against both flat and round worms, and rotational grazing in paddocks, adequate water and provision of supplementary feeding during the five months dry season. When raised under communal environments, animals bred under these management systems fail to adapt to conditions of low management, where there is regular kraaling, shortage of drinking water, inadequate grazing and zero supplementary feeding, irregular dipping and dosing leading to high challenges from both internal and external parasites and poor marketing strategies. This paper reports how smallholder farmers of Zimnyama Ward in Bulilima District of Matabeleland South Province have organized themselves (from 2007) into cattle associations to supply adapted breeding animals (Tuli, Nkone and Brahman (Black and White strains) to the local market. Twenty seven livestock farmers from Zimnyama Small-scale Commercial farming area have divided themselves into breeding clusters (3 farmers for the Black Brahman, 7 farmers for the White Brahman, 6 farmers for the Nkone and 11 farmers for the Tuli). The average herd size (\pm sd) *per* farmer for Black Brahman, White Brahman, Nkone and Tuli was 15 ± 9 , 11 ± 9 , 9 ± 4 and 12 ± 7 , respectively. Such farmers castrated all bulls within their holdings and committed themselves to using performance tested bulls of the respective breed. Over the four year period that the program has been operational the herds have increased *per* farmer (for Black Brahman, White Brahman, Nkone and Tuli) by 6 ± 1.7 , 2 ± 5.9 , 8 ± 11.1 and 10 ± 6.2 , respectively. Average sales *per* farmer (for Black Brahman, White Brahman, Nkone and Tuli) were 3 ± 3.6 , 2.3 ± 2.7 , and 3.7 ± 4.5 , respectively. Farmers are reporting low sales because they are building their herds. The Tuli and Nkone are showing higher productivity than the Brahman strains. The program is now strengthening training of farmers in management skills to increase the average herd sizes *per* farm.

Keywords: Brahman, cattle, feeding, Nkone, Tuli,

15. Effect of housing and vitamin B complex on the survival of goat kids born during winter

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A study was undertaken to investigate the effect of housing and parenteral vitamin B complex administration on the survival of goat kids born during winter. Some pregnant does were flushed in the last month of pregnancy. Kids born to these does were housed at night and injected with vitamin B complex, using the subcutaneous route. Ninety percent of these goat kids survived in the first 12 weeks of life. In the control group only 23.3% of the kids survived. For successful winter kidding, the does should be flushed, kids injected with vitamin B complex and housed in order to reduce kid mortality

Keywords: housing, goat kids, mortality, parenteral, Vitamin B,

17. Laying performance and egg traits of indigenous Tswana chickens under traditional management

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There is limited information on laying performance and the egg characteristics of indigenous Tswana chickens (ITC) under traditional system. The objectives of this study were to determine these parameters of ITC relative to those of commercial layer chickens (CLC) and to document indigenous knowledge on laying performance of ITC. This was achieved by the use of a structured questionnaire which was administered to a random sample of 26 indigenous Tswana chicken farmers in Oodi, Morwa and Bokaa villages in Kgatleng district. A total of 100 and 108 eggs were obtained from 8 Tswana chicken farmers and two commercial layer chicken farmers, respectively, and analysed for external and internal egg quality traits in the laboratory. Analysis of the survey data by SPSS revealed that on average, 81% of the farmers did not know the age at first egg of ITC and that on average indigenous chickens lay 7 eggs *per* week over an average laying period of 2-3 weeks. The average clutch size or average number of eggs incubated by ITC is 15 eggs and more egg production and consequently more chicks are hatched in winter than in summer. Analysis of external and internal egg traits using General Linear Models of SAS revealed that eggs of ITC had significantly higher values for egg length, yolk weight, yolk %, albumin pH and yolk pH. Indigenous chicken had significantly lower values for egg weight, egg shape index, albumin weight, albumin %, and egg contents weight compared to eggs of CLC. No significant differences between eggs of ITC and those of CLC were observed for egg width, shell weight, shell percentage and shell thickness.

Key words: egg traits, laying performance, Tswana chickens

18. Reproductive and growth performance of indigenous Tswana chickens under traditional management

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Indigenous Tswana chickens (ITC) are normally raised in small flocks of mixed ages under the traditional scavenging system. Assessing the productivity of ITC under this rearing system is difficult because most farmers do not keep any production records. As such there is paucity of information on the reproductive and growth performance of ITC under this management system. Therefore, the objectives of this study were to evaluate growth performance under different feed supplements on and to document indigenous knowledge on reproductive performance of indigenous Tswana chickens. To document indigenous knowledge on reproductive performance, a structured questionnaire was administered to a random sample of 26 indigenous Tswana chicken farmers in Oodi, Morwa and Bokaa villages in Kgatleng district. To assess growth performance a total of 12 (5 males and 7 females), 14 (4 males and 10 females) and 12 (4 males and 5 females) chickens mostly fed commercial feeds (broiler grower), sorghum bran and maize grains, respectively, were weighed using an electronic balance at one day old, 1 month, 3 months, 4 months and 5 months of age. Analysis of the survey data by SPSS indicated that on average indigenous Tswana chickens lay and incubate a total of 15 eggs per clutch and on average hatch 12 chicks/clutch/hen. On average 8 chicks survive up to 2 months of age and only 6 (representing 50% mortality) survive to adulthood. Common causes of mortality are predators, external parasites, diseases and bad weather. Analysis of growth performance data using General Linear Models of SAS in a model that included fixed effects of sex and type of supplementation revealed significantly higher body weights in males than in females at 1, 3, 4 and 5 months of age. Chickens mostly fed commercial feeds had significantly higher body weights than those fed sorghum bran or maize grains at 1, 3, 4 and 5 months of age. There were no significant differences ($P>0.05$) in body weights between the chickens supplemented on sorghum bran and maize grains at different ages.

Keywords: Growth, reproductive performance, traditional management

19. Growth performance of three strains of indigenous Tswana chickens under intensive management system

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Indigenous Tswana chickens are kept under traditional system characterized by poor feeding, poor housing, and poor health care which consequently lead to poor growth performance. This study evaluated the growth performance of the naked neck (NNS), dwarf (DS) and normal-feathered (NFS) strains of indigenous Tswana chickens under an intensive management system. A total of 55 (22 males and 33 females), 23 (12 males and 12 females) and 24 (13 males and 11 females) chickens of NFS, DS and NNS, respectively, were monitored for growth from hatching up to 20 wks of age. The chickens were raised under deep litter and were fed starter mash from day old to 2 weeks of age and thereafter fed grower pellet until 20 wks of age. Body weights were measured fortnightly up to 20 wks of age. Sex had a significant ($P < 0.05$) influence on body weights of the NFS and NNS from 14 to 20 wks of age. Males of all the strains were generally heavier than their female counterparts at all ages. There were significant differences ($P < 0.05$) in body weights between females of the NNS and DS at 6, 8 and 10 wks of age. There were no strain differences ($P > 0.05$) in body weights of females from 12 wks to 20 wks of age. There were significant differences ($P < 0.05$) in body weights between males of the NNS and the DS from 6 wks to 20 wks of age. There were however no significant differences ($P > 0.05$) in body weights between males of the NFS and the DS at all ages. Significant differences ($P < 0.05$) in body weights between NFS and NNS males started occurring at 16 weeks of age. Generally, NNS males and females were the heaviest and DS males and females were the lightest at any given age. The NNS therefore has superior growth performance compared to the NFS and DS.

Keywords: growth, Tswana chickens, intensive management

20. Gross and Microanatomical Changes Occurring at the weight bearing points of the body of the ostrich induced by soil or concrete floor and implications for the welfare of the birds

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This study investigated the gross and microanatomical changes occurring at the weight bearing points on the ostrich body surface induced by rearing on soil or on concrete floor and the implications for the welfare of the bird. Fourteen ostrich chicks age nine weeks and raised on concrete were randomly assigned to two rearing groups of seven birds each. The birds were raised in a pen 30 meters long by 6 meters wide with soil or concrete floor. All ostriches were fed and watered ad libitum. From week 24 two ostriches from each group were slaughtered each month. Photographic evidence and gross examination demonstrated relatively intact skin with superficial erosion of the keratinized layer at the weight bearing points of the ostriches raised on soil floor. Ostriches raised on concrete had observable erosion on the weight bearing points of the six month old ostrich. However, lesions of extreme tissue erosion involving the entire skin were observed in the heavier nine month old ostrich on concrete floor. Qualitative analysis of histology slides of the collected specimens revealed extreme skin erosion deep into the subcutis of the tarso-metatarsal pads of the nine month old ostrich raised on concrete. In contrast, the degree of skin erosion at similar sites on ostriches raised on soil surface was superficial with the surface keratinized layer still intact. Given the well-developed planter digital cushion, the planter digital skin was not subject to excessive wearing in either group of ostriches. For the welfare of ostriches, long term and continuous rearing on concrete surface should be strictly avoided as this practice obviously inflicts pain given the degree of tissue erosion observed, especially on the tarsal-metatarsal pad.

Keywords: ostrich, skin erosion, weight bearing, soil, concrete, welfare.

Animal Health

21. Experimental Transmission of *Campylobacter jejuni* in Broiler Chickens

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This experiment was designed to study the natural transmission of *Campylobacter jejuni* in broiler chickens. Thirty-five days old *Campylobacter*-free broilers were divided into three groups. Group I (n = 10) was kept in a separate shed as a control. A ‘seeder’ bird experimentally infected with *C. jejuni* was introduced to group II (n = 100, including the ‘seeder’ bird) and all the birds in the group were sampled and tested by bacterial culture methods, for colonization, every 12 hours for 108 hrs to determine transmission rate. Group III (n =10) birds were kept in a pen 2.5 m away from group II birds and were exposed to boots used in group II pen, to find out if *C. jejuni* could be transmitted to these birds via contaminated boots. All group III birds were tested for colonization after 108 hrs. *C. jejuni* was naturally transmitted from the ‘seeder’ bird to susceptible broilers within 12 hours of exposure and resulted in 100% colonization within 48 hrs. The transmission rate peaked 24 hours after exposure. All the birds in group III tested positive at the end of the experiment while the control group remained negative. Isolates from group II and III birds were shown to be identical to the experimental strain of *C. jejuni* by pulsed- field gel electrophoresis. The study demonstrated that *C. jejuni* spreads rapidly from an infected bird to susceptible birds and that boots can mechanically transmit the organism to broiler chickens.

Key words: *Campylobacter jejuni*, transmission rate, broiler chickens

22. Mixed *Rotavirus* and *Cryptosporidium* infection in bovine calves in South Botswana

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Faecal samples of 302 dairy calves in 12 herds and 144 beef calves in 10 herds from southern region of Botswana were screened for *Rotavirus* (RV) and *Cryptosporidium parvum* infection. For detection of RV and *C. parvum* coproantigens, Enzyme immunoassay (EIA) and for cryptosporidial oocysts, Modified acid fast (MAF) staining technique was used. RV and *C. parvum* infection rates were 38.4% and 28.8% in dairy calves and 26.4% and 10.4% in beef calves, respectively by using EIA. MAF staining technique could detect *Cryptosporidium* oocysts in 24.5% and 9% in dairy and beef calves, respectively. Dairy calves reared under semi-intensive and intensive management conditions were found to be more susceptible to both RV and *C. parvum* infections than beef calves kept under communal or extensive husbandry system ($P < 0.01$). A total of 36 calves (32 dairy and 4 beef) demonstrated mixed RV and *C. parvum* infections as determined by EIA. Younger dairy and beef calves aged ≤ 4 weeks and animals passing soft to liquid faeces (diarrheic) showed significantly higher *C. parvum* infection rates than 4 - ≤ 12 weeks old animals and those excreting formed faeces (non-diarrhoeic). RV infection rates were relatively higher in diarrhoeic beef calves, but the differences were not significant in comparison to non-diarrhoeic beef calves ($P > 0.05$). Adoption of good management practices resulted in marked reduction of mortality rates at livestock farms, and dairy farms in particular. Considering the findings of the present study indicating the role of these two major enteropathogens in inducing calf diarrhea at livestock farms in southern Botswana, possibilities of their inter-species transmission abilities including zoonotic implications, livestock handlers need to be educated on good husbandry and hygienic practices as well as on potential dangers of acquisition of these infections while working with infected animals.

Keywords: Cryptosporidium, infection, dairy calves, rotavirus, zoonotic

23. The geographical prevalence and potential epidemiology of heart water in Botswana: implications for planning control under climate change

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Heartwater caused by *Ehrlichia ruminantium* is a widespread animal health problem in Botswana. Although long known to be endemic, its current distribution and possible future occurrence in new areas within the country requires updating to help guide planned control in the midst of climate change. Thus an understanding of the spatial occurrence of the disease and its environmental risk factors is essential for control and management planning. The goal of this paper is to explore the current and potential spatial occurrence of heartwater across Botswana and its associated environmental factors. To reach this goal, geographical information systems are used to map the distribution of heartwater infection and also overlay infection data with interpolated environmental surfaces. The derived maps indicate both a widespread occurrence of infection and a marked variability in infection prevalence, with the south east and north eastern parts of the country having the highest incidence rates while the western part has the highest potential for disease occurrence. The results are discussed in reference to the ecology of infection and provide an epidemiological framework for the design and implementation of control efforts.

Key words: Botswana, Climate change, heart-water, spatial occurrence

Rangelands & Fodder Production

24. The influence of rangeland management systems on rangeland condition under different environmental conditions, Botswana

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Ranches were introduced in Botswana to address rangeland degradation associated with overgrazing in communal lands. However, there is limited evidence to suggest that ranching management affects rangeland ecosystem differently. This study therefore conducted to compare effects of communal and ranching management systems under different environmental condition. The vegetation and soil indicators were used to assess rangeland condition at Xanagas, Matlolakgang and Goodhope. The composition of herbaceous vegetation and woody cover differed significantly between sites ($P < 0.05$), but no consistent pattern was established in relation to management systems. The communal grazing land and ranches especially around Matlolakgang were similarly being degraded as indicated by dominance of increaser II herbaceous vegetation, and bush encroachment.

Keywords: Bush encroachment, degradation, savanna, soil organic carbon

25. Declining dependency of natural stands of tree and shrub legumes on symbiotic N₂ fixation in Botswana: Climate change effect?

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Nitrogen fixation was measured in field populations of tree and shrub legumes across different agro-zones in Botswana, using the ¹⁵N natural abundance technique. These sites included Kalahari (291 mm rainfall), Ghanzi (338 mm), Central (384 mm), Gaborone (429 mm) and Southern (482 mm) regions. The ¹⁵N and ¹³C natural abundance were measured in leaf samples collected from field plants. The data showed a decreasing number of N₂-fixing species with aridity. Significant differences were found for the δ¹⁵N and δ¹³C of tree/shrub species at the study sites and across all five agro-ecological zones of Botswana. The δ¹⁵N of species increased with aridity irrespective of plant family, with lower values obtained in the wetter region and higher values in drier regions. The majority of legumes showed high δ¹⁵N values that rose with decreasing mean annual precipitation. The δ¹³C values in putative N₂-fixing legumes were found to be more negative in comparison to non-N₂-fixing counterparts, suggesting greater water-use efficiency in the latter relative to the former. Tree/shrub legumes play an important role in the N economy of the savanna ecosystems in Botswana. The gradual decline in the number of functional N₂-fixing shrub/tree legumes along an aridity gradient suggests that soil moisture is a major constraint to N₂ fixation in natural ecosystems. These findings also suggest that δ¹⁵N and δ¹³C values of plant leaves can be used to predict the effect of climate change on ecosystem functioning, including symbiotic N nutrition in plants.

Keywords: Botswana, Nitrogen fixation, legumes, shrub, climate change

General

26. Does Botswana need a Society for Animal Scientists?

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In Botswana agriculture contributes about 2.5% to GDP and involves about 124 000 householders. Of these, animal agriculture contributes 80% of the income generated by agriculture. In the past two decades it has emerged that small-scale arable farmers get negative returns to their investment. Contrary, return to investment in cattle rearing is about 2 to 1 in a non-drought year but as much as 50 to 1 in a drought year. Thus, livestock farming has the potential to help create wealth, improve farmers' livelihoods and reduce poverty. Animal products are excellent sources of high quality protein; help improve the quality of life and food security. On the other hand, livestock has a direct impact on the environment through land degradation and emission of greenhouse gases. All these positive attributes and challenges can be harnessed through research and partaking in the stewardship of the environment. This research is carried out by individuals with specialized qualifications in different facets of animal sciences. The need for these men and women to get recognition, to promote their profession and pass information about their vocation can be achieved through a concerted networking or an association. The objectives for such a society for animal scientists in Botswana would include publicizing animal science as a profession, publicizing research; organizing conferences, workshops and seminars, mentor students of animal science and to positively influence policy development at national and regional level. The society would also help members network with their peers nationally, internationally and with sister societies. This is imperative for the survival of the profession and its image in Botswana.

Keywords: Animal science, Botswana, Society, livestock, networking