CSIR-ANIMAL RESEARCH INSTITUTE

C S I R - A R I

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ANNUAL REPORT

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Contents

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FOREWORD

After a very difficult year in 2022, struggling with land encroachment, research activity picked up slowly in 2023 with the advent of three new projects. The areas of research of these new projects are particularly exciting as they touch on capacity building for both small-holder farmers and the institute. This should be the model for future projects of the institute. The institute would continue to focus on food security and poverty reduction, biomedical and public health research, and the development of technologies for livelihoods and wealth creation. Particular attention would be paid to climate-smart crop-livestock systems, climate resilient livestock breeds, vaccines and probiotics development. This emphasis would help the nation to prepare and adapt to adverse climatic conditions that threaten devastations for livestock production in Ghana. The institute would increase the drive for donor-funded projects although only small holder farmers seem to be prioritized in this research space.

Supporting small-holder farmers is good but expanding livestock production on an industrial scale and addressing its accompanying research questions is best. In that light, CSIR-ARI would develop a commercial farm that would be a model for commercial farmers in Ghana. It is expected that, this farm would be in a unique position to fund research and development activities that would give produce of commercial livestock farmers in Ghana an edge over imported animal products. Research that would reduce the cost of feed by introducing waste raw materials as feed ingredients would continue and would be vigorously pursued.

A land use map to optimize land use and protect CSIR-ARI land would also be developed. We are grateful to all our stakeholders for their support knowing we can always count on you.

EXECUTIVE SUMMARY

The research and development activities of CSIR-Animal Research Institute in the year 2023 were reported on the following thematic areas: Food security and poverty reduction (livestock and poultry): Biomedical and public health; and Science and people: technology for livelihood and wealth creation as well as value chain promotion. Under the food security and poverty reduction theme, preference studies were conducted to find out which plants rabbits would prefer most. Four plants were compared and it emerged that rabbits preferred *Brassica oleracea* leaves most. Another study experimented with adding ground corncobs at 10% to the diet of chickens and they realized that giving corncobs will reduce performance compared with the standard commercial diet, but if an enzyme or flaked oyster mushroom is added to the corncob diet, it will restore the performance of the birds as if they are consuming the standard commercial diet. This study clarifies how even corncobs can be utilized as chicken feed rather than allowing them to be a nuisance. Yet another study's focus was to determine the essential amino acid as well as sulphur-containing amino acid contents in the leaves of four plants commonly fed to rabbits and the conclusion was that the contents of these essential amino acids and the sulphur-containing amino acids in the leaves of these plants were adequate to meet the nutritional requirements of rabbits. A study looked at the inclusion of different levels of bamboo meal leaf in the diet of growing rabbits and the investigators realized that a 15% or even a 20% inclusion level reduced the production cost via reducing feed cost while maintaining the final products of the rabbit comparable to a standard diet. Three Brachiaria (*B. brizantha, B. ruzziziensis and Brachiaria species cv. mulato II*) species were assessed in terms of quality and quantity for livestock feed. Soil and biomass samples were taken for laboratory analysis to assist in evaluating them and for the interpretation of the results. For use as pig feed, some scientists investigated the treatment of chopped plantain and banana stems with brown sugar, fermenting the product for one week and adding a beneficial microbe. This replaced 50% of maize in a pig diet, and the performance of pigs on this new diet was comparable to those on a standard diet.

The biomedical and public health research collection covers a broad spectrum, spanning agriculture, public health, environmental science, and animal studies with a predominant emphasis on the One Health approach. A clinical trial was conducted to explore the efficacy of ethnoveterinary preparations, specifically *Bombax costatum* and *Evolvulus alsinoides* decoction, as a treatment for Newcastle disease in chickens. The results demonstrated a significant reduction in mortality rates and increased hatching rates in the treatment group, suggesting the potential of these plant-based solutions in poultry disease control. In addressing the emergence of antimicrobial resistance (AMR), studies were undertaken across diverse sources, including food animals, water, and the environment. One study focused on the prevalence and AMR of *E. coli* causing avian colibacillosis (AvL), revealing high resistance to commonly used antimicrobials and emphasizing

the urgency for informed veterinary practices. Another investigation into the presence and AMR patterns of *Enterococcus* spp. in healthy pigs highlighted the need for antimicrobial stewardship. A study on AMR *Salmonella* spp. in beef at slaughterhouses underscored the importance of sanitation measures and routine monitoring to mitigate transmission to humans. Additionally, examining the impact of increased influent wastewater volume on *E. coli* removal and AMR profiles in a sewage treatment plant, a study revealed efficient *E. coli* reduction but an increase in AMR patterns in effluent water, suggesting a potential environmental reservoir for AMR. Parasite infestation and its significance in zoonosis were explored in a study on the prevalence of *Cryptosporidium* spp. and other intestinal parasites in rabbits. The findings underscored the importance of further research to comprehend their spread and impact on public health. To enhance livestock management under global warming, an *in-vitro* study simulated thermal stress on Indian Gir cattle peripheral blood mononuclear cells (PBMC). The study demonstrated the utility of PBMCs as a cellular system to understand thermotolerance potential, offering insights for improved livestock management and performance. Another study investigated the impact of representative fatty acids on adipogenesis in 3T3-L1 cell culture. The outcomes revealed that eicosapentaenoic acid during the differentiation stage reduced intracellular triacylglycerol accumulation, offering valuable insights for potential obesity interventions.

In response to the increasing prevalence of malaria and acute dengue virus coinfection in Africa, a systematic review estimated the coinfection's prevalence among acute undifferentiated febrile diseases. The findings emphasized healthcare workers to consider both diseases in the differential diagnosis of febrile illnesses in the region.

On the aspect of technology for livelihood and wealth creation, a study was conducted to profile the clients of the livestock training in order to more appropriately tailor training needs to their education and income level. Hatchery experts tested different combinations of storage time and temperature regimes to determine the appropriate storage conditions for chicken eggs. Other teams working on poultry made recommendations on poultry manure management to reduce their environmental impact and make its use more climate friendly. An ongoing experiment tested the effect of different combinations of growth media and soil on germination and growth of cashew nut seedlings. Researchers evaluated the nutrient intake and growth performance of sheep under different management systems in northern Ghana and concluded that there is better nutrient availability in the more intensive systems compared to the more extensive ones, which reflected in better growth performance of sheep under the more intensive systems. In another study, 10 accessions of tropical forage seeds from two main tropical forages thus *Brachiaria and Panicum* species were evaluated to determine their agronomic performance for integration into the mixed farming system as a sustainable intensification pathway to increase smallholder

farmers productivity and resiliency. The results showed that the forage varieties exhibited good potential with high possibilities of fitting well when integrated into the mixed farming system.

In 2023, a total of 20 refereed journal publications were recorded. For the financial year, the total operating income was GH₵ 19,568,403.36 and the total expenditure was GH₵ 19,424,100.29 leaving a surplus of GH₵ 144,330.07

INTRODUCTION

The Animal Research Institute (ARI) of the Council for Scientific and Industrial Research (CSIR) is a public institution formed in 1964 when the mandate was expanded to include areas of Animal Science other than Animal Health. The CSIR-ARI like other institutes of the CSIR is currently governed by CSIR Act 521, 1996.

Mandate

The mandate of the CSIR-ARI is to develop and transfer technologies that promote livestock and poultry production in Ghana.

Mission

The mission of CSIR-ARI is to inspire efficiency and entrepreneurship in the Ghanaian livestock industry through technology development and innovative interventions for food security and wealth creation.

Core Values

To ensure that the mandate of CSIR-ARI is effectively and efficiently carried out, the following core values are continually emphasized:

Dedication to duty

Teamwork

Loyalty to ethical standards and quality assurance

Dedication to customer satisfaction

Core Competence

Pig and poultry production

Quality feed formulation

Livestock and poultry disease control

Grasscutter production

Dairy production

Livestock production economics

Participatory improvement in small ruminants

Training and consultancy services in animal production and health

Development of quality pastures for sustainable feeding of livestock

Laboratory services in feed analysis, microbiological, biochemical and parasitological analysis.

Veterinary services

RESEARCH AND DEVELOPMENT ACTIVITIES -2023

FOOD SECURITY AND POVERTY REDUCTION: LIVESTOCK AND POULTRY

Intake and palatability of forages fed to Rabbits in the Coastal Savannah Ecological Zone of Ghana

D. Y. Osei., S. F. Owusu, J. E. Timpong Cofie, P. Asiedu and D. Amedorme

Three different methods, first bite of a forage and intake duration, voluntary intake of forages when offered separately and together, were used to evaluate rabbits' preference of four commonly used forages, *Brassica oleracea, Stylosanthes guianensis, Musa paradisiaca* and *Megathyrsus maximus*, in the Coastal Savannah zone of Ghana. Thirty-two weaner rabbits were used in each trial. In the first trial, the time of first bite and intake duration of the forages offered together for 15 minutes were recorded. In the second trial, the weaners were randomly allocated to four groups, and kits in each group were offered one of the forage species separately with concentrate for three- and seven-days adaptation and testing periods respectively. In the third trial the kits were offered the forages together with concentrate for three- and seven-days adaptation and testing periods respectively. *Brassica oleracea* was bitten first (0.20 min) and had the highest intake duration (2.07 min). *Brassica oleracea* had the highest daily and relative intakes and was the most consumed when the forages were offered separately and together. Intake of *Brassica oleracea* was followed by *Stylosanthes guianensis*, while *Musa paradisiaca* and *Megathyrsus maximus* were the least preferred forages in terms of quantities consumed. The study suggests that the first method, time of the first bite and intake duration of the forages, had a comparative advantage over the other methods, voluntary intake of forages separately and together, in determining the preference of forages by rabbits in view of the shorter period required for the trial.

Figure 1. Forages offered together to a rabbit with *Stylosanthes guianensis* on the left

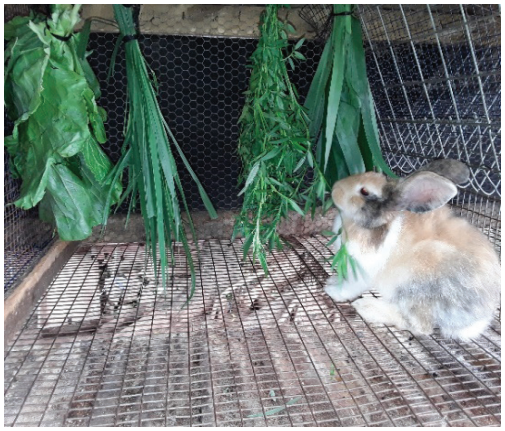

Figure 2. Forages offered together to a rabbit with *Musa paradisiaca* leaves on the right

Oyster mushroom and enzyme supplementation of corncob diet improve growth performance and nutrient digestibility in Sasso broiler chickens

A. A-A. Koranteng, K. A. Gbogbo, B. Adjei-Mensah, J. O. Darko, M. A. Okai and K. Tona

This study investigated the use of ground corncobs (GCC) as an alternative fibre source for broiler diet. Three hundred and sixty (360) 3-week-old dual-purpose chicks (Sasso X44) obtained from Maison Diop de Lomé, Togo, were randomly allocated to four dietary treatments having 6 replicates with 15 birds per pen in a completely randomized design. Four experimental diets were formulated: C0 (Control/standard diet), C1 (10% GCC diet), C2 (10% GCC diet with 0.05% multi-blend enzyme), C3 (10% GCC diet with 0.5% flaked oyster mushroom (FOM)). At the end of the experimental period, it was revealed that apart from blood platelet counts which were significantly low ($p<0.05$) in the additive-supplemented diets, GCC and its supplementation with either multi-blend enzyme or FOM had no influence ($p>0.05$) on hematological parameters. Birds fed the C0, C2 and C3 diets were more efficient ($p<0.05$) in feed utilization in comparison to those fed the raw 10% GCC diet at week 12, with the final body weight of the C2 group significantly higher ($p<0.05$) than the C1 group. Percent breast weight was lowest ($p<0.05$) in the birds of the C1 group compared with the other treatment groups. Crude protein was retained better ($p<0.05$) in the additive-supplemented groups (C2 and C3) compared with the control group, whereas crude fibre digestibility was lowest in the C1 group. It is therefore beneficial to supplement corncob diets with multi-blend enzymes to improve feed efficiency and body weight.

Figure 1: Oyster Mushroom (*Pleurotus ostreatus*)

Figure 2: Sasso broiler

Essential and sulfur amino acid composition of five commonly fed tree leaves to rabbits in the Coastal Savannah zone of Ghana

D.Y. Osei, S.O. Apori, J. K. Hagan, P. Asiedu, D. Amedorme and G. Adu-Aboagye,

The essential amino acids (EAA) and the major sulfur-containing amino acids (SAA), methionine and cysteine, contents in *Moringa oleifera, Gliricidia sepium, Carica papaya* and *Musa paradisiaca* leaves were determined. The EAA contents ranged from 0.28 to 2.45% dry matter (DM) for methionine in *Gliricidia sepium* and leucine in *Carica papaya* leaves respectively. The total EAA contents ranged from 7.24 to 12.86% DM for *Gliricidia sepium* and *Carica papaya* leaves respectively. The EAA contents of crude protein (CP) in the leaves ranged from 1.59 to 8.58% for methionine in *Gliricidia sepium* and leucine in *Musa paradisiaca* leaves respectively. The methionine plus cysteine % of DM was lowest for *Gliricidia sepium* leaves, and that of total nitrogen in the SAA was lowest in *Musa paradisiaca* leaves. The mean methionine plus cysteine and total nitrogen in the SAA of the leaves expressed as percentage of DM were 0.68 ± 0.3 and 0.42 ± 0. 1% respectively, whilst the corresponding mean contents expressed as percentage of CP were 3.0 ± 0.3 and 1.89 ± 0. 2% respectively. The results obtained in the study suggest that the leaves of the selected trees are good sources of CP, EAA and methionine plus cysteine, and are capable of meeting the requirements of rabbits when fed as sole diets or incorporated into concentrate diets at appropriate inclusion levels.

Figure 1. Leaves for drying in aluminum foil

Figure 2. Leaves drying in an oven

Nutrient digestibility, growth performance and carcass characteristics of grower rabbits fed graded levels of Bamboo (*Bambusa vulgaris*) leaf meal

Osman, Y. A. Aziz, K. O. Amoah, E. L. K. Osafo, V. Attoh-Kotoku and P. Sasu

This study aimed at determining the growth performance, nutrient digestibility and carcass characteristics of grower rabbits fed diets containing graded levels of *Bambusa vulgaris* leaf meal (BVLM). Thirty rabbits weighing an average of 999 g were allocated in a Completely Randomized Design (CRD) to five treatments (BVLM 0%-control diet, BVLM 5%, BVLM 10%, BVLM 15% and BVLM 20%) with six replicates. The rabbits were adapted to the assigned diets for one week and fed for ten weeks. Feed intake, live weight changes and feed conversion ratio were measured. Existing market prices for feed items were used to appraise the diets economically. A digestibility study was undertaken during the 10th week. No mortality was recorded. Before termination of the feeding trial, 15 rabbits (3 from each treatment) were selected randomly, taken off feed for 24 hours and humanely slaughtered. Carcass parameters and weights of internal organs were measured and recorded. Results revealed that live weight changes, feed intake and feed conversion ratio were similar for all treatments. However, the cost of feed/kg (Gh¢) (i.e., BVLM 0%-1.84, BVLM 5%-1.80, BVLM 10%-1.77, BVLM 15%-1.74 and BVLM 20%-1.71) and feed/kg gain (Gh¢) (i.e., BVLM 0%-9.90, BVLM 5%-9.70, BVLM 10%-9.40, BVLM 15%-9.20 and BVLM 20%-9.40) decreased linearly with an increase in the inclusion level of BVLM. The results also showed that BVLM could be utilized in up to 15% of grower rabbit diets without lowering nutrient digestibility and dressing percentage. It was concluded that BVLM could be used up to 20% of the diet of grower rabbits to reduce the cost of feed/kg and cost of feed/kg gain without any adverse effects on live weight changes and weights of internal organs.

Figure 1: Bamboo leaves

Figure 2: Experimental rabbits in cages

Qualitative and quantitative assessment of some common *Brachiaria* species produced in sub-humid zone in Ghana

E. Marfo-Ahenkora, C. Y. F. Domozoro, E. T. Sottie, D. K. Puozaa, K. O. Ansah and W.H.K Dorgbetor

The aim of this study was to assess the quantitative and qualitative traits of three of the species of Brachiaria (*B. brizantha, B. ruzziziensis and Brachiaria species cv. mulato II*) maintained at the CSIR-Animal Research Institute within the sub humid zone of Ghana to support livestock productivity. Previously overgrazed pasture fields at the Katamanso research station of the CSIR-Animal Research Institute were fertilized with composted cattle manure and ploughed for pasture re-establishment at the beginning of the major rainy season in 2023. Experimental plots were designated and setup with 3 treatments and 3 replicates in a randomized complete block design. Treatments comprised of 3 species of Brachiaria (*B. brizantha*, *B. ruzziziensis*, and *B. Brachiaria species cv. mulato II*). Plots had dimensions of 3 x 3 m and seeded at 1 x 0.5 m; 1 m between plots and 2 m between blocks. Soil samples were taken before the experiment and biomass sampling is being done at 6 weeks intervals after establishment. Laboratory assessment of samples for nutritive qualities (proximate data, NDF and ADF) and dry matter quantities of yields. Climatic data for the experimental site is to be accessed from the Ghana meteorological service department for the period of the experiment.

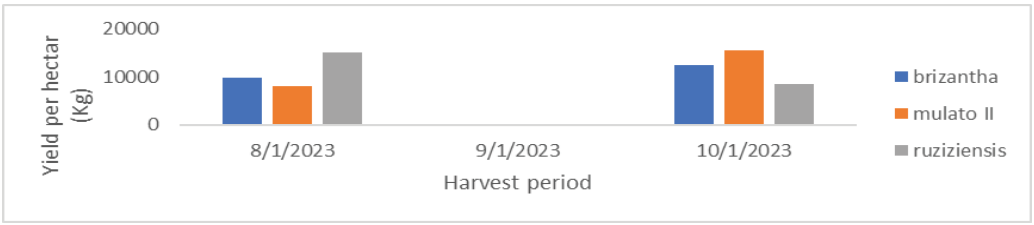

Figure 1 Initial Biomass yields of three species of *Brachiaria* in a sub humid zone of Ghana

Figure 2: Planting of forages

Figure 3: Harvesting of established pasture

A preliminary study evaluating the nutritional value of treated plantain/ banana stem feed and its effect on the growth performance of pigs.

Alesane, A. N. O. Sackey. A. D. Oduro-Owusu, K. O. Amoah and A. Atter

This preliminary study assesses the nutritional value of treated plantain stems as a feed ingredient and identifies a beneficial microbial inoculant for fermentation in swine production. Harvested plantain pseudo-stems, after peeling the outer portions, were chopped into 1-2 cm pieces and treated with 100 g of brown sugar per 10 kg of stem. The chopped stems underwent anaerobic fermentation in plastic barrels for a week. Two diets were tested: a control diet (maize soybean meal) and a plantain stem diet replacing 50% of maize. Six growing pigs (initial weight: 19.77 ± 1.86 kg) were randomly assigned to the diets, with three pigs per treatment, fed at 3.5% of their body weight, and provided water ad libitum. The experiment lasted 28 days. Before feeding the plantain stem diet, a beneficial microbial inoculant was added. Proximate analysis of fresh plantain stems before and after fermentation, along with microbial composition analysis of the inoculant, was conducted. Fresh stems had 2.15% ether extract, 0.98% ash, and 0.36% crude protein, while treated stems showed reduced ether extract (1.75%), 0.95% ash, and increased

crude protein (2.94%), a 700% increase. Weight gain and final weight of pigs were similar (p>0.05) between the Control (5.57 kg and 25.27 kg) and plantain stem (5.20 kg and 25.03 kg) groups. In conclusion, fermented plantain stems, inoculated with beneficial microbes, can replace up to 50% of maize in pig diets without adverse effects on performance.

Figure 1: Experimental pigs

Figure 2: Plantain pseudo-stems

BIOMEDICAL AND PUBLIC HEALTH: ANIMAL HEALTH AND BIOSAFETY

A clinical trial to assess the efficacy of an ethnoveterinary medicine for the treatment of Newcastle Disease in the Savanna Region of Ghana

F. K. Avornyo, B. B. Bortieh, E. Wahaya, J. E. Akortia Agbemeetsi, F. B. Awuni

This project was done to assess the efficacy of *Bombax costatum* (Silk cotton tree) and *Evolvulus alsinoides* (Dwarf morning glory) as a decoction for the control of Newcastle disease (NCD) in chickens. Four neighbouring communities were randomly assigned to two treatments, namely control and treatment. Within each community, about 20 farmers, each with about 40 chickens were assigned to the treatment chosen for the community. The decoction was given to the poultry on treatment whereas farmers on control were allowed to use their normal practice which consisted of the administration of conventional antibiotics and infusions from the bark of the mahogany tree or an old dry cell. The Generalized Linear Model of SAS was used to compare the treatment outcomes at a 5% level of significance and the Student Newman Keuls test was done to separate the means. The treatment communities recorded a lower mortality rate (17% of chicks died) compared with the control communities (87% of chicks died) ($P<0.05$). While few hatches (20%) were observed in the control communities, significantly more hatches (74%) were observed in the treatment community ($P<0.05$). The disposal of chickens was significantly higher in the control group compared with the treatment group ($P<0.05$) because the control group recorded a higher incidence of disease and control farmers were therefore compelled to dispose of more chickens before they died. The experiment should be repeated on-station for the confirmation of the results, however, the results suggest that the plants may have properties capable of treating the Newcastle disease.

Figure 1: Preparation of the decoction for preventing and treating the Newcastle disease

Figure 2: During the on-farm Newcastle disease experiment, the community farmers reported that their chickens were dying from a strange disease. The hen in the photo is suffering from the said disease

Multi-drug and colistin resistance phenotypes of *E. coli* isolated from poultry diagnosed with colibacillosis

M. Ayim-Akonor, R. Atakora, R. Ohene Larbi, P. Ababio, P. Adawo and T. Odoom

Worldwide, avian colibacillosis (AvL), caused by *E. coli,* is considered the most prevalent infectious bacterial disease of poultry, causing substantial economic losses. The increasing resistance of bacteria to veterinary antimicrobials is contributing further to reducing producers' net profits. To inform veterinarians of suitable antimicrobials for AvL treatment, we evaluated the susceptibility of AvL-isolated-*E. coli* to frequently used antimicrobials in poultry and to colistin, a WHO reserved antimicrobial. Tetracycline was frequently prescribed to farms after post mortem. From December 2022-March 2023, 54 organs (lungs, heart, spleen and liver) were collected from 16 AvL-diagnosed birds (predominantly broilers (75%, n=12), aged 2 to 8 weeks) at the Accra Veterinary Laboratory. Standard culture and biochemical methods were employed at the Animal Research Institute to isolate and confirm *E. coli* from these samples. Susceptibility to six antimicrobial classes was determined using the Kirby-Bauer disc diffusion method, and CHROMagar COL-APSE for colistin. The highest isolation frequency, 84.6% (n=11) was from the lungs. Isolates exhibited high resistance to ampicillin (95%), tetracycline (93%) and sulfaamethoxazole (80%); moderate resistance to chloramphenicol (55%) and ciprofloxacin (55%) and low resistance to gentamicin (15%). More than two-thirds (87.5%, n=35) of isolates showed multi-drug resistance, of which 40% (n=13) were resistant to five antimicrobial classes. About a quarter (35%, n=14) of isolates demonstrated resistance to colistin. *E. coli* isolated from AvL-diagnosed birds were highly resistant to most antimicrobials frequently used in the poultry industry including colistin and calls for farmer education on cautious antimicrobial use during production.

Figure 1: *E. coli* on Eosin methylene blue agar (EMBA) plate.

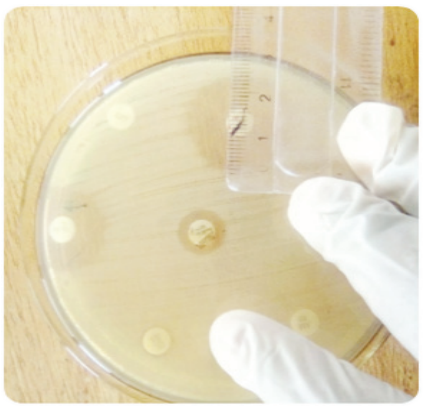

Figure 2: Measurement of zone of inhibition on Muller Hinton agar plate.

Assessing changes in bacterial load and antibiotic resistance in the Legon sewage treatment plant between 2018 and 2023 in Accra, Ghana

R. L. Adjei, L. A B. Adomako, A. Korang-Labi, F. K. Avornyo, C. Timire, R. Ohene Larbi, C. Kubasari, S. E. D. Ackon and R. Anthony

Wastewater treatment plants are efficient in reducing bacterial loads but are also considered potential drivers of environmental antimicrobial resistance (AMR). In this study, we determined the effect of increased influent wastewater volume (from 40% to 66%) in the Legon sewage treatment plant (STP) on the removal of *E. coli* from sewage, along with changes in AMR profiles. This before and after study compared *E. coli* loads and AMR patterns in influent and effluent samples from a published baseline study (January–June 2018) with a follow-up study (March–May 2023). Extended-spectrum beta-lactamase (ESBL) *E. coli* was measured pre- and post-sewage treatment during the follow-up study. The follow-up study showed 7.4% and 24% ESBL *E. coli* proportions in influent and effluent, respectively. In both studies, the STP was 99% efficient in reducing *E. coli* loads in effluents, with no significant difference (p = 0.42) between the two periods. More *E. coli* resistance to antimicrobials was seen in effluents in the follow-up study versus the baseline study. The increased influent capacity did not reduce the efficiency of the STP in removing *E. coli* from influent wastewater but was associated with increased AMR patterns in effluent water. Further studies are required to determine whether these changes have significant effects on human health.

Figure 1. A picture of cultured *E. coli*

Figure 2. Sampling site

Parasitic infestations in rabbits and their significance for zoonosis

D.D. Owusu-Ntumy, S.A. Squire, E.T. Sottie, H.E. Ohene-Asa, E. Marfo-Ahenkora and A. Keleve.

This study set out to determine the prevalence of *Cryptosporidium* spp. alongside other intestinal parasites in rabbits in parts of the Greater Accra, and to also determine the genotype(s) of the Cryptosporidium seen. In all, 125 fresh faecal droppings representing 354 apparently healthy rabbits were taken from a total of 30 farms in the Ga East, Madina La-Nkwantanang, and Shai-Osudoku areas. Following processing of faecal samples with Formol ether concentration technique, protozoan oocysts and worm ova were examined under light microscopy. Concentrated samples were further processed using the Modified Ziehl-Neelsen technique for Cryptosporidium. *Eimeria* spp., *Cryptosporidium* spp. and worms were present in all three sampling areas. Across all the study sites, the prevalence of *Eimeria* spp. Ranged from 46.8 % to 78 %, Cryptosporidium 11.2 % to 18 % and worms 51 % to 78 %. Single and two parasite co-infestations were common. Only one sample from Ga East had all three parasites present in it. All cryptosporidium-positive samples and some randomly selected negative samples will further be analysed with PCR and sequencing to determine the species of Cryptosporidium present. The prevalence of Cryptosporidium found in healthy rabbits is high. There is the need for wider studies to determine their spread and impact on public health.

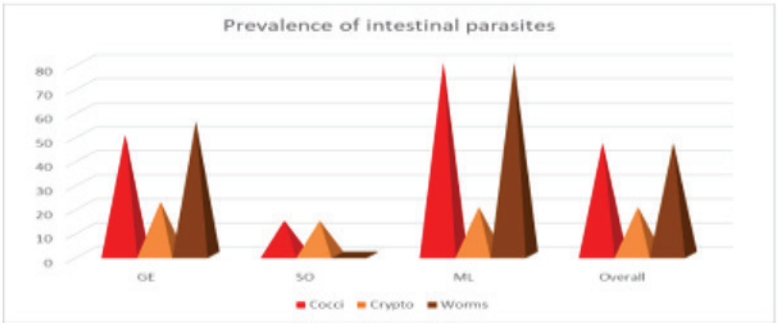

Figure 1. Prevalence of intestinal parasites in the three study areas.

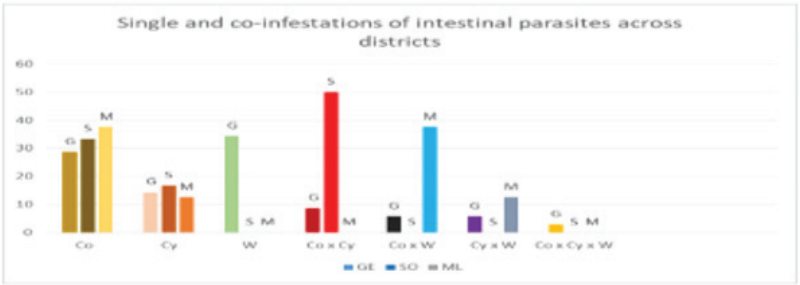

Figure 2: Single and co-parasitic infestations of rabbits across the three study areas.

Thermal apoptosis causes reduction in peripheral blood mononuclear cells in Indian Gir cattle breed exposed to high temperatures for a long time

G.O. Onasanya, K.G Tirumurugaan, A.K Thiruvenkadan, G.M Msalya, N. Murali, R. Saravanan, A. Raja, A.A Yisa, J.A.A Yamoah, J.B Danquah, A. Yakubu & C. O Ikeobi

The changing effect of climate and the consequences of global warming on livestock management and production is grave. Hence, this study aims to conduct *in-vitro* thermal stress simulation (TSS) on Indian Gir cattle peripheral blood mononuclear cells (PBMCs) by exposing them to a range of thermal assault conditions (TAC), as well as time per duration of thermal exposures (DTEs), in order to determine how PBMCs react to different levels of heat shock regimen. Fresh blood (10 mL) was collected from each of the 45 Indian Gir cattle breeds and PBMC's were separated. PBMC's were divided into 9 groups; each group had 5 PBMC samples. Aliquots of 500 uL of PBMC's were stressed by exposing them to different TACs (Normal: 37°C and Extreme 45°C) for DTE's of 0 h, 1 h, 2 h, 3 h and 4 h. The control samples which were not stressed (500 uL aliquots of PBMC's) were exposed to no TACs (No TS: 0°C) and zero DTE (0 h). Afterwards, PBMCs were counted and checked for viability using Trypan exclusion dye. We found a very strong association between TACs and PBMCs count. Moreover, the viability of PBMCs was negatively impacted by heat shock, which accounted for the exponential decrease in PBMCs as TACs toughened. *In-vitro* study of thermally stressed PBMCs provides insight into the response of cellular system to heat shock, as demonstrated in our investigation. Also, this study proves that PBMCs can be employed as a cellular system to learn about thermotolerance potential of mammalian species under actual environmental conditions to improve management and performance.

Figure 1: Indian Gir Cattle

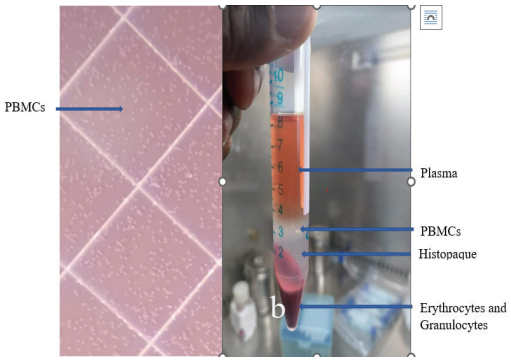

Figure 2: a. microscopic detection of PBMC's b. Fractional Separation of blood from Gir Cattle

Prevalence and characterization of ESBL *E. coli* and *Salmonella* in dogs in the Greater Accra Region

H. E Ohene-Asa. R. Ohene Larbi, M. Ayim-Akonor, D. D. Owusu-Ntumy, T. Nkrumah and N. Owiredu

Reports have shown antimicrobial use in animals as one of the drivers of antimicrobial resistance (AMR) development. Studies have also shown that close interaction between dog owners and their dogs, results in some infectious diseases as well as antimicrobial resistant bacteria from dogs being passed on to their owners.

Due to the knowledge that the food chain and direct contact with animals could serve as a channel for dissemination of antimicrobial resistant pathogens from animals to humans, we seek to study the epidemiology of these pathogens from a One-Health perspective. The study will determine the prevalence and antimicrobial resistance patterns of *E. coli* and Salmonella of dogs from the Greater-Accra region in Ghana. Questionnaires will be administered to dog owners, and their consent sought to sample their dogs.

Dogs in the study site will be sampled using sterile rectal swabs and standard techniques will be used to isolate bacteria and carry out antimicrobial susceptibility testing on isolates. At the end of this study, it is expected that *E. coli* and Salmonella of canine origin in the Greater- Accra region would be isolated and characterized. Antimicrobial resistance patterns of *E. coli* and Salmonella pathogens will be established and phenotypic resistance to antimicrobials by isolated bacteria will be characterized genotypically.

Figure 1: Rectal swab and container for sampling.

Figure 2: A dog on an examination table for sampling.

Eicosapentaenoic acid induces the inhibitory effects of adipogenesis by reducing the effect of PPARγ activator and mediating PKA activation and increased COX-2 expression in 3T3-L1 cells at the differentiation stage

M.N.N. Nartey, H. Shimizu, H. Sugiyama, M. Higa, P. Karim Syeda, K. Nishimura, M. Jisaka and K. Yokota

Obesity has received increasing attention in recent years because it is a factor in the development of non-communicable diseases. The current study aimed to analyze how representative fatty acids (FAs) such as palmitic acid, stearic acid, oleic acid, α-linolenic acid (ALA), and eicosapentaenoic acid (EPA) affected adipogenesis when/if introduced at the differentiation stage of 3T3-L1 cell culture. These FAs are assumed to be potentially relevant to the progression or prevention of obesity. EPA added during the differentiation stage reduced intracellular triacylglycerol (TAG) accumulation, as well as the expression of the established adipocyte-specific marker genes, during the maturation stage. However, no other FAs inhibited intracellular TAG accumulation. Coexistence of Δ^{12}-prostaglandin J_2, a peroxisome proliferator-activated receptor γ activator, with EPA during the differentiation stage partially attenuated the inhibitory effect of EPA on intracellular TAG accumulation. EPA increased cyclooxygenase-2 (COX-2) expression and protein kinase A (PKA) activity at the differentiation stage, which could explain the inhibitory actions of EPA. Taken together, exposure of preadipocytes to EPA only during the differentiation stage may be sufficient to finally reduce the mass of white adipose tissue through increasing COX-2 expression and PKA activity.

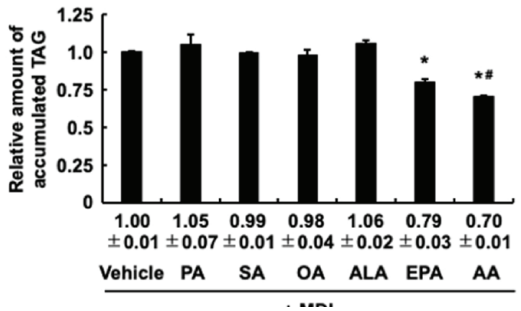

Figure 1: Effects of fatty acids during the differentiation phase of 3T3-L1 cells on the intracellular triacylglycerol accumulation.

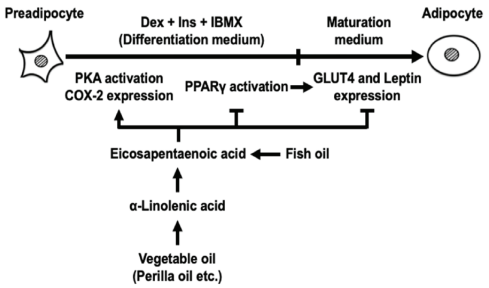

Figure 2: Schematic illustration of the predicted mechanisms by which EPA suppresses adipogenesis during the differentiation phase.

Effect of contamination and adulteration on the crude protein content of fishmeal used in the formulation of animal feed

A. Nsiah, S. Asaam, M. N. N. Nartey, and G. Andrew

Feed consumption and efficiency are crucial in animal production. Fishmeal is a key ingredient that enhances feed efficiency, but contamination during processing and adulteration for financial gain reduce its nutritional quality. Using the AOAC method of proximate, silica, and real protein assays, the nutritional content of 15 fishmeal samples from five feed mill firms in the Greater Accra region of Ghana were assessed. The majority of the fish meal samples' macronutrient content fell below recommended levels, decreasing the quality. The range of crude protein content was 11.44% to 66.49%, while the range of moisture content was 3.68% to 23.68%, with the majority of samples falling below the minimum advised crude protein value. The real protein determination showed that alternative nitrogen sources may have been added because the percentages decreased when compared to the comparable crude protein, which ranged from 0.99% to 59.28%. Ash and silica levels ranged from 14.02% to 75.58% and 10.23% to 60.44%, respectively, whereas fibre contents ranged from 0.10% to 13.11%. In this investigation, low-quality fish meals were discovered to make up the majority of the samples used in animal feed formulation.

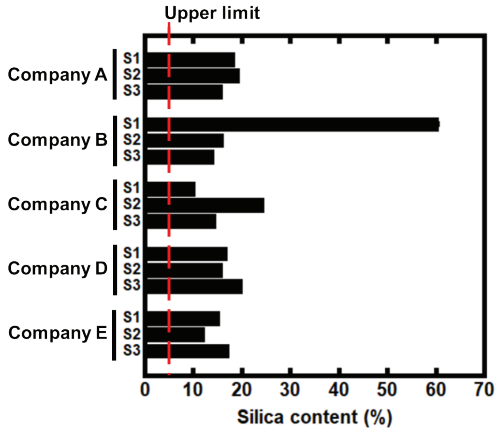

Figure 1: Analysis of silica content in the fishmeal samples.

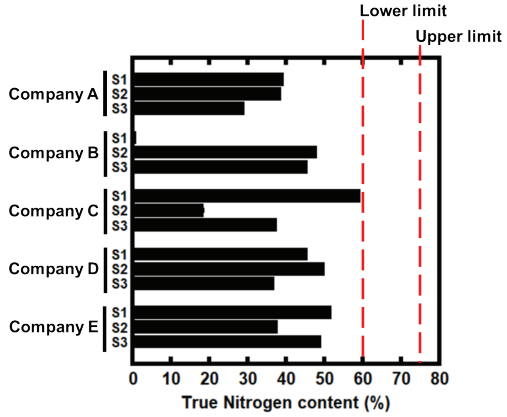

Figure 2: Analysis of true nitrogen content in the fishmeal samples.

Occurrence and antimicrobial resistance profile of *Salmonella* spp. of beef cattle from three principal abattoirs in Accra

N. Owiredu, T. Nkrumah, A.A.A Koranteng, H. Ohene-Asa and R. Ohene Larbi

Salmonella is a major foodborne pathogen worldwide and presents severe food safety and zoonotic risk. In Ghana, data on its prevalence and attendant antimicrobial resistance (AMR) in foods of animal origin have not been fully elucidated. Since contaminated raw meat has been identified as one of the main sources of foodborne illnesses, this study was carried out to determine the occurrence of *Salmonella* spp. in beef at slaughter and their AMR profiles.

49 bovine fecal samples were obtained from the Accra, Tulaku and Amasaman abattoirs in the Greater Accra Region of Ghana. Samples were processed according to standard microbiological procedure. An isolation rate of 32.7% (16/49) has so far been recorded. To ensure representativeness, 5 isolates were harvested from each positive sample and stored in Brain Heart Infusion Broth with 20% glycerol in -80 freezers. Antimicrobial susceptibility testing and sequencing would be undertaken on the harvested isolates. Data obtained would bridge the knowledge gap regarding antimicrobial resistant salmonella in the food continuum.

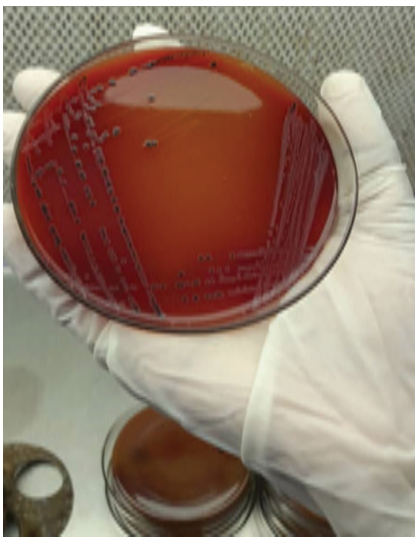

Figure 1: Isolated *salmonella* on XLD agar

One health perspective of malaria transmission

J.B Danquah & J.A Afrifa Yamoah

Global effort towards malaria control and elimination is promising; despite this, current alterations in transmissions keep modifying and frustrating such efforts. In 2020 and 2021, malaria transmissions increased significantly. While 2021 showed a decline in malaria deaths by 6000 (1%), the numbers were still 51,000 (9%) higher than malaria deaths in 2019. Two-thirds of the contributing factors were attributed to the COVID-19 pandemic, thus demonstrating the capability of future pandemics and zoonotic diseases to stagger or derail earned achievements toward malaria elimination. Compounded by zoonotic and environmental actors that promote malaria transmission, there will be a need for relevant modelling and an update on current and past disease distribution information. Common and changing driving factors of malaria in the different malaria zones will be required to shape policy actions and to improve public health decision-making on malaria. These will help strengthen the evidence for the adoption of relevant implementation strategies to aid the 2030 vision of eliminating malaria a reality.

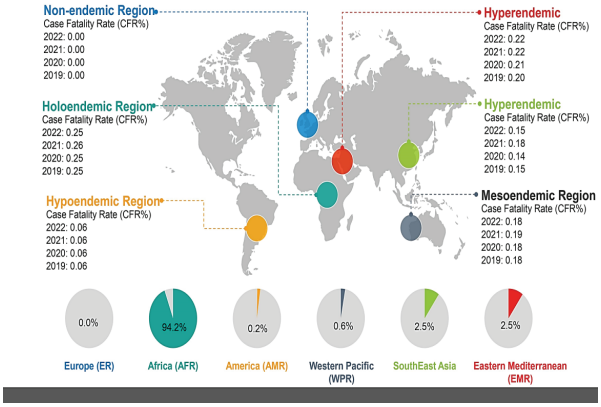

Figure 1: Malaria Burden in Pre- and Post-COVID Period Across WHO Regions (Author construct: 2023)

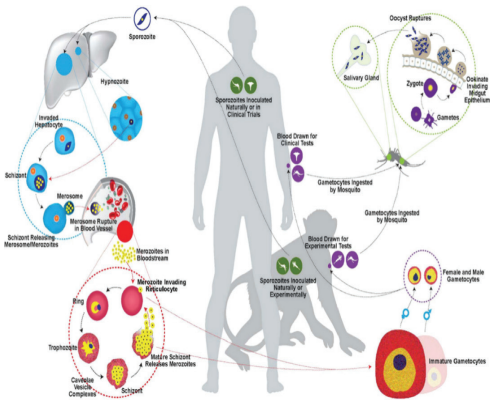

Figure 2: Life cycle of Plasmodium species involved in human and non-human primate transmissions (Galinski, 2022)

Presence of antimicrobial resistance Enterococcus spp. in healthy pigs in the Greater Accra Region

R. Ohene Larbi, D.D Owusu-Ntumy, J.B Teye, B.N. Kombat, W. Adeapena, M. Ayim-Akonor.

The gram-positive *Enterococcus* spp. is an important indicator for faecal contamination of water, antimicrobial resistance (AMR) in animals and a WHO priority pathogen. Under AMR, transfer of resistant bacteria may occur along the food supply chain. Cross contamination in food preparation and poor hygiene could also be contributors to the transfer of antimicrobial resistant

Enterococcus spp. from animals to humans. However, there is scanty information on the presence and AMR patterns of *Enterococcus* spp. in healthy pigs in the Greater Accra Ghana. Thus, this study sought to answer questions in this regard. Two hundred (200) frozen rectal swab samples of apparently healthy pigs collected from 14 farms in the Greater Accra region between January to March 2022, were subjected to standard microbiological techniques to isolate and identify *Enterococcus* spp. Using the Kirby Bauer disc diffusion method, 94 confirmed isolates were tested against six antimicrobials (ampicillin 10µg, vancomycin 30 µg, ciprofloxacin 5 µg, erythromycin 15 µg, tetracycline 30 µg and linezolid 30 µg) according to CLSI guidelines. *Enterococcus* spp. was least resistant to ampicillin (11.7%) and vancomycin (14.9%), whereas higher resistance to erythromycin (67%) and ciprofloxacin (55.9%) were observed. Multidrug resistance was present in about a quarter (23.4%) of all isolates tested. These preliminary study findings, indicate the need to continually advance good antimicrobial stewardship and proper hygiene to avoid the proliferation of AMR bacteria.

Figure 1. Apparently healthy pigs on a farm.

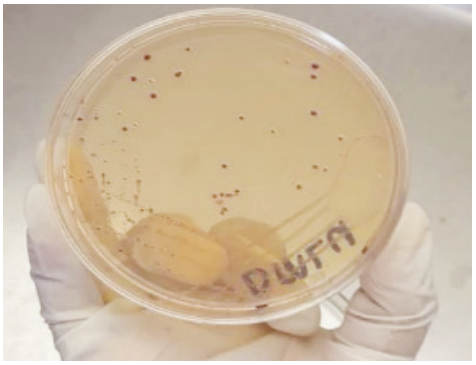

Figure 2. *Enterococci* colonies on Slanetz and Bartley agar.

Increasing prevalence of malaria and acute dengue virus co-infection in Africa: a meta-analysis and meta-regression of cross-sectional studies

T.T Genremariam, H.D.F.A Schalling, M. Zeleke and J.B Danquah

Malaria and dengue fever are the leading causes of acute, undifferentiated febrile illness. In Africa, misdiagnosis of dengue fever as malaria is a common scenario. Through a systematic review of the published literature, this study seeks to estimate the prevalence of dengue and malaria coinfection among acute undifferentiated febrile diseases in Africa. Relevant publications were systematically searched in the PubMed, Cochrane Library, and Google Scholar until May 19, 2023. A random-effects meta-analysis and meta-regression were used to summarize and examine the prevalence estimates. Twenty-two studies with 22,803 acute undifferentiated febrile patients from

10 countries in Africa were included. The meta-analysis findings revealed a pooled prevalence of malaria and dengue coinfection of 4.2%, with Central Africa having the highest rate (4.7%), followed by East Africa (2.7%) and West Africa (1.6%). Continent wide, *Plasmodium falciparum* and acute dengue virus coinfection prevalence increased significantly from 0.9% during 2008–2013 to 3.8% during 2014–2017 and to 5.5% during 2018–2021 (p = 0.0414). There was a high and increasing prevalence of malaria and acute dengue virus coinfection in Africa. Healthcare workers should bear in mind the possibility of dengue infection as a differential diagnosis for acute febrile illness, as well as the possibility of coexisting malaria and dengue in endemic areas. In addition, high-quality multicentre studies are required to verify the above conclusions.

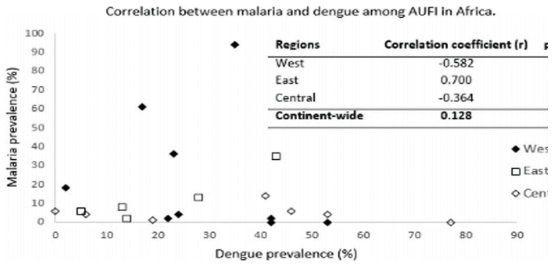

Figure 1: Flow diagram for study screening and selection process

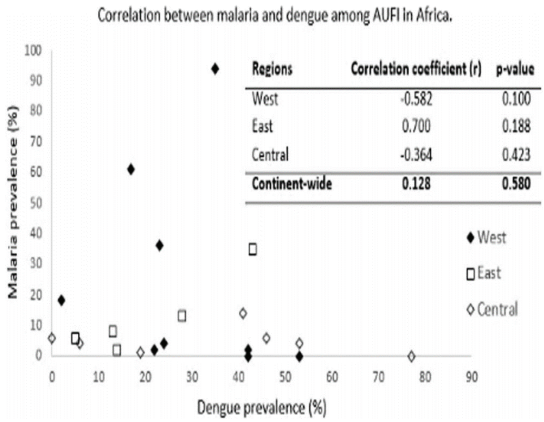

Figure 2: Correlation between malaria and dengue fever among acute undifferentiated febrile patients (AUFI) in three regions of Africa

SCIENCE AND PEOPLE: TECHNOLOGY FOR LIVELIHOOD & WEALTH CREATION, VALUE CHAIN PROMOTION

What do we know about clients of fee-for-service training programmes in livestock production in Ghana?

G. Y. Ameleke, C. Mantebea, and L. Munkaila

The study identifies socio-demographic characteristics of clients of fee-for-service livestock production training programmes in Ghana; clusters the clients based on these characteristics, and determines the share of clients participating in the various programmes. Gender differences in clients' socio-demographic characteristics, share of participants in each programme, and cluster membership were analysed. Secondary data on 128 clients who participated in livestock production training programmes organized by a research organisation in Ghana were analysed using descriptive and inferential statistics, and cluster analysis. Only a fifth of participants were female, however, most of them had tertiary level education. Majority of clients were aged between 30 and 50 years and had little or no experience in rearing the livestock associated with their training. The analysis further revealed two participant clusters based on age and experience. Moreover, there were no gender differences in the socio-demographic characteristics of cluster members, or the share of participants a particular programme. These findings suggest that training programmes should be designed to meet the different needs of both experienced and inexperienced farmers, and younger and older farmers. The results suggest that fee-for-service training programmes in livestock production are likely to be patronized more by persons with commercial orientation, higher education and financial endowment. This paper contributes to the literature on fee-for-service extension and provides insights into which category of clients have access and how they could be better targeted.

Figure 1: Theory session of training in sheep and goat production

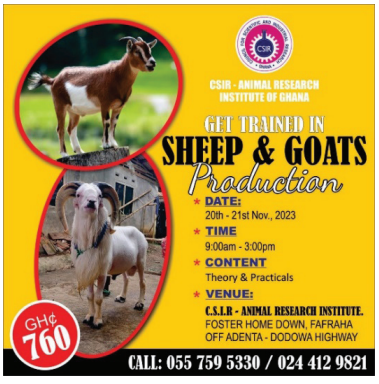

Figure 2: Flyer advertising training in sheep and goat production

Poultry Waste Management- Manure

J. Hamidu, A. Osie Adjei, A. D. Oduro-Owusu

Poultry production is an important sector of the animal industry in agriculture throughout the world. This has become important because of the increasing demand for poultry meat and eggs as healthy proteins. Farmyard manure from poultry is generated as the by-product of poultry production and is rich in plant nutrients such as nitrogen (N), phosphorus (P), and some trace elements for the growth of crops. Poultry manure improves the physical and biological properties of the soil. Poultry manure is an ideal organic fertilizer for land application for crop production and increasing crop yield. Despite these advantages, the animal industry is currently facing a serious environmental crisis due to a lack of cost-effective means of processing manure and unsuitable ways of disposing of poultry manure. If poultry waste, especially manure, is improperly managed, severe problems such as odor, the attraction of insects, rodents, pests, pathogens, groundwater contamination with phosphate and nitrate, surface water runoff, and accumulation of trace elements will result in phytotoxic effects on succeeding crops. Therefore, proper managerial skills, technical knowledge of waste composition; as well as innovative methods should be put into action to harness poultry litter as manure with minimal environmental and climate impacts.

Figure 1: Different types of poultry farming systems: (a) intensive: deep litter system, (b) intensive: battery cages, (c) semi-intensive system, and (d) free-range (extensive) system.

Effects of strain and age of layer chickens on mineral contents of egg yolk and albumen

F. Kruenti, J. K. Hagan, S. A. Ofori, and V. K. Lamptey

This study evaluated the effects of strain (genotype) and age on the mineral composition of egg yolk and albumen of the domestic chicken. A total of 810 eggs were used in a 3 X 3 factorial arrangement of treatments involving the Lohmann White, Lohmann Brown and White Leghorn which were 31, 40 and 53 weeks old. Data obtained were subjected to the Analysis of Variance (ANOVA) using the General Linear Model procedure in Minitab (version 18). Phosphorous was highest in yolks from the White Leghorn (4433.4 µg/g) than in yolks from the Lohmann Brown (4402.4 µg/g) and Lohmann White (4397.5 µg/g) strains. Iron content of egg yolk was significantly ($p < 0.05$) different among all the layers with the highest in the Lohmann Brown (77.0 µg/g) followed by the Lohmann White (37.2 µg/g) and lowest in the White Leghorn (21.7 µg/g). There was significant ($p < 0.05$) effect of layers' age on all the mineral elements of the chicken yolk except calcium, while all but phosphorous was substantially affected by hen-age in the albumen. Copper and zinc concentrations of the yolk significantly increased from week 31 (0.7 and 21.2 µg/g) to week 40 (1.2 and 28.9.2 µg/g) to week 53 (1.9 and 39.5 µg/g) correspondingly. Chicken strain and age interactions were detected for all minerals in the egg parts with the exception of calcium in the yolk. The results showed that yolk from White Leghorn at week 40 had about 5% more potassium than at weeks 31 and 53, comparable to the observation made for the same element where the yolk from the Lohmann White at week 40 had about 11% more potassium than at weeks 31 and 53. In summary, there are variations in the mineral contents of egg yolk and albumen of layer chickens by virtue of their genetic constitution and ages. Consequently, farmers must produce from the best strains (genotypes) at the appropriate hen-ages to make mineral contents of eggs meet the needs of specific consumers and products. The outcomes will therefore be beneficial for dieticians to recommend quality eggs for persons with specific mineral challenges and also assist the manufacturing industry to choose eggs for particular products.

Figure 1: Eggs stored under room and cold temperatures

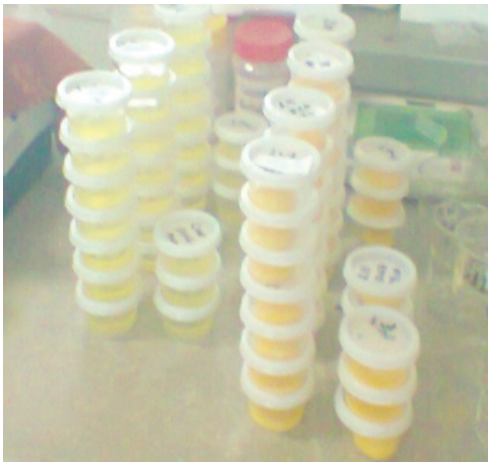

Figure 2: Egg yolk separated from the albumen

Effects of sheep management systems on nutrient intake and growth performance of Djallonke sheep in the Guinea Savannahs of Ghana

S. Salifu, I. I. Abdul-Rahman, T. Ansah and S. P. Konlan

This study assessed the effect of different sheep management systems on nutrient intake and growth performance of Djallonke sheep raised in the guinea savannah zone of Ghana. The study involved 12 sheep flocks raised under four different management systems. The sheep under intensive management were kept in complete confinement and fed 300g of formulated concentrate and hay *ad libitum;* those under semi-intensive management received 100g of concentrate before grazing natural pasture. Sheep under extensive management were allowed to roam freely and consumed only natural pasture, while tethered sheep were tied at selected spots to graze natural pasture throughout the daytime. Sheep nutrient intake, body weight changes and body condition scores were monitored. The experiment was designed as a 4 x 2 factorial with 4 management systems and 2 seasons (rainy and dry seasons). Sheep under intensive management had a significantly higher ($p<0.001$) dry matter, organic matter and crude protein intake, (780.9g/d, 662.1g/d and 93.6g/d, respectively) while sheep under the tetherextensive system had the lowest nutrient intake (456.9g/d, 386.5g/d, 31.9g/d). Similarly, the sheep under intensive management grew significantly faster ($p<0.001$) compared to those under the other systems (intensive = 68.7g/d, semi-intensive =40.1g/d, extensive = 19.8g/d, tether-extensive =19g.d). The BCS of sheep under the more extensive systems were poorer compared to sheep under the more

intensive systems. Djallonke sheep reared under the extensive and tether-extensive systems and depending only on natural rangelands showed poorer performance compared to those reared under the intensive and semi-intensive systems and receiving feed supplementation.

Figure1: Sheep maintained under complete confinement (intensive system).

Figure 2. Tethered sheep with low body condition score (BCS).

A comparative study of impact of soil and other growth media on germination and growth of seedlings of cashew (*Anacardium Occidentale*).

W.H.K. Dorgbetor

The study compared the effect of cocopeat, sawdust, rice husk and their mixtures with soil on the rate of germination and early growth of cashew seedling. Topsoil from the 0 – 20 cm depth was sampled, dried and sieved through 2 mm sieve before use. The three media, cocopeat, sawdust and rice husk, were each combined with topsoil at ratios of 1 part: 9-part soil, 1 part: 4 parts soil, 2 parts: 3 parts soil, 1 part: 1 part soil and 3 parts: 2 parts soil. The potted media were then arranged in a nursery in a randomized complete block design on a plastic mulch. They were watered to field capacity, allowed to stand for three days and seeds were planted. Cashew seeds were from the same mother tree, had equal bulge on each side and all weighed 10 g. A floating test was done for the seeds by soaking them and seeds which sank were selected and sown at two seeds per polybag. The treatments, totaling 16, were 5 soil-rice husk-based treatments, 5 cocopeat- soil based treatments, 5 sawdust – soil-based treatments and soil as control, were replicated four times. After germination, unhealthy seedlings were uprooted while the healthy were monitored, watered, and used for data collection. Data was collected at weekly intervals on stem girth (mm), plant height (cm), number of leaves per plant, weights of fresh biomass (g) and dry biomass (g) per plant after six weeks of growth. The texture and chemical properties of the topsoil was also determined. The experiment was repeated. Data collection is ongoing.

Figure. 1 Pots filled with growth media.

Figure. 2 Cashew seedlings growing in nursery

Forage integration as a sustainable intensification pathway into the mixed farming system of smallholder farmers in Northern Ghana

S.P. Konlan and N.M Akufo

Ten accessions of tropical forage seeds from two main tropical forages thus *Brachiaria and Panicum* species were obtained from ALLIANCE for Biodiversity & CIAT and evaluated in the CSIR-ARI experimental field at Nyankpala to determine their agronomic performance for integration into the mixed farming system as a sustainable intensification pathway to increase smallholder farmers productivity and resiliency. The forage varieties were planted in two main plots as blocks and divided into sub-plots (5 m x 2 m) as treatment units and replicated two times within each block. The total treatment units were 40 from the 10 forage seeds. The seed was drilled into the prepared field in 10 rows per sub-plot with a planting distance of 50 cm between rows, at an average seeding rate of (42.5 kg/ha). The forages were harvested two times at 7 and 9 weeks after planting. The results of biomass yield showed a significant difference ($P<0.05$) among forage varieties during the first harvest. *Panicum* varieties performed better than the *Brachiaria* varieties. The dry matter yield differed significantly ($P=0.002$) among the forage varieties during the first harvest and ranged from 0.53 tons/ha (*B. basilisk*) to 1.52 tons/ha (*P. mombasa*). The plant population and plant height of the forages showed significant differences ($P<0.05$) among forage varieties. *P. maasai* recorded the highest dry matter yield of 13.04 tons/ha and the lowest being *B. basilisk* with 8.04 tons/ha during the second harvest when forages were approaching their maximum vegetative growth. Interaction ($P<0.001$) was observed in the harvesting periods and forage varieties in terms of biomass yield. The forage varieties exhibited good potential with high possibilities of fitting well when integrated into the mixed farming system. A number of on-farm demonstrations are, however, needed to ensure their effective integration.

Figure 1: Forage establishment in trial field

Figure 2: Forage agronomic evaluation with farmers

SUMMARY OF FINANCIAL STATEMENT – 2023

REVENUE	2023		2022
GOG grant for compensation	17,554,476.85		15,403,982.44
Institutional Support	161,851.63		60,217.48
Internal Generated Fund (IGF)	658,838.70		460,291.70
Doner Support for Research	1,193,263.18		602,174.77
	19,568,430.36		**16,526,666.39**
LESS EXPENDITURE			
Compensation for Employees	17,554,476.85		15,403,982.44
Goods and Services Cost	496,689.43		278,270.98
Research and Development Expenses	824,637.91		691,768.78
Consumption of Fixed Assets	312,099.81		22,840.00
IGF Expenses	236,196.29		268,922.75
	19,424,100.29		**16,665,784.95**
Deficit/Surplus for the Year	**(144,330.07)**		**(139,118.56)**

NOTE: The above financial report is the unaudited account for the 2023 financial year.

HUMAN RESOURCE ACTIVITIES-2023

This report summarizes information on Administration and Human Resource issues of the Institute for the year 2023.

1.0 STAFF STRENGTH

The total number of staff by the close of 2023 stood at **231.** The breakdown is as follows:

Senior Members			Male	Female
Research Scientists	-	25	14	11
Technologists	-	24	15	9
Non-Core Senior Members	-	9	5	4
ii. **Senior Staff**	-	63	45	18
Junior staff	-	110	102	8
TOTAL	-	231	181	50

1.1 PROMOTIONS

The following members of staff were promoted in the year under review.

SENIOR MEMBERS

No.	NAME	FROM	PROMOTED TO
1	Mrs. Monica Allotey	Senior Admin. Officer	Principal Admin Officer
2	Ms. Janet Acquaful	Admin. Officer	Senior Admin. Officer
3	Mr. Felix Hagan	Admin. Officer	Senior Admin. Officer

SENIOR STAFF

No.	NAME	FROM	PROMOTED TO
1.	Mr. Absalom Danso	Principal Technical Officer	Chief Technical Officer
2	Mr. Michael Baba Agombire	Principal Technical Officer	Chief Technical Officer
3	Ms. Doreen Ahinson	Principal Technical Officer	Chief Technical Officer
4	Mrs. Irene Ago Adjei	Principal Accounting Assistant	Chief Accounting Assistant
5	Mrs. Augustina D. Akweshie	Principal Stores Superintendent	Chief Stores Supt.

6	Mrs. Rebecca Adjei	Senior Marketing Assistant	Principal Marketing Assistant
7	Mr. Benjamin Opoku	Technical Officer	Senior Technical Officer
8	Mr. Albert Owusu Buadu	Accounting Assistant	Senior Accounting Assistant
9	Ms. Joyce Oforiwaa	Administrative Assistant	Senior Administrative Assist.

1.2 UPGRADING

No.	Name	Upgraded To	Date of Upgrade
1	Ms. Perpetual Fosua Eshun	Administrative Officer	7th July 2023
2	Mr. Edem Gemegah	Administrative Officer	7th July 2023

TRANSFERS

One inter-institutional transfer was recorded as indicated in the table below;

NO.	NAME OF STAFF	GRADE	FROM	TO
1	Mr. Enock Karbo (Nyankpala Station)	Chief Accounting Assistant	CSIR-ARI	CSIR-WRI

1.4 RETIREMENT

The Institute recorded the following retirements at the end of 2023.

SENIOR MEMBERS

No.	Name	Designation	Date of Retirement
1	Mr. John O. Teiko	Accountant	24th March, 2023
2.	Mr. Gabriel Adu Aboagye	Senior Research Scientist	17th July, 2023

SENIOR STAFF

No.	Name	Designation	Date of Retirement
1.	Ex Sgt.Benjamin K. Dzormeku	Senior Security Officer	17th August, 2023
2.	Mr. Martin K. Adjei	Security Officer	19th October, 2023

JUNIOR STAFF

No.	Name	Designation	Date of Retirement
1.	Mr. Michael Tackie	Farm Overseer	21st January, 2023

2.	Mr. George Opare	Senior Security Assistant	25th January, 2023
3i.	Mr. Emmanuel Akotua	Senior Security Assistant	24th March, 2023

1.5 LEAVE OF ABSENCE

Three Research Scientists were granted leave of absence for the year 2023.

NAME	DESIGNATION	DURATION
1. Dr. Jennifer A. Afrifah-Yamoah	Research Scientist	2nd May, 2023 to 1st April, 2024
2. Mrs. Nikki Owiredu	Research Scientist	1st September, 2023 to 1st March 2024
3. Dr. Doris Puozaa	Research Scientist	1st August, 2023 to 31st July, 2024

1.6 RESIGNATION

Ms. Mary Koranteng, farm overseer, resigned from service of the Council on 12th May, 2023

1.7 DEATH

No.	Name	Designation	Date of Demise
1	Ms. Henrietta Tengan (Nyankpala Station)	Chief Administrative Assistant	15th May, 2023

1.8 STUDY LEAVE

The following members of staff were granted study leave during the year under review.

No.	NAME	LEVEL OF STUDY	AREA OF STUDY	INSTITUTION
	Mr. Maxwell Ansong	PhD	Animal Husbandry	Shandong Agricultural University, China
	Ms Theresah Nkrumah	PhD	Agro. Product Quality and Food Safety	Chinese Academy of Agricultural Sc. China
	Mr. Raymond Lovelace Adjei	PhD	Molecular Physiology and Cardiovascular Biology	Mie University, Japan
	Mr. Ebenezer Amoah	MSc.	Project Management	University of Northampton, UK
	Mr. Teteh Sumney Tawiah	MPhil.	Climate Change	University of Energy and Natural Resource, Sunyani

	Mr. Jonas Ago-Adjei	MBA	Marketing	University of Professional Studies, Accra
	Mr. David Amerdome	MPhil.	Computational Genomics Technology	Kwame Nkrumah University of Science and Technology, Kumasi
	Mr. Sule Alhassan	Certificate	Animal Health	Animal Health & Production College. Pong, Tamale
	Mr. Michael Baba Agombire	MPhil.	Animal Science	University for Development Studies, Tamale
10	Mrs. Irene Ago – Adjei	MBA	Accounting and Finance	University of Professional Studies, Accra

1.9 RESUMPTION OF DUTY FROM STUDY LEAVE

The table below outlines members of who resumed duty from study leave.

No.	NAME	LEVEL OF STUDY	AREA OF STUDY	INSTITUTION
1.	Mrs. Achiama Asafu-Adjaye Koranteng	PhD	Animal Science	University of Lome, Togo.
2.	Mrs. Nikki Owiredu	PhD	Veterinary Sciences	Murdoch University, Perth Western Australia

1.10 WORKSHOP/ CONFERENCES ATTENDED BY STAFF

Dr. Justice Opare Odoi, Dr. Michael Nartey, Dr. Sylvia Squire, Ms. Lantana Mukaila and Mr. Collins Antwi attended a two-day workshop organized by Heritors Labs in collaboration with the CSIR-STEPRI funded by Research and Innovations systems for Africa from 23rd-24th March, 2023 at CSIR-STEPRI

Mrs. Vida Lamptey represented the Director at a stakeholder meeting organized by the Ministry of Food and Agriculture (MoFA) on Thursday, 13th April, 2023 at the MoFA, Head Office in Accra.
Dr. Justice Opare Odoi, Mr. Collins Antwi and Ms. Lantana Mukaila attended a three-day training workshop on '***The Collection and Analysis of Research and Development and Innovation Data in***

Ghana' organized by CSIR-STEPRI in collaboration with African Union Development Agency of New Partnership for African Development (AUDA-NEPAD) on Tuesday, 25th to Thursday, 27th April, 2023 at the CSIR-STEPRI, Accra.

Dr. Edmund Sottie represented the Director at the Development of a National Action Plan on '***Natural Capital Accounting for Sustainable Development and Decision Making'*** 'organized by the Ghana Statistical Service in collaboration with the Ministry of Environment, Science, Technology and Innovation (MESTI), Environmental Protection Agency (EPA) on Wednesday, 26th April, 2023 at the Coconut Grove Hotel. Accra.
Mr. Leonardo Abormegah, Mrs. Diana Frempong and Mrs. Antoinette Keleve attended the Standardization, Certification and Conformity Assessment Workshop on the theme: ***"Advancing Standards and Certification in Research and Innovation: Building a Symbolic relationship with Regulators and culture of Standards among Researchers and Innovators"*** on 26th July, 2023 at the Holiday Inn, Accra Airport City.

Dr. (Mrs.) Esther Marfo-Ahenkora, Dr. Edmund T. Sottie, Dr. Godwin Ameleke, Dr. (Mrs.) Sylvia A. Squire, Dr. Justice Opare Odoi, and Mr. francis Kurenti participated in a workshop on the state of '***Genetically Modified Crops, The Case of Ghana'*** on 18th August, 2023 at Holiday Inn, Accra Airport City. Mr. Samuel A. Bediako attended the Bloomberg Road Safety Workshop at Ange Hill Hotel on Friday, 20th October, 2023.

Mr. Vincent A. Botchway attended a two-day residential workshop for selected stakeholders on ***"Revising/ Updating Guidelines to Facilitate Climate Mainstreaming into National Development Planning and Budget Process"*** from Friday 17th November to Saturday, 18th November, 2023 at the Hill Palace Hotel, Aburi.

1.11 SPECIAL EVENT

The CSIR-Animal Research Institute hosted the 273rd Director's Management Committee (DMC) meeting from Wednesday, 8th February, 2023 to Thursday 9th February, 2023 respectively.

1.12 MANAGEMENT BOARD MEETINGS

Two Management Board meetings were held within the year, one on Thursday 20th April, 2023 and the other on Thursday 12th October, 2023. There was however an emergency meeting on 8th November, 2023.

1.13 OFFICIAL VISITS TO THE INSTITUTE

A team from the Adentan Municipal Assembly (ADMA) led by Mr. Afriyie paid an official visit to the Director on 5th October, 2023.

A team of four Scientists from Avril Biopharma, USA and Imperial College, London paid an official visit to the Institute on Friday, 3rd November, 2023 to discuss a collaboration on vaccine development in Ghana.

Mr. Thomas Dakogre from the Ghana Sumatra paid an official visit to the institute and served as a resource person during a staff durbar on 7th November, 2023.

Management of Farm Unique, led by Dr. Siegfried Obresi made a presentation to staff of the CSIR-ARI on 7th November, 2023

1.16 LIST OF NATIONAL SERVICE PERSONNEL POSTED

No	NAME	INSTITUTION	AREA OF SPECIALIZTION	ASSIGNED DIVISION
1.	Kelly-Davis Toppar	KNUST	BSc. Forest Resource Technology	Natural Resources Management
2.	Samuel Ofori	Univ. of Ghana	BSc. (Biological Sc.) Animal Biology and Conservation Sc.	Animal Health (Microbiology)
3.	Hussein Abdul Karim	Univ. of Ghana	BSc. (Biological Sc.) Animal Biology and Conservation Sc.	Animal Health (Microbiology)
4.	Kevin Kwaku Buabasah Poku	Univ. of Ghana	BSc. in Agric. (Animal Sc.)	Livelihood & Innovation
5.	Samuel Amankwah Aboagye	KNUST	BSc. Agricultural Biotechnology	New Product Dev. & Food Safety
6.	Selina Dewie Nartey	Accra Technical University	HND (Science Laboratory Technology)	Farm Animal Tech. (QCL)
7.	Godwin Dugbeson Adzohun	AAMUSTED Mampong	Bsc. Mathematics Education	Livelihood & Innovation
8.	Helen Mawusi Juanita Tornyewonya	Univ. of Ghana	BSc. Biological Science	Animal Health Div. (Biotech Lab)
9.	Nora Nartekuor Nartey	Univ. of Cape Coast	Bachelor of Commerce (Accounting)	Accounts

10	Henry Korli Nartey	University of Ghana	Bachelor of Science Marine Science	Animal Health (Parasitology)
11.	Albert Nsoh Apana-Adagzina	Ghana Comm Techn. University	BSc. Inf. Technology	Administration
12.	Raphael Nyarko	Univ. of Ghana	BSc. Agric (Agribusiness)	Livelihood & Innovation
13.	Yussif Saeed	Univ. of Ghana	BA (Political Science & Philosophy)	Administration
14.	Abednego Amanortey	UDS	BSc. Vet. Nursing	Animal Health
15.	Bismark Asramah	KNUST	BSc. Agricultural Biotechnology	Animal Health

1.17 LIST OF ATTACHMENT STUDENTS

The under-listed students had their attachment within the Institute in the year under review.

No.	NAME	INSTITUTION	AREA OF SPECIALIZTION	ASSIGNED DIVISION
1.	Fortune Dela Kwadwo Gadezeti	KNUST	BSc. Agribusiness management	Commercialization
2.	Adjana Enoch Wepia	KNUST	Theoretical & Applied Biology	Animal Health
3.	Mary Seyram	KNUST	BSc. Agriculture	Commercialization
4.	Owusu Micheal Badu Opoku	KNUST	BSc. Agribusiness management	Commercialization
5.	Sebastine Naasaa	AAMUSTED Mampong	BSc. Agribusiness Mgt & Entrepreneurship Educ	Animal Health
6.	Rebecca Naa-Adobea Darku	KNUST	Theoretical & Applied Biology	Animal Health
7	Ibrahim Abdul-Mumin	KNUST	Bsc. Agriculture	Commercialization
8.	Eugene Dutt Mateyenu	AAMUSTED Mampong	Bsc. Information Technology Education	Administration
9.	Caroline Akua Quainoo	KNUST	Theoretical & Applied Biology	Animal Health
10.	Boateng Isaac Tuffour	KNUST	BSc. Agriculture	Commercialization
11.	Adam Bashiru	UDS	BSc. Biotechnology & Molecular Biology	Animal Health
12.	Asiedu Adwoa Otubea	Univ. of Ghana	BSc. Agriculture	Animal Health

13.	Twumas Pearl	Univ. of Ghana	BSc. Agriculture	Animal Health
14.	Phanuel Nunekpekul Mawuli	KNUST	BSc. Agriculture Biotechnology	Animal Health
15.	Elelakpodia Samuel Ayiku	Univ of Ghana	BSc. Agriculture	Commercialization
16.	Clad Keren Esee	KNUST	BSc. Agriculture Biotechnology	Animal Health
17.	Jeremy Akuaku Tettenhell	KNUST	BSc. Agriculture Biotechnology	Animal Health
18.	Eunice Ayorkor	UPSA	BA. Business Admin	Administration
19.	Lawrencia Akpor	KNUST	BSc. Agriculture Biotechnology	Animal Health

PUBLICATIONS

Refereed Journal Papers

1. Koranteng, A. A. A., Gbogbo, K. A., Adjei-Mensah, B., Bouassi, T., Agbehadzi, R. K., & Tona, K. (2023). Influence of palm kernel cake on the growth performance, gut health and haematochemical indices of slow-growing broilers. Journal of Applied Animal Research, 51(1), 554-563. http://dx.doi.org/10.1080/09712119.2023.2242447

2. Adjei-Mensah, B., Koranteng, A. A. A**.,** Hamidu, J. A., & Tona, K. (2023) Antibacterial activities of garlic (Allium sativum) in broiler and laying hens production, World's Poultry Science Journal, 79:1, 155-176, DOI: 10.1080/00439339.2023.2164236

3. Adjei, L.R., Nkrumah, T., Okai, A. M., Kruenti, F. and Blessie E. (2023) Assessment of heavy metal concentration and their relationship in beef sold in markets. Cornous Biology, 1(1), 26-34.

4. Kruenti, F., Hagan, J. K., Ofori, S. A. and Lamptey, V. K. (2023) Variability in proximate and mineral compositions of yolk and albumen in eggs kept under different storage conditions. Online Journal of Animal and Feed Research, 13(3), 171-176.

5. Kruenti, F., Hagan, J. K., Ofori, S. A. and Lamptey, V. K. (2023) Effects of strain and age of layer chickens on mineral contents of egg yolk and albumen. Ghanaian Journal of Animal Science, 13(2), 42-50.

6. Hamidu J., Adjei A. O., Oduro-Owusu, A. D. (2024) Poultry Waste Management-Manure, Reference module in Food Science. Elsevier, Encyclopedia of Meat Sciences (Third Edition) Pages 56-71. https://doi.org/10.1016/B978-0-323-85125-1.00136-8

7. Bumbie, G. Z., Abormegah, L., Asiedu, P., Oduro-Owusu, A. D., Danso, F., Owusu A. K., Mohamed, T. M., Tang. Z., (2023) Different concentration of probiotic *Pediococcus pentosaceus* GT001 on growth performance, antioxidant capacity, immune function, intestinal microflora and histomorphology of broiler chickens. Animals 13, 3724. https://doi.org/10.3390/anil3233724 (in press)

8. Genremariam, T. T., Schalling, H. D. F. A., Zeleke, M. & Danquah, J. B. (2023) Increasing prevalence of malaria and acute dengue virus coinfection in Africa: a meta-analysis and meta-regression of cross-sectional studies. Malaria Journal 22 (300):1-11

9. Quaye, E. K., Adjei, R. L., Isawumi, A., Allen, D. J., Caporaso, J. G., & Quaye, O. (2023). Altered Faecal Microbiota Composition and Structure of Ghanaian Children with Acute Gastroenteritis. *International Journal of Molecular Sciences*, *24*(4), 3607.

10. Kubasari, C., Adeapena, W., Najjemba, R., Hedidor, G. K., Adjei, R. L., Manu, G., & Asante, K. P. (2023). Quality of Data Recording and Antimicrobial Use in a Municipal Veterinary Clinic in Ghana. *Tropical Medicine and Infectious Disease*, *8*(11), 485.

11. Adjei, R. L., Adomako, L. A. B., Korang-Labi, A., Avornyo, F. K., Timire, C., Larbi, R. O., Kubasari, C., Ackon, S. E. D. and Reid, A. (2023). Assessing Changes in Bacterial Load and Antibiotic Resistance in the Legon Sewage Treatment Plant between 2018 and 2023 in Accra, Ghana. Tropical Medicine and Infectious Disease 8 (9), 427

12. Michalscheck, M., Kizito F., Kotu B. H. , Avornyo, F. K., Timler C., & Groot J. C. J. (2023) Preparing for, coping with and bouncing back after shocks. A nuanced resilience assessment for smallholder farms and farmers in Northern Ghana, *International Journal of Agricultural Sustainability*, 21(1): 2241283, DOI: 10.1080/14735903.2023.2241283

13. Asiedu, P., Bumbie, G. Z, Owusu, A. K., Osei, D.Y. Oduro-Owusu, A. D. Effect of feeding regimes on growth and carcass characteristics of grower-finisher pigs. Ghanaian Journal of Animal Science (Volume 14, 2023). (in press)

14. Osei Doris Yaa, Sarkwa Felix Owusu, Timpong-Jones Eric Cofie, Asiedu Peter and Amedorme David (2023). Intake and Palatability of Forages Fed to Rabbits in the Coastal Savannah Ecological Zone of Ghana. Acta Scientific Veterinary Sciences, 5.11: 52-58 DOI: 10.31080/ASVS.2023.07.0775.

15. Owusu-Ntumy, D. D., Owiredu, N., Osei, D.Y., Bortieh, B.B., Afedzie-Obresi, S., Beyuo, J. and Keleve, A. Survey and prevalence of *Eimeria* spp. infecting local rabbits in the Greater Accra Region of Ghana. Under review: Cogent Food and Agriculture.

16. D.Y., Osei, Apori, S. O., Hagan, J. K., Asiedu, P., Amedorme, D., Adu-Aboagye, G. (2023). Essential and sulfur amino acid composition of five commonly fed tree leaves to rabbits in the coastal savannah zone of Ghana. Ghanaian Journal of Animal Science, 13(1): 63-69.

17. Asiedu, P., Amoah, K. O., Bumbie, G. Z., Oduro-Owusu, A. D., Osei D. Y. and Rhule S. W. A (2023). Effect of feeding regimes on growth and carcass characteristics of grower-finisher pigs. Ghanaian Journal of Animal Science, 14(1): 32 - 40.

18. Asiedu P., Gyamera E Bumbie G. Z., Osei D. Y and Ako Odoi F (2023). Growth performance of pigs fed hatchery waste meal. Livestock Research for Rural Development, 2023, 35 (5). http://www.lrrd.org/lrrd35/5/3545pete.html

19. Nartey, M.N.N., Shimizu, H., Sugiyama, H., Higa, M., Syeda, P.K., Nishimura, K., Jisaka, M., and Yokota, K. (2023). Eicosapentaenoic acid induces the Inhibition of adipogenesis by reducing the effect of PPARγ Activator and mediating PKA Activation and increased COX-2 expression in 3T3-L1 cells at the differentiation stage. Life, 13, 1704.

20. Osman, A., Aziz, Y. A., Amoah, K. O., Osafo, E. L. K., Attoh-Kotoku, V. and Sasu, P. (2023). Growth performance, nutrient digestibility and carcass characteristics of grower rabbits fed graded levels of Bamboo (*Bambusa vulgaris*) leaf meal. International Journal of Agricultural Research Innovation and Technology, 13(1): 6-14. https://doi.org/10.3329/ijarit.v13i1.67945

Conference Papers

1. Okai, M. A, Hamidu, J. A, Kruenti, F, Owusu, A. D. O, Nkrumah, T, Koranteng, A. A. A, Mensah, B. A, Tona, J. K, Lamptey, V. K and Adu-Aboagye, G (2023). Challenges Facing the West African Poultry Industry: A Review of Ghana, Nigeria, and Togo. 2nd Joint Biennial Conference of GSAP and GASA, 28th August – 1st September, 2023. Pp 53

2. Timpong-Jones, E. C., Osei, D.Y, Sarkwa, F. O. and Amedorme, D. (2023). The contribution of woody species from rangelands as feed resource and other beneficial uses. Book of Abstracts; 2nd Joint Conference of Ghana Society of Animal Production and Ghana Animal Science Association held at Kwame Nkrumah University for Science and Technology, Kumasi on 28th August to 1st September, 2023, page 77.

3. Asiedu, P., Adonbire, A. C., Achempem, A. I., Nartey, M., Osei, D.Y. and Yeboah, A.E. (2023). Response of growth and carcass traits of rabbit (*Oryctolagus cunniculus*) fed hydroponics

maize fodder harvested at different times - (2nd Joint Biennial Conference 28th August to1st September 2023 Abstract GSAP and GASA.

4. Asiedu, P., Nartey, M., Adonbire, A.C., Hagan, B.A., Asumah, C., Osei, D.Y., Yeboah, E.D. and Achempem A.I. (2023) Effect of harvesting period of hydroponic maize fodder on growth, blood metabolites and carcass characteristics of rabbit (*Oryctolagus cuniculus*) -Book of Abstract (2nd Joint Biennial Conference for GSAP and GASA. 28th August to1st September 2023.

5. Addy, H. P, Ohene Larbi R, Owusu-Ntumy D, Adeapena W, Bannerman E. Y, Adjetey K, Fiagbe R, Annan K. F, Acquah R, Henyo P, Semeshia P. S, Ayim-Akonor M and Mills R. O (2023). Prevalence and molecular characterisation of extended-spectrum b-lactamase (ESBL)- producing *E. coli* from healthy pigs in Accra. Annual research meeting, Noguchi Memorial Institute for Medical Research, University of Ghana. November 22-24, 2023. Pp 41

6. Amakye-Anim, J., Ayim-Akonor M., Odoom T., Wallace P., Folitse R., Fenteng D. and Aryee M. (2023). High Sero-prevalence of Infectious Bronchitis in Commercial Poultry in Ghana: Evidence-Based Justification for Serotyping and approval for Vaccination. 33rd Biennial conference of Ghana Science Association, September 5-7, 2023. Pp 34

7. Atakora, R., Ayim-Akonor M., Ohene Larbi R., Ababio P., Adawo P. and Odoom T. (2023). Susceptibility of pathogenic *E. coli* associated with avian colibacillosis to frequently used antimicrobials: a prospective study. 33rd Biennial conference of Ghana Science Association, September 5-7, 2023. Pp 35

8. Yamoah, J. A. A., Owusu-Ntumy D. D., Bortei B. B., Ayim-Akonor M., Ohene Larbi R., Owiredu N. and Boateng Y. K. (2023). Understanding the impact of poultry production training on antimicrobial usage, knowledge of antimicrobial resistance, and attitude towards prudent antimicrobial usage mong poultry farmers. 33rd Biennial conference of Ghana Science Association, September 5-7, 2023. Pp 43

9. Ohene-Asa, H, Ohene Larbi R, Owusu-Ntumy D. D, Sasu B, Odoom T and Ayim-Akonor M (2023). One or more? Diversity of pathogens associated with respiratory disease outbreaks in Greater Accra. 33rd Biennial conference of Ghana Science Association, September 5-7, 2023. Pp 33

10. Teye J. B, Ohene Larbi, R., Otoo, F, Osei, L. A., Akwa, S., Owusu-Ntumy, D., Hamidu, J. and Ayim-Akonor, M. (2023). Antimicrobial susceptibility profile of E. coli isolated from poultry in two districts in the Greater Accra region. 33rd Biennial conference of Ghana Science Association, September 5 -7, 2023. Pp 42

11. Kombart, B. N., Ayim-Akonor M,. Badu T., Ohene Asa H. and Nkrumah T. (2023). Microbial evaluation of edible beef offal in Greater Accra. 33rd Biennial conference of Ghana Science Association, September 5-7, 2023. Pp 44

12. Sarkwa, F. O., Antwi, V., Timpong-Jones, E.C., Osei, D.Y., Adu-Boahene, F.Y. and Andoh, S. (2023). Methane emission and performance indicators of sheep fed two basal diets supplemented with two browse leaves. Book of Abstracts of 8th All African Conference in Animal Agriculture, Gaborone, Botswana, 26th to 29th September, 2023. pp 143.

13. Ohene-Asa H. E., Ohene Larbi R., Ayim-Akonor M., Owusu-Ntumy D.D., Nkrumah T., and Owiredu N. (2023) One or More? Diversity of Pathogens Associated with Respiratory Diseases in Poultry in Greater-Accra. Ghana Science Association 33rd Biennial Conference

14. Osei, D. Y., Sarkwa, F. O,Timpong-Jones, E.C., Amedorme, D. Adjorlolo, L. K. and Nyarko, A. A. (2023). The impact of seasonal changes in rangeland forage quality on total serum protein levels and methane emission of sheep. Book of Abstracts of 8th All African Conference in Animal Agriculture, Gaborone, Botswana, 26th to 29th September, 2023 pp 145.

15. Salifu S., Abdul-Rahman I. I., Ansah T., and Konlan S. P. (2023). Effects of sheep management systems on nutrient intake and growth performance in Djallonke sheep in the Guinea Savannahs of Ghana: In: Book of abstracts, 2nd Joint Biennial Conference GSAP and GASA. 28th August to 1st September, 2023 at KNUST, Kumasi, Ghana. p 71

16. Danquah, J.B. (2023) Risk & Benefits of the Human-Companion Animal Ties. Series 5 CSIR-Southern Zone Seminars, September 11, 2023

17. Boateng, M., Amoah, K. O., Atuahene, P. Y., Frimpong, Y. O., Okai, D. B. and Opoku, E. (2023). Assessment of the incidence of tail and ear biting in some selected pig farms in the Ejisu municipality of the Ashanti Region-Ghana. Proc. of the 2nd Joint Conference, Ghana Society of Animal Production (GSAP) and Ghana Animal Science Association (GASA), Kwame Nkrumah University of Science and Technology, Kumasi. pp 168-176.

18. Boakye, C. D., Boateng, M., Amoah, K. O., Frimpong, Y. O., Atuahene, P.Y. and Okai, D. B. (2023). Effects of fermented pineapple pulp residue on the growth performance, blood profile and internal organs of albino rats. Proc. of the 2nd Joint Conference, Ghana Society of Animal Production (GSAP) and Ghana Animal Science Association (GASA), Kwame Nkrumah University of Science and Technology, Kumasi. pp 159-167.

19. Frimpong, Y. O., Boateng, M., Amoah, K. O., Adjei, A., Atuahene, P. Y., Alhassan, N. P. and Okai, D. B. (2023). Response of albino rats to diets containing varying levels of ginger residue. Proc. of the 33rd Biennial Conference of the Ghana Science Association, Department of Biochemistry, Cell and Molecular Biology, University of Ghana, Legon. pp. 79

Consultancy Reports

1. Sackey, A. N. O., Amoah, K. O. and Asafu-adjaye, A. (2023). Development of improved poultry and pig feed formulations to support MGM Estate Limited: An Emerging Feed Manufacturing Company in the Private Sector in Accra.

Technical Reports/Papers

1. S. P. Konlan and N. M. Akufo (2023). Integration of forages as a sustainable intensification path way into the mixed farming systems among smallholder farmers in Northern Ghana.

Newspaper Article

1. Danquah, J.B., Yamoah, J.A.A & Ohene-Asa, H. (2023) Zero human deaths from dog-mediated rabies by 2030: Myth or reality. Daily Graphic Newspaper, October 18, 2023.

2. Yamoah, J.A.A, Danquah, J.B & Ohene-Asa, H. (2023). Combating the Nemesis of a preventable disease. Ghana Web, September 26, 2023

3. Ohene-Asa, H, Danquah, J.B & Yamoah, J.A.A (2023). Rabies Virus: Early Post-exposure Prophylaxis Saves life. Ghana News Agency, September 28, 2023

Thesis

1. Owiredu N. (2023). Public health implications and Antimicrobial Resistance of *Campylobacter* from Chicken and Pigs. Murdoch University, Perth. Australia. PhD Thesis. 192pp

2. Salifu S. (2023). Effects of management systems on the physiological and biochemical biomarkers of stress, productivity and reproductive performance of Djallonke sheep. UDS, Tamale, PhD thesis. 389pp