



COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

Animal Research Institute



2022 ANNUAL REPORT

CONTACT

The Director
CSIR-Animal Research Institute
P.O. Box AH 20, Achimota,
Accra-Ghana

Website: <https://ari.csir.org.gh>

Telephone: 233-30-912178/9

LOCATION

Adenta-Frafraha, off Dodowa Road, near Foster Home, Frafraha, Accra

Editorial Team

Dr. Ebenezer D. O. Ansa

Dr. Franklin Avornyo

Dr. Justice Odoi Opare

Mr. Sadat Salifu

Mr. Collins Antwi

TABLE OF CONTENT

Foreword	5
Executive Summary	6
Introduction	8
Research and Development Activities -2022	9
Food Security and Poverty Reduction: Livestock And Poultry.....	9
Effects of the dietary inclusion of varying levels of paper mulberry (<i>Broussonetia papyrifera</i>) leaf meal on growth performance, nutrients digestibility and carcass characteristics of grower rabbits	9
Phenotypic correlations between post mixing skin injuries and aggressive behaviour in pigs	10
Drive towards small ruminant intensive production: tools and lessons in a sub-humid location in southern Ghana	11
Impact of palm kernel cake with or without multi-blend enzyme on the growth performance and carcass traits of Sasso broilers	12
Influence of corn cob supplemented with either enzyme or flaked oyster mushroom on the growth, carcass, gut health performance, hematology and serum biochemistry of sasso broilers.....	13
Effect of strain and age of layer chickens on proximate contents of egg yolk and albumen	14
Biomedical and Public Health: Animal Health and Biosafety	15
Metagenomic profiling of tick microbiome across the coastal savannah zone of Ghana	15
Epidemiology of respiratory pathogens in poultry in Greater-Accra region, Ghana	16
Awareness and practices relating to zoonoses and safety among livestock farmers in Ghana.....	17
Antimicrobial, Multi-Drug and Colistin Resistance in Enterobacteriaceae in Healthy Pigs in the Greater Accra Region of Ghana, 2022: A Cross-Sectional Study	18
Effective treatment of poultry pathogenic <i>E. coli</i> : infections: antimicrobial susceptibility and extended spectrum beta lactamase profiling.....	19
Antimicrobial Resistance of Enterobacteriaceae Isolated from Chicken in Accra	20
Incidence of blood and meat spots in eggs from a commercial poultry farm	21
Prostaglandin D2 added during the differentiation of 3T3-L1 cells suppresses adipogenesis by dysfunction of D-prostanoid receptor P1 and P2	22
Biocontrol of Methicillin /Vancomycin resistance strains of <i>Staphylococcus aureus</i> and other potential bacterial pathogens along the Cattle value chain in Ghana through Bacteriophage-based technology	23
<i>Campylobacter</i> resistance to fluoroquinolones in Australian Chickens.....	24
Science and People: Technology For Livelihood & Wealth Creation, Value Chain Promotion	25

Profiling fee paying participants of livestock production training programmes: The case of CSIR-Animal Research Institute	25
Assessment of farm welfare conditions and the observance of welfare by cattle farmers in Ghana.....	26
Sensory characteristics of meat from rabbits fed concentrate diets containing Brassica oleracea outer leaves and Musa paradisiaca leaves	27
The effect of different sheep management systems on chronic stress in West Africa Dwarf Sheep	28
Impact of Incubation Temperature Profile on Hatchability, Chick Quality, Chick Bone Development, and Immunological Parameters: Case Study of Cobb 500 Broiler Breeder Eggs.....	29
The quality of white and brown chicken eggs kept under different storage length and storage temperatures	30
Facilitating institutional innovation for sheep and goats value chains in Northern Ghana	31
Summary of Financial Statement - 2022	32
Human Resource Activities - 2022	33
Publications	42

MEMBERSHIP OF NEWLY CONSTITUTED INSTITUTE MANAGEMENT BOARD

- | | |
|---------------------------------|---|
| 1. Prof. Abraham Kwabena Anang | Immediate Past Director, Noguchi Memorial Institute of Medical Research, Legon Ghana (Chairman) |
| 2. Dr. Ebenezer D. O. Ansa | Director, CSIR-ARI |
| 3. Mr. Willaim Awuku Ahiadormey | CEO, Cropcare Ghana Ltd & Former MD, Agricare MOFA, Accra |
| 4. Mr. Willaim Agyei-Manu | Chief Executive Officer, Agrosol Ltd MOFA, Accra |
| 5. Mr. Edwin Bekoe | Director, Animal Production Directorate, MoFA |
| 6. Mrs. Josephine E. Geraldo | Director of Internal Audit, CSIR Head Office |
| 7. Dr. Francis Kusi | Director, CSIR-SARI, (Cognate Director) |
| 8. Mrs. Monica Allotey | Head Administration, CSIR-ARI (Secretary) |

INTERNAL MANAGEMENT COMMITTEE MEMBERS

- | | |
|--------------------------------------|---|
| 1. Dr. Ebenezer D. O. Ansa | Director (Chairman) |
| 2. Dr. Franklin K. Avornyo | Deputy Director |
| 3. Dr. Esther Marfo-Ahenkora | Head, Natural Resource Management Division |
| 4. Mrs. Vida Lamptey | Acting Head, Farmed Animals Technology Division |
| 5. Dr. Yaa Osei Doris | Head, Animal Health Division |
| 6. Dr. Edmund T. Sottie | Head, New Products Development Division |
| 7. Dr. Godwin Ameleke | Head, Livelihood & Innovation Division |
| 8. Ms. Celestine E. Quashie | Head, Commercialization |
| 9. Mr. Arimeyaw Ibn Saeed | Head, Accounts Division |
| 10. Mrs. Monica Allotey | Head, Administration Division |
| 11. Dr. (Mrs.) Sylvia Afriyie Squire | President., Research Staff Association (RSA) |
| 12. Mr. John Nortey | President., Senior Staff Association (SSA) |
| 13. Mr. Jerry Laryea | Local Chairman., Trade Union Congress (TUC) |
| 14. Mr. Collins Antwi | Scientific Secretary/Recorder |
| 15. Ms. Janet Nana Acquaful | Administrative Officer/Recorder |



FOREWORD

The year 2022 would perhaps be remembered in the history of CSIR-Animal Research Institute (CSIR-ARI) as the year of demolition. Heightened illegal land encroachment virtually brought the Research and Development activities of the institute to its knees. Encroachment of CSIR-ARI land has been going on for decades and the institute has been fighting back all these years. From mid-2021 to 2022 however the

encroachment activity took an unprecedented proportion. Land guards armed with knives and guns broke down walls of the institute, destroying donor-funded experiments, destroying animal housing facilities, threatened the lives of the staff and physically assaulted some of them.

On 23rd June 2022, with the support of the Greater Accra Regional Coordinating Council and the Adenta Municipal Assembly, a team of security personnel comprising the Regional Police Command of the Ghana Police Service, the 5th Battalion of the Ghana Armed Forces, the Fire Service, Immigration and Customs under the leadership of the Hon. Henry Quartey conducted a demolition exercise to remove all the illegal structures within the 200-acre fenced portion of the CSIR-ARI lands at Katamanso (Adenta-Frafraha). CSIR-ARI is grateful to the Greater Accra Regional Security Council for upholding the rule of law and good governance. We cannot however overemphasize the major role played by the media and staff of CSIR-ARI in exposing the criminal activities of these thugs. We are also grateful to corporate CSIR and other sister CSIR institutes for their support.

Having removed the illegal structures that the encroachers put up, it is now time for CSIR-ARI to take advantage of the demolition exercise to secure the reclaimed land and also to use it to improve the fortunes of the institute. Forming strategic partnerships with the private sector to scale up the operations of the institute is going to be a major focus. This we believe would enable the institute to site structures along the boundaries of the 200-acre land to secure it against future encroachment. We are grateful to all stakeholders for their patience and support during very trying times.

EXECUTIVE SUMMARY

In 2022, the research and development activities of scientists at CSIR-Animal Research Institute focused on three broad thematic areas of the Institute namely 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 food security and poverty reduction, a feeding trial was conducted to evaluate the effects of the inclusion of varying levels of paper mulberry leaf meal (PMLM) on the performance of rabbits. The results showed that feed costs could be decreased and more profit made as one increases the level of the PMLM and that dietary inclusion of up to 20% could be used in rabbits to reduce feed costs per unit of rabbit weight gain. Another study looked at aggressive behavioural responses in pigs at the weaning stage after supplementing their diets with chicory herbs. The results showed that the herbal diet influenced the behaviour of piglets by making them less aggressive. In a study to determine the influence of corncob supplemented with either enzyme or flaked oyster mushroom as partial substitutes for the expensive conventional grains and protein poultry diets, it was found that total bacterial counts were lower in the diets that contained ground corncobs. Also, birds fed no corncob or corncob treated with enzyme or the oyster mushroom performed better than those whose diets were partially replaced with corncob alone. It was therefore concluded that to improve feed efficiency, body weight and gut performance, corncob diets with multi-blend enzymes supplement were significant. A study on the effect of strain and age of layer chickens on the proximate contents of egg yolk and albumen observed that the protein content of the yolk significantly increased as the birds advanced in age. However, yolk fat content significantly decreased as the birds grew. By their genetic constitution and ages, it was recommended that producers must select the best strains and factor in the appropriate hen ages to make the nutrient contents of eggs meet the specific needs of consumers.

Research on Animal health and food safety was mostly under the one health concept to benefit both humans and animals. These included the characterization of tick-borne pathogenic and non-pathogenic microorganisms across the coastal savannah zone of Ghana to provide information that will contribute to the formulation of effective control measures against tick and tick-borne pathogens. This study revealed that *Amblyomma variegatum* and *Rhipicephalus annulatus* were the most common parasites in farm animals in Ghana. Due to the high morbidity and variable mortalities associated with respiratory disease outbreaks in poultry, a study was conducted to determine the pathogens involved. The results identified five major pathogens; *Mycoplasma gallisepticum* (MG), Infectious bronchitis virus (IBV), New Castle disease virus (NDV), Avian Influenza virus and *Escherichia coli* (*E. coli*) as being responsible for respiratory diseases in poultry in Accra.

The knowledge of livestock farmers regarding zoonoses (diseases transmissible between animals and humans) and safety measures were examined. More than half of the farmers were aware of some zoonotic diseases and farm safety measures however only few practised them. Bacteria resistance to antimicrobials is on the increase globally, impacting negatively treatments in both humans and animals. A study on this showed that bacteria of the *Enterobacteriaceae* family mainly *E. coli* and *Enterobacter* spp. were resistant to antimicrobial agents such as tetracycline (TET), ampicillin (AMP), and amoxicillin/clavulanic acid (AMC). Some bacteria showed multidrug resistance (MDR) which makes them resistant to colistin, a last-resort drug for infection treatment. The researchers suggested that there is a need to review the efficacy and application of TET and AMP in the poultry industry. A very important research study is being conducted to explore the use of bacteriophage (a virus that kills bacteria but is not harmful to humans/animals) to prevent Methicillin-resistant *Staphylococcus aureus* infections. The success of this project will usher in an effective treatment option that will lessen the use of antimicrobial agents.

To better target and design adequate short training programs, researchers profiled past participants in various livestock training programmes offered by CSIR-ARI. Young university graduates with little experience in agriculture were found to highly patronize the training sessions, however, only 20% of women participated.

An assessment of the welfare conditions of cattle farms and cattle farmers' observance of welfare in northern Ghana revealed that most farmers were concerned about the welfare of their cattle in general but placed more premium on their feeding and health while laying less emphasis on their thermal comfort, or their experience of fear and distress.

Finally, a multi-year analysis of the small ruminant value chain produced a set of recommendations for consideration by policymakers in the agriculture sector.

A total of 17 peer-reviewed publications was recorded in the year.

For the financial year, the total operating income was GH 16,526,666.39 and the total expenditure was GH 16,665,784.95 leaving a deficit of 139,118.56

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

FOOD SECURITY AND POVERTY REDUCTION: LIVESTOCK AND POULTRY

Effects of the dietary inclusion of varying levels of paper mulberry (*Broussonetia papyrifera*) leaf meal on growth performance, nutrients digestibility and carcass characteristics of grower rabbits.

A. Osman, U. I. Bashiru, D. Agbesi, Y. Abdul Aziz, K. O. Amoah and E. L. K. Osafo

A ten-week feeding trial was conducted using 25 grower rabbits in a completely randomised design to evaluate effects of the inclusion of varying levels of paper mulberry leaf meal (PMLM) on growth performance, nutrients digestibility and carcass characteristics. The rabbits were of mixed breeds and sexes, aged 8 weeks and weighing between 1000 – 1350 g. PMLM was incorporated into five diets designated T0, T1, T2, T3 and T4 at 0, 5, 10, 15 and 20 % levels of inclusion. Feed intake and live weight changes were monitored throughout the study. A digestibility study was carried out during the sixth week. At the end of the feeding trial, two rabbits per treatment were randomly selected and humanely slaughtered. Hot carcass weight, blood weight, dressed weight, weights of gastrointestinal tract, internal organs and caecum were taken. Dressing percentage was determined by dividing the hot-dressed carcass weight by the slaughter weight and multiplied by hundred. Existing market prices for feed ingredients were used for the economic appraisal of feeds. Results did not show significant differences ($p>0.05$) in live weight changes. However, feed cost/kg and feed cost/kg gain declined with increase in level of PMLM. Digestibility coefficients were similar for all nutrients across the treatments except for ash which improved with increase in level of PMLM. PMLM inclusion also improved dressing percentage without deleterious effects on internal organs. It was concluded that dietary inclusion of PMLM up to 20 % could be used in rabbits to reduce feed cost/kg gain.



Figure 1: Paper mulberry leaf

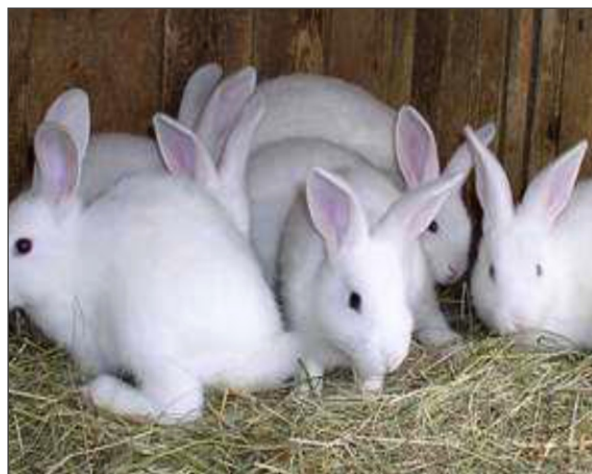


Figure 2: Experimental rabbits

Phenotypic correlations between post-mixing skin injuries and aggressive behaviour in pigs

S.Aikins-Wilson, M.Bohlouli, P. Engel, S. König

The aim of this study was to investigate the behavioural adaptation of pigs in the weaning stage by observing behavioural responses of piglets. In order to predict their future coping style, backtest (BTS) was performed at birth and based on their responses, hundred piglets were classified into low resisters (LR), intermediate resisters (IR) and high resisters (HR). At weaning, piglets were mixed and group into two feeding groups herbal diet (HD; basal diet plus a supplement with chicory herbs) and control diet (CON; basal diet). Individuals' behaviours were observed directly after weaning and at five weeks post-weaning by recording the time of occurrence with the aid of video camera. Statistical analyses were performed to infer fixed and random effect on behaviour traits using the statistical software package R. The lme4 package was applied to fit the linear mixed model for behaviour traits. HR piglets showed more aggressive behaviour than IR and LR piglets, i.e. they performed more fights, initiated fights and delivery fights during the observation period. In the HD environment where diet high in fibre and crude protein was served, ear-tail bites was rarely recorded but rather exploring and lying in contact with others was frequently recorded. In conclusion, our results suggest that herbal diet influenced the behaviour of piglets by becoming less aggressive. This information may provide potential benefits for welfare of pigs, minimise production costs through utilization of cost-effective diet as well as minimizing the physical activity of the pigs.



Figure 1: Diseased tail

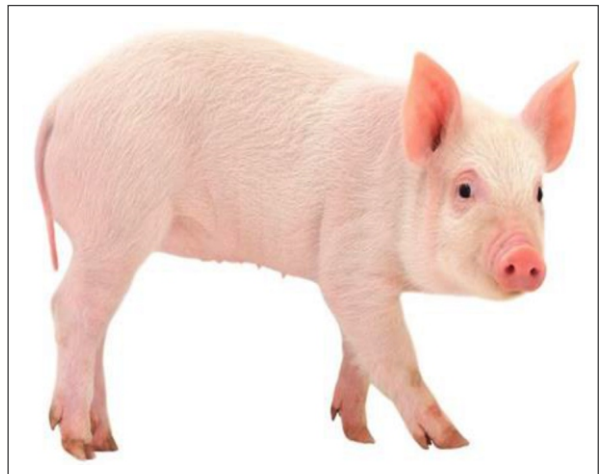


Figure 2: Healthy tail

Drive towards small ruminant intensive production: tools and lessons in a sub-humid location in southern Ghana.

C. Y. F. Domozoro, E. Marfo-Ahenkora, E. T. Sottie

The study aimed at sustainable intensive production of small ruminants in peri-urban communities through feed resource management and nutrient recycling. Thirty Djallonke sheep were confined and intensively raised during the study. All animals were tagged for identification and individual data collection and weighed fortnightly. Backyard pasture comprising *Brachiaria mullato*, *Medicago sativa*, *Manihot esculenta* and bordered by *Gliricidia sepium* were established; feeding was done twice daily. Feed supplied ranged from 3% to 5% body weight and comprised of crumbled Multi-Nutritional Feed Block (MNFB) – (70%), produced using locally available ingredients, fresh forage from *Brachiaria mullato* – (10%), Silage from *Brachiaria mullato*, *Manihot esculentum* leaves, *Medicago sativa* and *Gliricidia sepium* (5%) and fresh fruit peels (15%). Water was provided ad-libitum. The animals were vaccinated against PPR. They were dewormed and ectoparasite controlled. Wood shavings were used as bedding materials; waste materials were composted. New births recorded singles and twins at regular intervals, of 2 crops a year. Time to return to oestrous activity was less than 2 months. Lamb weights at birth ranged between 1.7 – 3 kg, weaning weight at 3 months was greater than or equal to 3 times the birth weights, and survivability was 100%. Time to ewe reproductive maturity 8 - 10 months (attained 80% matured weight). Mean growth rate of 140 (Ram lambs), 115 (Ewes), 86 (Ewe Lambs) and 57 (Rams) g/d was sustained among the flock. Manure processing and nutrient recycling were seen as key to sustainable forage yields and effective feeding however, external nutrient inputs were crucial to maintaining adequate feeding regimes.



Figure 1. Smart livestock housing along self-sustaining pasture field



Figure 2. Healthy lambs and mothers

Impact of palm kernel cake with or without multi-blend enzyme on the growth performance and carcass traits of Sasso broilers

A. A.-A. Koranteng, K. A Gbogbo, B. Adjei-Mensah, T. Bouassi, C. T. F. Aïna, J. Glago and K. Tona

The use of non-conventional feeds could help alleviate competition faced by the poultry industry as the prices of conventional poultry feed ingredients, especially cereals, are continually increasing. Thus, the objective of this study was to evaluate the effect of palm kernel cake (PKC) with or without enzyme on the performance of Sasso X44 broiler chicks. Four hundred and fifty (450) unsexed 21-day-old broiler chicks of homogenous weight were randomly allocated to five dietary treatments in a completely randomized design with six replicates having 15 birds per replicate. Treatment diets comprised the control, PKC0 (basal broiler diet), PKC10 (10% palm kernel cake diet), PKC10+E (10% palm kernel cake + 0.05% enzyme), PKC20 (20% palm kernel cake diet) and PKC20+E (20% palm kernel cake + 0.05% enzyme). Data were collected on feed intake, body weight gain, feed conversion ratio (FCR), and carcass parameters. Results revealed that birds in the PKC10+E group had an improved ($p<0.05$) FCR compared to the control group at the grower phase. At the finisher phase, the PKC20+E group consumed the highest feed ($p<0.05$), which was significantly different from the other treatment groups except for the PKC10+E treatment group. Average daily body weight gain was highest for birds fed PKC10+E diet, which, was significantly different ($p<0.05$) from birds fed PKC20 diet. The percent dressed weight was significantly superior ($p<0.05$) for birds fed PKC10+E and PKC10 relative to PKC20. Sasso broilers could therefore benefit from a diet partially replaced with 10% palm kernel cake incorporated with multi-blend enzyme.



Figure 1: Palm kernel cake and milled Palm kernel cake



Figure 2: Sasso day-old chicks and 12-week-old broiler

Influence of corncob supplemented with either enzyme or flaked oyster mushroom on the growth, carcass, gut health performance, hematology and serum biochemistry of sasso broilers

A. A-A. Koranteng and K. A. Gbogbo

Owing to the high cost of grains and protein, poultry nutritionists need to consider alternative feed sources from non-conventional, agro-industrial by-products to feed poultry. These non-conventional feed sources are relatively high in fibre and usually impede the smooth digestive process. This study investigated the use of ground corncobs (GCC) as an alternative fibre source for the 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 six replicates with 15 birds per replicate in a completely randomized design. Four experimental diets were formulated: C0 (Control diet), C1 (10% GCC), C2 (10% GCC + 0.05% multi-blend enzyme), C3 (10% GCC + 0.5 % flaked oyster mushroom (FOM)). The results revealed that total coliform counts were significantly low ($p<0.05$) in the GCC diet groups regardless of additive inclusion at 8 weeks and throughout the study period, *Streptococcus spp.* counts of the C1 group were lower ($p<0.05$) than the control group. Birds fed the C0, C2 and C3 diets were more efficient ($p<0.05$) in feed conversion in comparison with those fed the C1 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 heavier in the birds of the C2 group compared with the C1 group. It is therefore beneficial to supplement corncob diets with multi-blend enzymes to improve feed efficiency, body weight and gut performance.

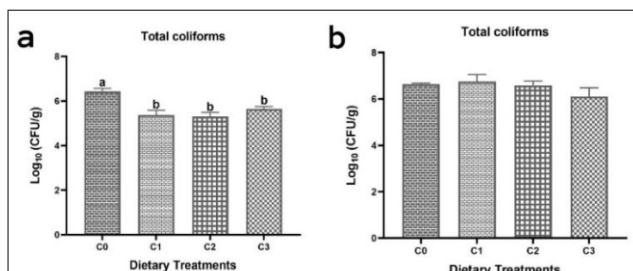


Figure 1: (a, b): a – Total coliform counts at 8 weeks. b – Total coliform counts at 12 weeks, Letters indicate significance at $p<0.05$. C0 (basal broiler diet), C1 (10% GCC diet), C2 (10% GCC diet with 0.05% multi-blend enzyme), C3 (10% GCC diet with 0.5% FOM)

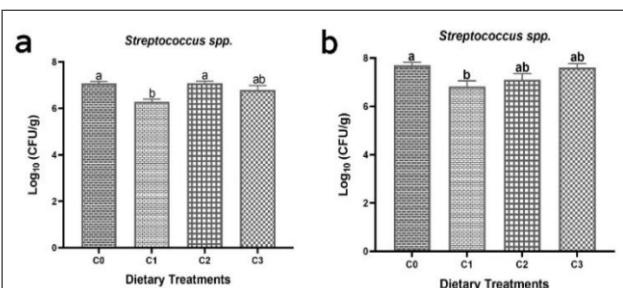


Figure 2 (a, b): a – *Streptococcus spp.* counts at 8 weeks. b – *Streptococcus spp.* counts at 12 weeks. Letters indicate significance at $p<0.05$. C0 (basal broiler diet), C1 (10% GCC diet), C2 (10% GCC diet with 0.05% multi-blend enzyme), C3 (10% GCC diet with 0.5% FOM)

Effect of strain and age of layer chickens on proximate contents of egg yolk and albumen

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

This research assessed the effects of strain and age on the proximate compositions of egg yolk and albumen of domestic chicken. A total of 504 eggs were used in a 3 X 3 factorial experiment involving the Lohmann white, Lohmann brown and White Leghorn which were 31, 40 and 53 weeks old using a completely randomised design (CRD). Data obtained were subjected to two-way analysis of variance (ANOVA) using the general linear model (GLM) procedure. Differences in means were separated using Tukey pairwise comparisons method at 5% significance level. The results show that eggs from the Lohmann layers have significantly more protein but lower fat content in the yolk than the White leghorn ($p < 0.05$). Albumen protein was slightly higher in the White leghorn; while albumen fat was lower in the white strains than the Lohmann brown. Protein content of egg yolk significantly increased but albumen protein was not affected as the birds aged. Yolk fat significantly decreased as the birds grew but albumen fat was not substantially affected by age of the hens. There was significant effect of strain by age interaction on yolk and albumen protein contents but not on their fat content across the chicken groups. There are variations in the proximate contents of egg yolk and albumen of layer chickens by virtue of their genetic constitution and ages; so, eggs must be produced from the best strains at the appropriate hen-ages to make their nutrient contents meet the needs of specific consumers and products.



Figure 1: Burning egg yolk and albumen into ash in a furnace

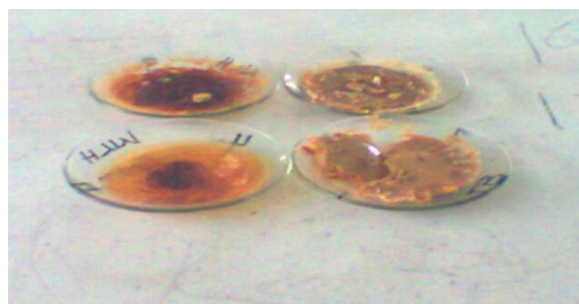


Figure 2: Oven-dried egg yolk and albumen

BIOMEDICAL AND PUBLIC HEALTH: ANIMAL HEALTH AND BIOSAFETY

Metagenomic profiling of tick microbiome across the coastal savannah zone of Ghana.

J. A. Afrifa Yamoah, K. D. Kwofie, D. Ladzekpo, K. Boateng Yeboah, J. Beyuo, A. V. Keleve, C. Tawiah-Mensah, J. Ansah-Owusu, S. Dadzie, P. A. Wallace, N. Tsuji and H. Takeshi

The tick microbiome comprises a variety of microorganisms, including viruses, bacteria and eukaryotes. Despite the extensive studies on tick microbiome in most parts of the world, Ghana has limited information available on the diversity of tick species that infest livestock and their associated microbial diversity. Hence, the aim of this study is to survey and characterise tick-borne pathogenic and non-pathogenic microorganisms across the coastal savannah zone of Ghana. To achieve this, tick samples collected from ruminants from selected districts of the Greater Accra Region were morphologically identified by microscopic means. Genomic DNA was also extracted from the ticks. Morphologically identified ticks from farm animals include *Amblyomma variegatum*, *Rhipicephalus annulatus*, *Rhipicephalus appendiculatus*, and *Hyalomma impressum*. *A. variegatum* (444/805) and *R. annulatus* (292/805) were the predominant species across all the study sites. The Adentan district had the highest tick burden (197/805) among cattle. *R. appendiculatus* (80/86) was the major tick species identified among the small ruminants. Of the 200 ticks analysed by conventional Polymerase Chain Reaction (PCR) targeting the 16S rRNA and 18S rRNA genes, 194 and 198 ticks were infected with bacteria and protozoans, respectively. The cytochrome c oxidase subunit 1 of the mitochondrion was targeted for PCR for the confirmation of the morphologically identified ticks. However, Sanger sequencing of these PCR amplicons and metagenomic data analysis of tick DNA for microbiome profiling is currently ongoing. Data generated from this study will contribute to the formulation of effective control measures against ticks and tick-borne pathogens.

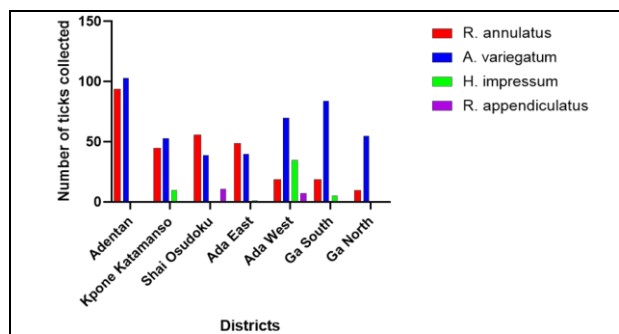


Figure 1: Distribution of ticks species on cattle across the different study sites by morphological approach

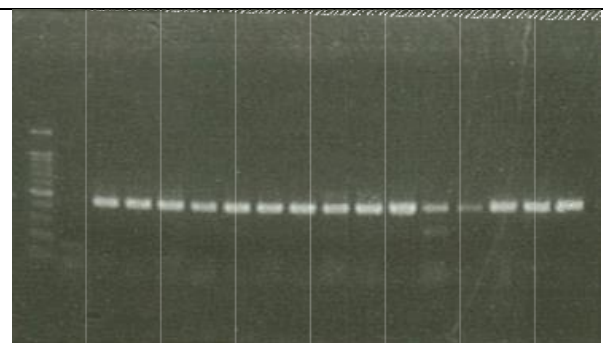


Figure 2: Detection of tick-borne pathogens in tick using conventional PCR targeting 16S rRNA gene

Epidemiology of respiratory pathogens in poultry in Greater-Accra region, Ghana

H. Ohene-Asa, R. Ohene-Larbi, D. Owusu-Ntummy and M. Ayim-Akonor

Respiratory disease outbreaks remain a major concern to the global poultry industry due to the high morbidity and variable mortalities associated with them. Respiratory diseases are caused by a myriad of pathogenic agents such as bacteria, viruses, and fungi. Clinical signs seen in poultry during respiratory disease outbreaks are indistinguishable from each other. To determine the major pathogens involved in respiratory disease outbreaks in commercial poultry in the Greater-Accra region, 140 samples were taken from birds on 7 farms that were confirmed to have outbreak of respiratory disease. Samples were analysed using ELISA, PCR and bacterial culture to identify 5 major pathogens responsible for respiratory diseases on the farms; *Mycoplasma gallisepticum* (MG), Infectious bronchitis virus (IBV), New Castle disease Virus (NDV), Avian Influenza and *Escherichia coli* (E.coli). Prevalence of MG (37.9%), IBV (26.4%), NDV (25.7%), and E.coli (20%) was recorded. Chi-square analysis showed a statistically significant ($p < 0.05$) association between poultry farms with respiratory disease outbreaks and the identification of at least two pathogenic causes in affected birds. The coinfection rate of two of the pathogens per farm will be determined. Results from this study will provide baseline data for the extension of the study to other regions in Ghana.



Figure 1: Sample collection on farm



Figure 2: Bacteria culture and isolation

Awareness and practices relating to zoonoses and safety among livestock farmers in Ghana

S. A. Squire, H. O. Asa, N. Mensah, D. Takyiakwaa and E. T. Sottie

Zoonoses are diseases, naturally transmissible between vertebrate animals and humans. Livestock farming is a major contributor to zoonoses and therefore livestock farmers are at high risk. To provide baseline data on livestock farmers' awareness of zoonoses and farm-related safety and promote zoonoses prevention and safety culture among the farmers, 150 livestock farmers from the Coastal Savannah agroecological zone of Ghana were interviewed using structured and open-ended questionnaires for information on their knowledge, attitude and practices in relation to zoonoses and farm safety. The farmers were mostly (78.7%) males while 21.3% were females. Although 65.3% of the farmers were aware of the potential zoonoses transmission from animals to humans, 34.7% were not aware. About 6.7% to 61.3% of the farmers had never heard about at least one zoonotic diseases or pathogen such as avian influenza, zoonotic tuberculosis, anthrax, rabies, zoonotic intestinal worms, and some ectoparasites. Also, 25.3% to 70.0% of the farmers were not aware of zoonotic potential of at least one of the diseases. Majority of the livestock farmers were not aware of basic safety measures on the farm and among those who had some knowledge, few practiced them. To increase livestock farmers awareness on zoonoses, antimicrobial resistance and farm safety, workshops were organised, and user-friendly education leaflets were developed, printed, and distributed. To reduce the risk of zoonoses among farmers and their families, further studies that will include testing and treatment of farmers and their animals for specific zoonoses and more awareness creation is recommended.



Figure 1: Questionnaire interview on a cattle farm at Lutta in the Ada West District



Figure 2: Awareness creation workshop at Kpeyibor in the North Tongu District

Antimicrobial, Multi-Drug and Colistin Resistance in *Enterobacteriaceae* in Healthy Pigs in the Greater Accra Region of Ghana, 2022: A Cross - Sectional Study

R. Ohene Larbi, W. Adeapena, M. Ayim-Akonor, E. D. O Ansa, H. Tweya, R. F. Terry, Labi A-K Labi, and A.D Harries

There is little published information on antimicrobial resistance (AMR) in animals in Ghana. We determined the prevalence and factors associated with AMR, multi-drug resistance (MDR-resistance to ≥ 3 antimicrobial classes) and colistin resistance in *Enterobacteriaceae* in healthy pigs in Accra, Ghana. Rectal swabs obtained from the pigs on 20 farms from January to March 2022, were examined for *Escherichia coli*, *Enterobacter spp.* and *Klebsiella pneumoniae*. AMR was determined using standard microbiological techniques and the *mcr-1* gene detected through molecular analysis. *Enterobacteriaceae* were isolated from 197 of 200 pigs: these comprised 195 *E. coli* isolates, 38 *Enterobacter spp.* and 3 *K. pneumoniae*, either singly or combined. Over 60% of *E. coli* were resistant to tetracycline, with 27% and 34% being resistant to amoxicillin/clavulanic acid and ampicillin, respectively; 23% of *E. coli* and 5% of *Enterobacter spp.* exhibited MDR phenotypes. Phenotypic colistin resistance was found in 8% of *E. coli* and *Enterobacter spp.*, with the *mcr-1* gene detected in half. Our study findings should be incorporated into on-going AMR, MDR and colistin resistance surveillance programs in Ghana. We further advocate for tailored-specific education for pig farmers on animal antimicrobial use and for strengthened regulatory policy on antimicrobial usage and monitoring in the animal production industry.



Figure 1 Rectal swab collection from a pig

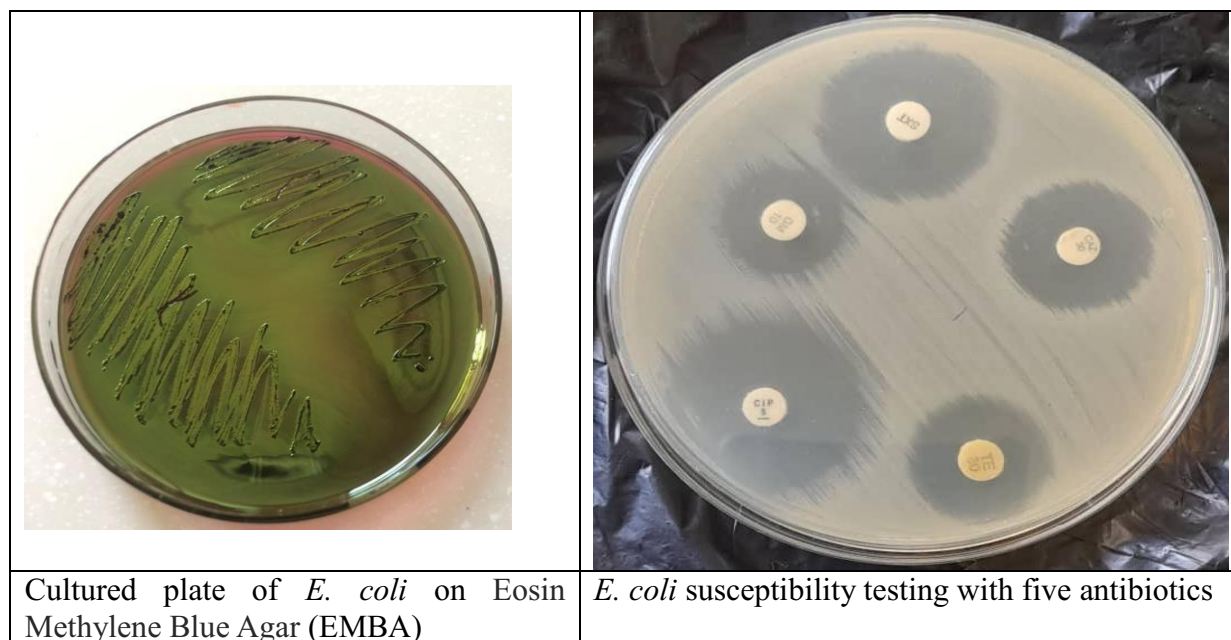


Figure 2 Plating out cloacal samples at the Lab.

Effective treatment of poultry pathogenic *E. coli*: infections: antimicrobial susceptibility and extended spectrum beta-lactamase profiling

M. Ayim-Akonor, R. Ohene Larbi, B. Sasu, D. D. Owusu-Ntumy, H. Ohene Asa and T. Odoom

Bacteria resistance to antimicrobials is on the increase globally, impacting negatively in treatments in both humans and animals. Nevertheless, information on antimicrobial resistance (AMR) in livestock-associated pathogenic bacteria in Ghana is scanty. From April -July, 2021, we isolated *E. coli* from choanal swabs of poultry with respiratory disease (RD) from seven farms in Accra using standard culture and biochemical techniques. Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method according to the Clinical and Laboratory Standards Institute guidelines, using eight antimicrobials: ampicillin (AMP), tetracycline (TET), sulfamethoxazole-trimethoprim (SXT), ciprofloxacin (CIP), chloramphenicol (CHL), amoxicillin/clavulanic acid (AMC), gentamicin (GEN) and ceftazidime (CAZ). The double-disk synergistic test and CHROMagar-Extended Spectrum Beta Lactamase (ESBL) were used to screen isolates for ESBLs. None of the 28 isolates obtained from five farms produced ESBLs. All isolates were susceptible to CAZ but resistant to AMP, equally high resistance to TET (96.4%), SXT (89.3%) and CIP (71.4%) were observed, with minimal resistance to GEN (17.9%). Most isolates (78.6%) exhibited multidrug resistance of which 22.7 and 4.5% were to six and seven antimicrobial classes respectively. TET/CIP/AMP/CHL/SXT/AMC accounted for 80% of antibiogram patterns of isolates resistant to six antimicrobial classes. GEN-containing-antimicrobials could be a suitable agent for treating *E. coli*-associated RD in Greater Accra. Continuous monitoring and evaluation of AMR in livestock-associated pathogens in Ghana is recommended.



Antimicrobial Resistance of *Enterobacteriaceae* Isolated from Chicken in Accra

R. Ohene Larbi, D. Owusu-Ntummy, H. Ohene-Asa and M. Ayim-Akonor

In Ghana, poultry farmers use a wide range of readily available antimicrobials (AM) during production for treatment and/or prophylaxis, with little to no supervision. This frequent usage could serve as a selection pressure, driving resistance build-up of microbes to commonly used AM. In this study, we aimed to determine the resistance of *Enterobacteriaceae* in poultry and assess the trends of AM usage on poultry farms in Accra. From 40 poultry farms in the Adentan Municipality and Shai Osudoku district, we collected cloacal swabs from 10 birds per farm between November 2021 and September 2022. Standard culture and biochemistry were used to isolate and identify. Basic farm characteristics and AM usage on farm were documented through questionnaire administration. A total of 142 isolates have been obtained so far with *Escherichia coli* being the predominant bacteria. Antimicrobial susceptibility of these isolates were determined by the disc diffusion method according to Clinical and laboratory Standard Institute guidelines using 11 AM. Multidrug resistance was detected in 72.5% isolates. Of this proportion, 22% were resistant to between six and eight antimicrobials. Tetracyclines and ampicillins recorded over 80% resistance compared to the other tested AM. These two classes of AM have been used in poultry and livestock worldwide for several decades. However, the current results indicate the need to review their efficacy and application in the poultry industry. By the end of the study, recommendations will be made with regards to what steps can be taken based on the overall results obtained.



Antimicrobial Sensitivity Testing of bacterial isolates



Cloacal sample collection from a chicken

Incidence of blood and meat spots in eggs from a commercial poultry farm

M. Boateng, P. Y. Atuahene, K. O. Amoah , Y. O. Frimpong and D. B. Okai

The study was conducted in two phases simultaneously in a commercial poultry farm to ascertain whether egg weight, temperature variation in pens and proximity of birds to a noise source had an influence on the incidence of blood and meat spots in chicken eggs. Phase one involved the random sampling of 60 eggs per week for 15 weeks, making a total of 900 eggs from the pens of a 50-week-old layer strain. Phase two determined the effect of noise from a 3.3 kW electrical gasoline generator on the incidence of blood and meat spots. It lasted for 14 weeks and involved the random sampling of 10 eggs per week directly from two pens (i.e., A & D). Pen A and D were 4.7 m and 68 m away from the noise source respectively. A Chi-square test was conducted to establish the relationship between the parameters, whilst a Cramer's V test was used to determine the extent of association where differences were deemed significant ($p < 0.05$). Out of the 1040 eggs collected, 63% of the eggs had spots (32% blood spots and 31% meat spots). No association was observed between the occurrence of spots and egg weight, temperature variation and proximity of birds to a generator.



Figure 1: Blood spot on a yolk

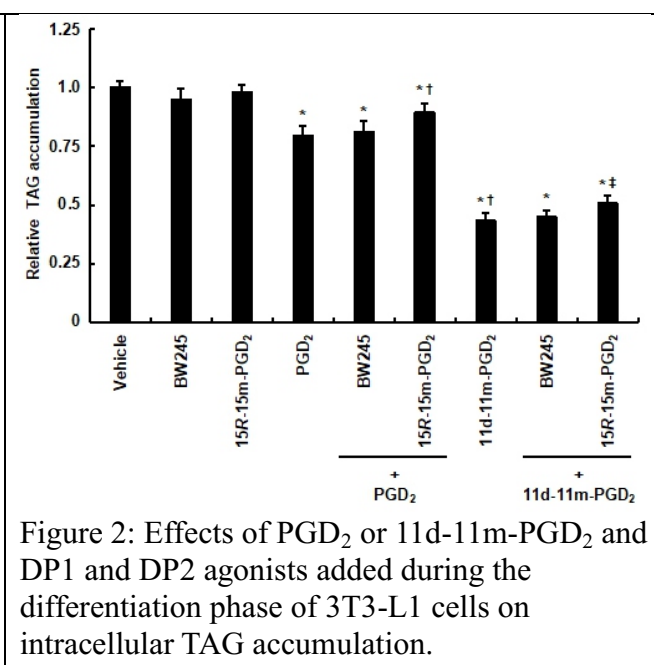
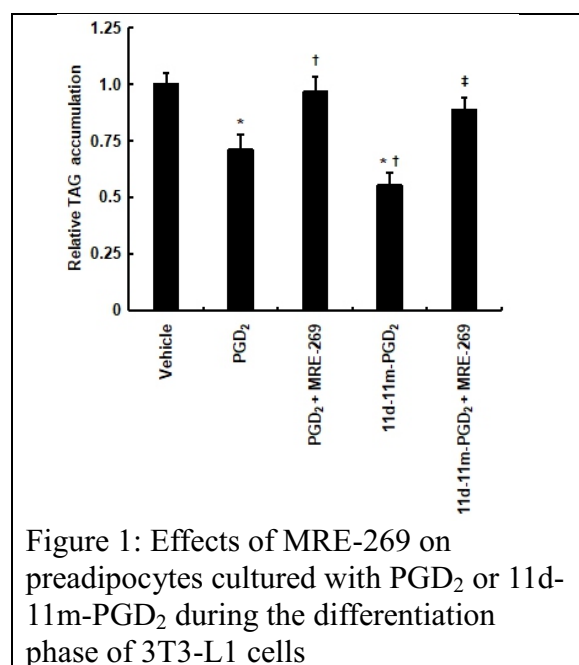


Figure 2: Meat spot in an albumen

Prostaglandin D₂ added during the differentiation of 3T3-L1 cells suppresses adipogenesis by dysfunction of D-prostanoid receptor P1 and P2

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

We previously reported that adding prostaglandin (PG)D₂ and its chemically stable analog 11-deoxy-11-methylene-PGD₂ (11d-11m-PGD₂) during the maturation phase of 3T3-L1 cells pro-mote adipogenesis. The present study aimed to elucidate the effects of adding PGD₂ or 11d-11m-PGD₂ to 3T3-L1 cells during the differentiation phase on adipogenesis and its mechanism of action. We found that both PGD₂ and 11d-11m-PGD₂ suppressed adipogenesis. However, the latter suppressed adipogenesis more potently than PGD₂ probably because of its higher resistance to spontaneous transformation into PGJ₂ derivatives. Additionally, this anti-adipogenic effect was attenuated by coexistence of an IP receptor agonist, suggesting that the effect depends on the intensity of signaling from IP receptor. The D-prostanoid receptors 1 (DP1) and 2 (DP2; also known as chemoattractant receptor-homologous molecule expressed on Th2 cells) are receptors for PGD₂. The inhibitory effects of PGD₂ and 11d-11m-PGD₂ on adipogenesis were slightly attenuated by a DP2 agonist. Furthermore, PGD₂ and 11d-11m-PGD₂ added during the differentiation phase reduced DP1 and DP2 expression during the maturation phase. Overall, these results indicated that PGD₂ or 11d-11m-PGD₂ added during the differentiation phase suppresses adipogenesis by dysfunction of DP1 and DP2. Therefore, unidentified receptor(s) for both molecules may be involved in suppressing adipogenesis.



Biocontrol of Methicillin /Vancomycin resistance strains of *Staphylococcus aureus* and other potential bacterial pathogens along the Cattle value chain in Ghana through Bacteriophage-based technology

M. N. N. Nartey, E. Agbemaflle, M. Ayim-Akonor, R. Larbi, C. K. Setsoafia Saba, M. Owusu, C. Dapulinga, and M. Clokie

Food can easily become a source of human infection caused by microbes including antimicrobial-resistant (AMR) bacteria due to contamination during production, collection, transportation and processing. Methicillin-resistant *Staphylococcus aureus* (MRSA) has emerged as a significant pathogen with zoonotic potential that could have devastating consequences on the health and well-being of animals and humans. The aim of the research is to obtain information on prevalence of *Staphylococcus aureus* and MRSA in Ghana and to enhance the cattle value chain through management of bacterial diseases using bacteriophage-based technology.

A cross-sectional study will be conducted in Southern, Middle and Northern ecological zones of Ghana and cattle farms will be selected based on farmers' willingness, and availability of lactating cows. Samples will be taken from farm floor sweepings, raw milk, swabs of farm handlers, butchers, raw beef, contact surfaces at abattoirs, cow dung, cattle skin swab and Wagashi. Bacteriophage isolation and characterization as well as field trial experiments and food application strategies will be performed. Preliminary results have shown promising phage candidates for *Pseudomonas putida*, *Bacillus cereus* and *Enterococcus cloacae*. It is expected that at the end of the study there would be better understanding of the prevalence level of methicillin/vancomycin resistance strains of *Staphylococcus aureus* along the cattle value chain. Bacteriophage cocktail products will be formulated and their effectiveness evaluated. Development of an innovative biodegradable packaging materials with lytic bacteriophages fixed to inner lining coating will help reduce post processed pathogenic bacterial contamination of meat products.



Figure 1: Team members isolating bacteriophage at CSIR, Food Research Institute

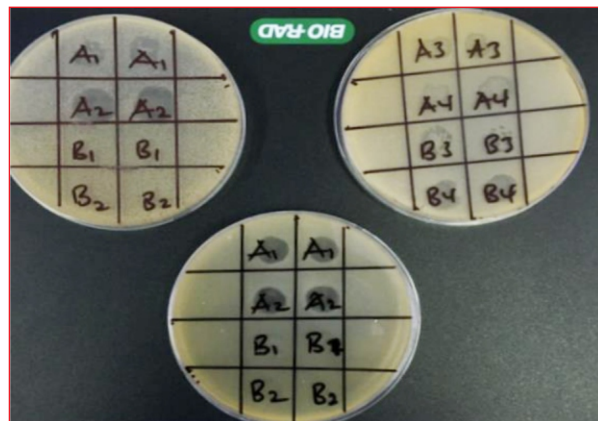


Figure 2: Promising phage candidates for *Pseudomonas putida*, *Bacillus cereus* and *Enterococcus cloacae* shown by clear inhibition zones

***Campylobacter* resistance to fluoroquinolones in Australian Chickens**

N. Owiredu, H. S. Allison, M. Burton, J. Blinco, K. Hewson, S. Sharpe, T. Pavic, D. Jordan, S. Abraham and R. Abraham

Fluoroquinolones (FQ) are not used in animal production in Australia. However, in 2016, a survey of meat chickens reported the emergence of FQ resistance in *Campylobacter*. Therefore, this study was conducted as an update to FQ resistance as well as elucidate the genomic diversity of *Campylobacter* from Australian chickens. In a structured survey of major chicken meat producers across Australia, 200 pooled chicken caecal samples were analysed for *Campylobacter* spp. *Campylobacter* was isolated as per the AS 5013.6-2015 method using *Campylobacter* selective Bolton broth. Antibiotic concentrations were prepared on a robotic platform and isolates tested against 11 antimicrobials using the broth microdilution technique. A total of 178 individual *Campylobacter* isolates were obtained from the 200 pooled caecal samples (115 *C. jejuni* and 63 *C. coli*). Antimicrobial resistance patterns were based on the epidemiological cut off values. A wide genetic diversity of 29 sequence types (ST) for *C. jejuni* and 12 ST for *C. coli* was observed. The FQ resistant ST detected include ST 10130, 2083, 2895 (*C. jejuni*) and ST 825, 827 (*C. coli*). There was an overlap of ST between chicken and human campylobacter cases emphasizing the role of chicken in Campylobacteriosis. Although at low rates, FQ-resistance still persisted. Humans, pests and vehicles were suggested as possible means of spread to poultry farms. Longitudinal study may help to narrow down on the reason for persistence of FQ resistance in the absence of use.

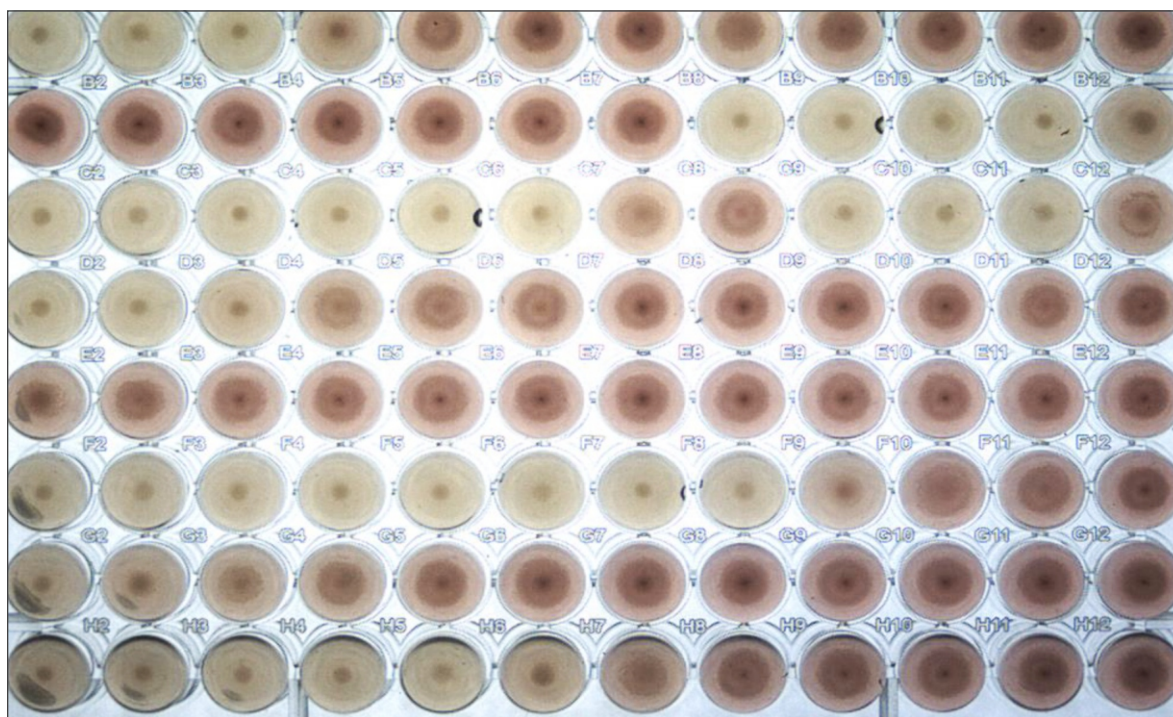


Figure 1: Image of a drug plate showing *Campylobacter* growth (MIC) in the presence of different antibiotics and at different concentrations during testing for antimicrobial susceptibility

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

Profiling fee paying participants of livestock production training programmes: The case of CSIR-Animal Research Institute

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

Training is one of the ways of introducing new technologies to farmers and getting them to use it. Such training may be sponsored by organizations and projects or paid for by trainees themselves from their own pockets. This group of people who pay from their own pockets are arguably better motivated to take up the technologies. Yet, they form the smaller percentage of training recipients, so they must be encouraged to enrol in training programmes. This can be done by better targeting prospective customers. In this study, we profiled clients who participated in CSIR-ARI livestock training programs using administrative data collected between 2020 to 2022, descriptive statistics and cluster analysis. We found that female participants were just about one-fifth of all participants. Participants were relatively young with a quarter of them falling within 20 – 49 years. A tenth were over 60 years. The majority of participants had tertiary education. Similarly, 75% of the participants had primary occupations other than farming and had little or no experience in the commodity they requested to be trained in. About 7 in 10 participants came from Greater Accra and Eastern Region while the rest came from five other regions of Ghana. The cluster analysis revealed two clusters or segments of clients. Furthermore, it showed that age and experience of participants significantly helped in the grouping of participants into clusters. Thus, to better target clients, training programmes should be designed to suit the different needs of clients with little or no experience and those with some experience. The different needs of the elderly and younger participants should be identified and catered for.



Fig 1. Advert for training in grasscutter production



Fig 2. Participant receiving certificate after training

Assessment of farm welfare conditions and the observance of welfare by cattle farmers in Ghana.

J. W. S. Mogre, F. Adzitey, and G. A. Teye

The objectives of the study were to assess farm welfare conditions and the observance of welfare by cattle farmers in Ghana. The study applied field approaches to gather and analyse data. Data was collected from farms in the Northern, North East and Savanna regions. A total of three hundred and eighteen (318) cattle farmers were interviewed using semi-structured questionnaire. Farm observations and focus group discussions were also used to obtain data or verify some of the responses from the cattle farmers. Data collected was classified and summarized based on the information provided. The study found evidence that most farmers were concerned about their animal's welfare but did not place equal weight on the five freedoms of animal welfare. Farmers placed the most premium on freedom from hunger, malnutrition, and thirst (95%), and freedom from pain, injury and disease (90%). Farmers placed less premium on their animals' freedoms from fear and distress (50%), and freedom from physical and thermal discomfort (50%). The freedom to express normal patterns of behaviour (0%) was not considered by the farmers. Observance of animal welfare by cattle farmers was relatively below the E.U acceptable standards and government interventions are needed to improve animal welfare in Ghana.



Figure 1: Cattle taken out for grazing



Figure 2: Cattle closely loaded for long distance trips.

Sensory characteristics of meat from rabbits fed concentrate diets containing *Brassica oleracea* outer leaves and *Musa paradisiaca* leaves

D. Y. Osei, S. Obeng Apori, J. K. Hagan, N. Asuming Bediako, D. Amedorme and P. Asiedu

Two experiments were conducted to investigate the effect of incorporating levels of *Brassica oleracea* outer leaves and *Musa paradisiaca* leaves on sensory characteristics of rabbit meat. In each experiment, forty-eight (48) eight-week-old rabbits were randomly allotted to four treatments of concentrate diets with 0, 10, 20 and 30% inclusion levels of *Brassica oleracea* outer leaves and *Musa paradisiaca* leaves. Six rabbits were randomly selected from each treatment group and used for sensory evaluation at the end of a 12-week feeding period. Muscle samples were collected from the longissimus dorsi of the carcasses, pan-fried using 300 ml of Frytol ® vegetable oil at 170 ° C for 10 minutes. Thirty evaluators conducted the sensory evaluation according to the consumer acceptance and preference testing technique on a nine-point hedonic scale comprising appearance, flavour, colour, mouth-feel, taste, texture and overall acceptability. Generally, the sensory characteristic scores for the meat samples support the evaluators' acceptability of the meat from rabbits fed the various diets. However, in specific terms, meat from rabbits fed diets containing 10 and 30% *Brassica oleracea* outer leaves and 20% *Musa paradisiaca* leaves tended to have higher sensory scores over meat from rabbits fed diets of the other inclusion levels of the leaves in the sensory attributes measured. The results of the study also suggest that feeding concentrate diets containing *Brassica oleracea* outer leaves and *Musa paradisiaca* leaves at 30% inclusion level resulted in the production of rabbit meat at a lower cost than feeding concentrate diets alone and acceptable to consumers.



Figure 1: Meat samples for sensory evaluation



Figure 2: Sensory evaluation of rabbit meat

The effect of different sheep management systems on chronic stress in West African Dwarf Sheep

S. Salifu, T. Ansah, L.L Abdul-Rahman

Chronic stress was assessed in Djallonke sheep flocks raised under different management systems using hair and blood cortisol, immunological parameters, and blood physiological adaptive profiles as tools. The sheep raised under intensive management were zero-grazed, kept in shaded confinement and fed 200g of concentrate and hay ad libitum daily; those under semi-intensive management received 100g of concentrate daily prior to grazing natural pasture. Those under extensive management were allowed to roam freely and consume only natural pasture without supplementation while tethered sheep were tied at selected spots to graze natural pasture throughout the daytime without extra feed supplementation. Serum cortisol and hair cortisol deposits, neutrophil:lymphocyte (N:L) ratios, total proteins, and liver enzymes (AST, ALT and GGT) were measured and subjected to statistical analysis using the general linear model, fitting management system, season and their interaction. Cortisol in both serum and hair were significantly higher in tethered and extensively managed sheep (36.9ng/mg and 30.7ng/mg) compared to sheep under the intensive system and semi-intensive system (18.8ng/mg and 21.6ng/mg)($P < 0.001$). The N: L ratios were highest in tethering and lowest in intensive sheep. Sheep reared under intensive and semi-intensive management however had significantly higher Hb, glucose and total protein compared to the extensive system and tethering. The extensive system and tethering exerted more stress on sheep compared to the semi-intensive and intensive systems which reflected in hormonal and biochemical indicators of chronic stress. Ameliorative measures targeting nutritional and heat stress may reduce stress levels in sheep under the extensive system and tethering.

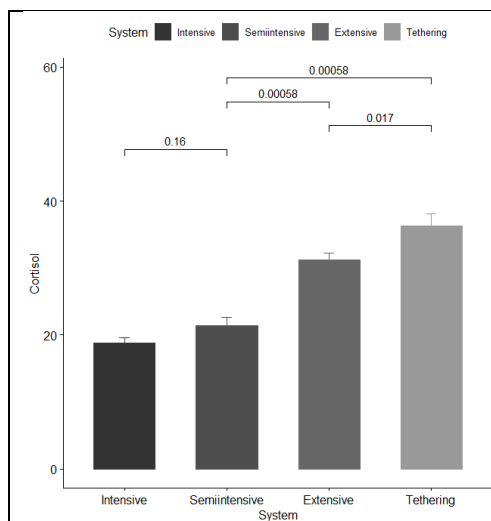


Figure 1: Effect of management systems on hair cortisol levels in Djallonke sheep



Figure 2: Shaved sheep hair for cortisol

Impact of Incubation Temperature Profile on Hatchability, Chick Quality, Chick Bone Development, and Immunological Parameters: Case Study of Cobb 500 Broiler Breeder Eggs

G. Agyekum, M. A. Okai, J. K. Tona, A. Donkoh and J. A. Hamidu

The present study examined the impact of incubation temperature profile on embryonic growth and chick quality post-hatch. Hatching eggs ($n = 405$) were incubated in a Jamesway PS-5000 single-stage incubator at 37.5°C and 56% RH until embryonic day 14 (**ED14**) when 135 eggs each were transferred into 3 identical G.Q.F. MFG. CO incubators, and each set to one of the following incubation temperatures: 36.5°C , 37.0°C , and 37.5°C . Data on eggshell temperature (**EST**) and embryo quality were collected from ED15 to ED20. At hatch, chick quality and leg bone qualities were assessed. Blood collected from chicks was used to assess hematological and immunological parameters. The remainder of the chicks was reared on standard broiler feed for 8 wks to measure growth performance. Data were analyzed using the SAS Proc. GLM at $P \leq 0.05$. The daily EST was higher at 37.5°C incubation temperature compared to 36.5°C and 37.0°C during ED15 to ED21. Chicks of 37.5°C had early external pipping and hatching times compared to 36.5°C . There were no significant differences in external chick quality parameters. The chick leg bone Ca and P levels increased with increasing incubation temperature at day old, 4 wks, and 8 wks. Besides mean corpuscular hemoglobin and concentration, which were higher at 37.5°C compared to 36.5°C and 37.0°C , real blood parameters measured were not different. Bone mineral levels may not be the same as bone development. Therefore, appropriate incubation and nutritional strategies are needed to increase bone development, and broiler growth to reduce leg problems.



Figure 1: Measuring of Femur of the embryo



Figure 2: Measuring of the Eggshell Temperature.

The quality of white and brown chicken eggs kept under different storage length and storage temperatures

F. Kruenti, K. J. Hagan, A. M. Okai and K. V. Lamptey

This work evaluated the effects of egg colour and storage conditions on quality traits of chicken eggs. 336 eggs were randomly picked from a flock of white and brown hens and classified into 4 groups of storage length (0, 7, 14 and 21 days) and 2 temperature groups (ambient and refrigeration). Data was analysed with the two-way Analysis of Variance embedded in the General Linear Model procedure of Minitab (version 18). Differences in means were separated using the Tukey Pairwise Comparisons Method at 5% significance level. The white eggs (58.5g) were significantly heavier than the brown eggs (55.3g). Storage length did not affect egg weight, but eggs stored at room temperature were 1.4g lighter. Egg colour x storage length and egg colour x storage temperature interactions significantly affected egg weight loss but the interactions did not affect the weight of the eggs and the shell quality traits. Egg colour and storage conditions significantly influenced yolk height and yolk weight. Albumen weight decreased as the storage was prolonged but was higher under refrigeration (27.3g) than room temperature (25.6g). Egg yolk was deeper in the brown (5.9) than white (3.4) eggs, deeper in the refrigerated eggs but varied irregularly with storage length. The interactions of yolk height was significantly influenced except for the egg colour x storage length interaction. The storage length x storage temperature interaction significantly affected Yolk pH. Eggs should be kept cold, but not more than 7 days because their quality can be affected under inadequate storage conditions.



Figure 1: Separation of egg yolk from the albumen (egg white)



Figure 2: Measurement of albumen height

Facilitating institutional innovation for sheep and goats value chains in Northern Ghana

F. K. Avornyo, M. T. Shaibu, A. A. Ayantunde, E. K. Panyan and M. A. Ahiagbe

The objective of this project was to develop a framework for the small ruminant value chain in Ghana. Relevant stakeholders were consulted to develop the framework and the following agreements were made:

- 1) There should be a National Unit in charge of Livestock Value Chain Development
- 2) Livestock actors should form cooperatives from the community level up to the National level
- 3) There must be a strengthening of the legal and regulatory framework of the livestock sector
- 4) Food-feed crops should be promoted as well as the establishment of pastoral areas with serviced corridors
- 5) Subsidized feed processing and meat processing equipment should be promoted together with model housing
- 6) Livestock production should be intensified and diversified to give milk, manure and hide in addition to meat
- 7) Neighborhood watch groups, market committees and the District Assembly should be used to control theft
- 8) There should be crossbreeding programmes between the Sahelian and the Djallonke sheep and well as between the exotic dairy and local cow
- 9) The Government should embark on vaccination campaigns, for example, free PPR to gather census data on animals
- 10) We should also promote vaccine production, validation of ethnoveterinary medicine and sustenance of training programmes for actors, integration of Fulani settlers with the rest of society and expansion of marketing infrastructures
- 11) A Livestock Development Fund should be established and the State budget allocation to the sector should be increased, and
- 12) There is a need to tap into sub-regional programmes to support livestock endeavours



Figure 1: Including women in all the stages of the value chain development ensures equity of benefits to women and children; women participating in a Focus Group Discussion at Passe community in the Upper West Region, Ghana
(Photo credit: Shaibu, M.T., 2019)



Figure 2: A team of researchers meeting national processors' union in Burkina Faso during activities to 'walk the chain' (Photo credit, Abajong, K., 2019)

SUMMARY OF FINANCIAL STATEMENT – 2022

REVENUE	2022	2021
GOG grant for compensation	15,403,982.44	12,662,952.00
Institutional Support	60,217.48	113,561.76
Internal Genetated Fund(IGF)	460,291.70	445,888.47
Donor Support for Research	602,174.77	862,453.20
	<u>16,526,666.39</u>	<u>14,084,855.43</u>
 LESS EXPENDITURE		
Compensation for Employees	15,403,982.44	12,662,952.00
Goods and Services Cost	278,270.98	246,243.93
Research and Development Expenses	691,768.78	896,762.14
Consumption of Fixed Assets	22,840.00	20,157.16
IGF Expenses	<u>268,922.75</u>	<u>281,682.61</u>
	<u>16,665,784.95</u>	<u>14,107,797.84</u>
 Deficit/Surplus for the Year	 <u><u>(139,118.56)</u></u>	 <u><u>(22,942.41)</u></u>

NOTE: The above financial report is the unaudited account for the 2022 financial year.

HUMAN RESOURCE ACTIVITIES-2022

This report summarizes information on Administration and Human Resource issues of the Institute for the year ending 2022.

1.0 STAFF STRENGTH

The total number of staff by the close of 2022 stood at 241. The breakdown was as follows:

i.	Senior Members		
	Research Scientist	-	28
	Technologists	-	23
	Non-Core Senior Members	-	<u>11</u>
			62
ii.	Senior Staff	-	68
iii.	Junior staff	-	111
	TOTAL	-	241

1.1 NEW APPOINTMENTS

The following appointments were made during the year under review:

NO.	NAME	DATE OF APPOINTMENT	DESIGNATION	DIVISION/ STATION
1	Dr. Justice Opare Odoi	1 st August 2022	Research Scientist	Animal Health
2	Ms. Priscilla N. Agyemang	1 st August, 2022	Principal Technologist	Commercialization
3	Ms. Naana Mintaah Akufo	1 st September, 2022	Principal Technologist	Nyankpala
4	Mr. Kweku Asante Hagan	4 th June, 2022	Technical Officer	Directorate
5	Attah Ampofo-Addo Jnr.	1 st August 2022	Administrative Assistant	Commercialization
6	Ms. Solace Appiah	1 st August 2022	Administrative Assistant	Commercialization
7	Ms. Nadina O. Sampah	1 st August 2022	Administrative Assistant	Commercialization
8	Mr. Mejida Abdul-Latif	1 st August, 2022	Accounting Assistant	Finance & Accounts
9	Mr. Godfred Leo	27 th July, 2022	Senior Security Assistant	Animal Health
10	Mr. Foster Adobah	4 th July 2022	Security Asst. Gd. I	Commercialization

1.2 PROMOTIONS

SENIOR MEMBERS

NO.	NAME	FROM	PROMOTED TO
1.	Dr. Franklin K. Avornyo	Principal Res. Scientist	Chief Research Scientist
2.	Mr. Emmanuel Nkegbe	Research Scientist	Senior Research Scientist
3.	Mr. Sadat Salifu	Research Scientist	Senior Research Scientist

SENIOR STAFF

NO.	NAME	FROM	PROMOTED TO
1	Henrietta M. Tengan	Prin. Admin. Asst	Chief Admin. Asst.
2	Jones Frimpong	Admin. Assistant	Senior Admin. Assistant

JUNIOR STAFF

NO.	NAME	PRESENT GRADE	PROMOTED GRADE
1	Mustapha Issifu	Junior Foreman	Foreman
2	Samuel K. Kwao	Junior Foreman	Foreman
3	David K. Neequaye	Junior Foreman	Foreman
4	Raphael Agbenyenu	Tradesman Gd. I	Junior Foreman
5	Bright Ayitey Quaye	Security Asst. Gd. I	Senior Security Asst.
6	Vincent Serwonyu	Security Asst. Gd. I	Senior Security Asst.
7	Isaac D. Kudjordjie	Security Asst. Gd. I	Senior Security Asst.
8	Sampson Attipoe	Security Asst. Gd. I	Senior Security Asst.
9	Dennis A. Debrah	Security Asst. Gd. I	Senior Security Asst.
10	Emmanuel Tsengei	Security Asst. Gd. I	Senior Security Asst.
11	Martin O. Antwi	Security Asst. Gd. I	Senior Security Asst.
12	Alfred Puo	Security Asst. Gd. I	Senior Security Asst.
13	Joseph Kumedzro	Security Asst. Gd. I	Senior Security Asst.
14	Derilee John Mark	Security Asst. Gd. I	Senior Security Asst.
15	David Narh	Security Asst. Gd. I	Senior Security Asst.
16	Paul Frimpong	Security Asst. Gd. I	Senior Security Asst.
17	Karimu Alhassan	Security Asst. Gd. I	Senior Security Asst.

1.3 UPGRADING

No.	Name	Upgraded To	Date of Upgrade
1	Mr. Thomas Putier	Accountant	31 st March 2022

1.4 TRANSFERS

1.4.1 INTER INSTITUTIONAL

Two inter institutional transfers were recorded as indicated in the table below;

NO.	NAME OF STAFF	GRADE	FROM	TO
1	Dr. Doris Kanvenaa Puozaa	Research Scientist	CSIR-SARI	CSIR-ARI
2	Ms. Joyce Oforiwaa	Admin. Asst.	CSIR-FORIG	CSIR-ARI

1.4.2 INTERNAL TRANSFERS

The following staff were also transferred from one station to the other within the Institute.

NO.	NAME OF STAFF	GRADE	FROM	TO
1	Dr. Franklin Avornyo	Chief Research Scientist/Deputy Director	Nyankpala Station	Katamanso Station
2	Ms. Joyce Akposoe	Snr. Admin. Asst.	Pokoase Station	Katamanso Station
3	Mr. Jones Frimpong	Admin. Asst.	Katamanso Station	Pokoase Station
4	Mr. Jerry Laryea	Snr. Tech. Asst.	Katamanso Station	Pokoase Station

1.5 RETIREMENT

The Institute recorded the following retirements at the end of 2022.

SENIOR MEMBERS

No.	Name	Designation	Date of Retirement
1	Dr. Siegfried A. Obresi	Senior Research Scientist	16 th July, 2022

SENIOR STAFF

No.	Name	Designation	Date of Retirement
1	Mr. Julius Beyuo	Prin. Technologist	22 nd March, 2022
2	Mr. Ramsey Amezugbe	Security Officer	19 th July, 2022
3	Mr. Malik Musah	Chief Works Supt.	21 st November, 2022

JUNIOR STAFF

No.	Name	Designation	Date of Retirement
1	Mr. Adjah Torgbor	Supervisor Gd. 1	1 st April, 2022
2	Mr. Wajah Nnam	Supervisor Gd. I	1 st July, 2022

1.6 LEAVE OF ABSENCE

One officer was granted leave of absence within the year of reporting.

No.	Name	Designation	Date of Leave of Absence
1	Ms. Mary Koranteng	Farm Overseer	11 th May 2022

1.7 VACATION OF POST

One Research Scientist vacated his post during the year under review.

No.	Name	Designation	Date of Vacation of Post
1	Dr. John Komla Nyameasem	Senior Research Scientist	1 st July 2022

1.8 STUDY LEAVE

The following members of staff are on study leave pursuing further courses at various Universities within and outside Ghana.

NO	NAME	LEVEL	AREA OF STUDY	INSTITUTION
1	Mrs. Nikki Owiredo	PhD	Veterinary Science	Murdoch University Perth. Australia
2	Mrs. A.A.A Koranteng	PhD	Animal Science	University of Lome, Togo
3	Ms. Sheila Aikins-Wilson	PhD	Animal Science	Justus Liebig University, Germany.
4	Dr. Carl Beckley	PhD	Clinical Biology	KNUST
5	Ms. Gifty Z. Bumbie	PhD	Hereditary Breeding and Reproduction	Southwest University, China
6	Mr. Kwabena Owusu Ansah	PhD	Animal Nutrition	KNUST
7	Mr. Charles Kusi	PhD	Animal Science	AAMUSTED
8	Ms. Susuana Asaam	PhD	Animal Science	UCC
9	Mr. Godson Aryee	PhD	Animal Breeding	University of Minnesota, USA
10	Mr. Kingsley Odum Sam	PhD	Agricultural Economics	UCC

11	Mr. Thomas Agyei Ansong	PhD	Food and Post harvest Engineering	KNUST
12	Dr. Kwadwo Y. Boateng	PhD	Medical Microbiology	University of Ghana
13	Mr. Bernard B. Borteih	PhD	Statistics	Dominion University
14	Mrs. Diana Frempong	MPhil	Food Science and Technology	CCST, Accra Campus
15	Ms. Benedicta Nsiah	MPhil	Food Science and Technology	CCST, Accra Campus
16	Mrs. Frances N. N. Nathan-Mensah	MPhil	Medical Microbiology	University of Ghana
17	Ms. Perpetual F. Eshun	MBA	Human Resource Management(Weekend)	University of Ghana
18	Mr. Jones Frimpong	MBA	Human Resource Management (Weekend)	UCC
19	Ms. Henrietta Tegan	MBA	Human Resource Management (Weekend)	UCC
20	Mr. Albert Owusu Boadu	MBA	Finance & Accounting (Weekend)	UPSA
21	Mr. Solomon M. Yoobat	Bachelor	Agric. Technology	UDS, Tamale
22	Mr. Abdul Mumin Masahudu	Bachelor	Accounting	University of Education, Winneba
23	Mr. Haruna Yakubu	Bachelor	Veterinary Nursing	UDS, Nyankpala

1.9 RESUMPTION OF DUTY AFTER STUDY LEAVE WITH PAY

1. Mr. Kwame Owusu Amoah, Senior Research Scientist resumed duty on 31st March, 2022 after the completion of his PhD. Degree in Animal Science at the Kwame Nkrumah University of Science and Technology, Kumasi.
2. Ms. Lantana Mukaila, Research Scientist resumed duty on 1st August, 2022 after the completion of her PhD. Degree in Agric. Extension at the University of Ghana.
3. Mr. Absalom Danso, Principal Technical Officer resumed duty on 30th November, 2022 after the completion of his Bachelor of Science Degree in Crop and Soil Science from the Evangelical Presbyterian University College, Ho.

1.10 TRAINING/WORKSHOP/SEMINAR ATTENDED BY STAFF

Under the year under review, the following members of staff participated in programmes as indicated against their names:

1. Mrs. Abigail Baiden-Aggrey, Senior Technologist represented the Institute at the launch of packs Africa's strategic plan (2022-2027) held under the theme: "launching our strategic take-off for evidence-informed decisions" as a virtual event on 23rd March, 2022.
2. Dr. Franklin K. Avornyo, Deputy Director attended a two-day virtual workshop on up- scaling private sector participation and science-based outreach in West Africa from 22nd to 23rd June, 2022 at CSIR-STEPRI, Accra, Ghana
3. Mr. Ibn. Saeed Arimeyaw, Head, Accounts Division and Ms. Emefa Quashie, Head, Commercialisation Division attended the second quarter meeting of the Council Committee on Commercialization scheduled for Thursday, 16th June 2022 at the Executive Conference Room, CSIR Head Office at 10:00am
4. Dr. Jennifer Afirifa Yamoah, Research Scientist attended a three (3) month fellowship programme at the Kitasato University School of Medicine, Japan from 14th September to 14th December 2022.
5. Dr. Hilda Ohene-Asa, Principal Technologist made a presentation at the Greater Accra Regional Agricultural Joint Sector Review (JSR) meeting on Monday, 24th October, 2022 at the MoFA E-Agricultural Resource Center. Her presentation was on "prevention and control of African swine fever and Avian flu disease" and the theme for the programme was "Sustaining the gains of PJF for a resilient national food system"
6. Mr. Vincent Botchway, Senior Scientific Secretary represented the Director at a stakeholder meeting on Formalization of Ghana Cattle Ranching and Transhumance Committee from Thursday 17th November to Friday 18th November, 2022 at Apaade lodge Hotel, Tesano, Accra.
7. Mrs. Monica Allotey, Ms. Janet N. Acquaful and Mr. Felix K. Hagan participated in the 2022 CSIR-Administrators' Conference from Wednesday, 30th November 2022 to Thursday, 1st December at the CSIR-Head Office.

1.11 SPECIAL VISITS TO THE INSTITUTE

1. The out-going Director-General, Dr. Victor K. Agyemang paid a farewell visit to the institute on Monday, 14th February 2022.
2. The Director-General, Prof. Paul P. Bosu and all the CSIR Directors paid a brief visit to the institute on Thursday, 12th May 2022 with some press men to inspect the extent of encroachment on CSIR lands at the Katamanso Station.

3. The Greater Accra Regional Minister and members of the Regional Security Council together with members of the press paid a visit to the institute on 7th June 2022 to access at first hand the extent of encroachment of the CSIR-ARI lands.
4. The National COVID-19 Vaccination team was at the institute on 21st June 2022 to vaccinate staff members who were yet to be vaccinated.
5. The Institute's Management Board Chairman, Prof Abraham Anang, together with Dr. Oppong Anane, Chairman, Ghana Cattle Ranching Committee participated in the 2022 In- House Research Review programme for Research Scientists from 9th August to 10th August 2022 at the Institute.
6. Mr. Cosmos Adjei from Quest Farms in the Bono East region paid an official visit to the Institute on 7th September 2022.

1.12 SPECIAL EVENTS

a. **Introduction of newly appointed Director-General and inauguration of newly constituted CSIR-ARI Management Board**

The Council Chairman, Prof Kingsford Adaboh and the Director of Administration, Mrs. Genevieve Yankey were at the institute to introduce the newly appointed Director-General, CSIR, Prof. Paul Pinnock Bosu on Monday, 16th May 2022. At the same event the CSIR Council Chairman inaugurated the newly constituted Institute's Management Board.

b. **Demolition exercise on the CSIR-ARI lands at Katamanso**

The Greater Accra Minister, Hon. Henry Quartey and members of the Regional Security Council led a demolition of all unauthorized structures within the 200.8 acres of the Institute's land from the 22nd to 23rd June 2022. The exercise was commendable for ending the long-standing battle between the Institute and the encroachers.

c. **Working Visit by the Parliamentary Select Committee on Environment, Science and Technology**

The Institute witnessed the visit by the Parliamentary Select Committee on Environment, Science and Technology that paid a day's working visit to the Institute on Wednesday, 3rd August 2022 to familiarize themselves with the Institute's operations, ongoing research, notable achievements and challenges.

1.13 MANAGEMENT BOARD MEETINGS

Two Management Board meetings were held within the year, one on 14th July, 2022 and the other on 20th October, 2022 after the formal inauguration in May, 2022.

1.14 DEATH

The following members of staff unfortunately passed on during the year 2022. They are:

No.	Name	Designation	Date of Demise
1	Prof. Naaminong Karbo	Former Director/Post Contract Staff	3 rd July 2022
2	Mr. Jabaa Bilibi Oka	Supervisor Grade 1	26 th October 2022

1.17 LIST OF NATIONAL SERVICE PERSONNEL

No.	Name	Institution	Qualification	Assigned Division
1	Nancy Tettey	Accra Tech. University	HND. Sec. & Mgt.	Administration
2	Sandra Gambah	KNUST	B.A. Culture & Tourism	Administration
3	Suweiba Y. Larry	Accra Tech. University	HND. Marketing	Accounts & Finance
4	Jude Teye Badu	KNUST	BSc. Agric. Tech.	Animal Health
5	Dickson Asare Manu	UCC	BSc. Molecular Biology & Biotech.	Animal Health
6	Priscilla Asabere	University of Ghana	BA Info. Studies & Psychology	Library
7	Ernest Ewoniah	KNUST	BSc. Agriculture	NPFSD
8	Bright Nayam Kombat	University of Ghana	BSc. Biological Science	Animal Health
9	Richmond O. Yeboah	University of Ghana	BSc. Biological Science	Pokoase
10	Archibald R. Quao	University of Ghana	BSc. Biological Science	Animal Health
11	Ursula S. Nkonu	University of Ghana	BSc. Biomedical Engineering	Animal Health
12	Sarah N. A. Pramang Asabere	KNUST	BSc. Natural Resource Management	Pokoase Station
13	Mahami A. Sadiq	University of Ghana	BSc. Agriculture	Animal Health
14	Bosomtwe N. Ababio	University of Ghana	BSc. Animal Biology & Conservation Sc.	Pokoase Station

17.0 LIST OF ATTACHMENT PERSONNEL

No.	Name	Institution	Area of Specialization	Assigned Division
1	Desmond Asare Gyesi	Univ. College of Agric. & Env't. Studies	BSc. Sustainable Agriculture	FATD
2	Anum Rhoda	KNUST	BSc. Agribusiness	FATD
3	Ashirifi Boadu Gideon	KNUST	BSc. Agric. Biotechnology	AHD
4	Poku B. Kevin	University of Ghana	BSc. Agriculture	NRMD
5	Angela B. Dalaba	KNUST	BSc. Agric. Biotechnology	Animal Health
6	Elikplim Apetorgbor	University of Ghana	B. A. Psychology	Administration
7	Juanita A. Oteng	KNUST	BSc. Agriculture	FATD
8	Thompson N. Lydia	University of Ghana	BSc. Agriculture	FATD
9	Ati Angela	KNUST	BSc. Agric. Biotechnology	FATD
10	Mensah Israel	KNUST	BSc. Agribusiness Management	Commercialization
11	Yawson P. Fiifi Bentum	KNUST	BSc. Agriculture	FATD
12	Akuaku Jeremy Tetteh	KNUST	BSc. Agric. Biotechnology	Animal Health
13	Safo Jessica Darko	KNUST	B.A. Economics	Commercialization
14	Dorto D. Irene	Accra Technical University	HND Sc. Lab. Tech	FATD
15	Akoto Rosalyn Bimpong	KNUST	Food Sc. Tech.	NPFSD
16	Amankwaa A. Samuel	KNUST	BSc. Agric. Biotechnology	Animal Health
17	Mohammed Nafisah	KNUST	BSc. Agric. Biotechnology	Animal Health
18	Adjetei Kadmiel	UCC	BSc. Biomedical Science	Animal Health
19	Annan K. Francis	UCC	BSc. Biomedical Science	Animal Health
20	Seirr-Teiwin A. Prosper	UCC	BSc. Biomedical Science	Animal Health
21	Acquah Roselyn	UCC	BSc. Biomedical Science	Animal Health
22	Asramah Bismark	KNUST	BSc. Agric. Biotechnology	Animal Health
23	Atakora O. Felicia	KNUST	BSc. Agric. Biotechnology	Animal Health
24	Monney S. Sandra	KNUST	BSc. Agric. Biotechnology	Animal Health

PUBLICATIONS

Refereed Journal Papers

1. Agyekum, G., Okai, M. A., Tona, J. K., Donkoh, A., and Hamidu, J. A. (2022). Impact of Incubation Temperature Profile on Chick Quality, Bone, and Immune System during the Late Period of Incubation of Cobb 500 Broiler Strain. *Poultry Science*, 101999.
2. Asuming-Bediako, N., Parry-Hanson Kunadu, A., Jordan, D., Abraham, S. and Habib, I. (2022) Prevalence and antimicrobial susceptibility pattern of *Campylobacter jejuni* in raw retail chicken meat in Metropolitan Accra, Ghana, *Intl Jnl of Food Microb.*, 376:109760. doi: 10.1016/j.ijfoodmicro.2022.109760
3. Koranteng A. A. A., Gbogbo K. A., Adjei-Mensah B., Bouassi T., Aina C. T. F., Glago J. and Tona Kokou (2022). Impact of palm kernel cake with or without multi-blend enzyme on the growth performance and carcass traits of Sasso broilers. *International Journal of Veterinary Science and Medicine*, 10(1): 80-89, DOI: 10.1080/23144599.2022.2125735
4. Boateng, M., Atuahene, P. Y., Amoah, K. O., Frimpong, Y. O. and Okai, D. B. (2022). Incidence of blood and meat spots in eggs from a commercial poultry farm. *Ghana Journal of Science*, 63(1): 90-96
5. Hagan B. A., Salifu S, Asumah C., Yeboah E. D. and Boa-Amponsem K. (2022). Effects of genetic and non-genetic factors on body weight, pre-weaning growth, birth type and pre-weaning survivability of lambs in a sheep nucleus station. *Livestock Research for Rural Development*. 34 (4): Article #30
6. Mogre J. W. S., Adzitey F., and Teye G. A. (2021) Assessment of cattle welfare on Ghanaian farms. *Asia Pacific Journal of Sustainable Agriculture Food and Energy (APJSAFE)*. 9 (2): 1-
7. Kruenti, F., Lamptey, K. V., Okai, A. M., Adu-Aboagye, G., Oduro-Owusu, D. A., Bebanaayele, F., Suurbesig, B. (2022). The influence of flock age and egg size on egg shape index, hatchability and growth of japanese quail chicks. *Journal of Innovative Agriculture*: 9(1): 8-16.
8. Kruenti, F., Hagan, K. J., Okai, A. M., Lamptey, K. V. (2022). The quality of white and brown chicken eggs kept under different storage length and storage temperatures. *Journal of Innovative Agriculture*: 9(2): 1-11, 2022.
9. Lamptey, K. V., Hagan, K. J., Hagan, A. B., Kruenti, F., and Osei, Y. D. (2022). The influence of sex and age on growth rate of domestic rabbits (*Oryctolagus cuniculus*). *Journal of Innovative Agriculture*: 9(2): 21-27.
10. Kruenti, F., Hagan, K. J., Ofori, A. S., Lamptey, K. V. and Adu S. (2022). Effect of strain and age of layer chickens on proximate contents of egg yolk and albumen. *Online Journal of Animal and Feed Research*: 12(5): 272-278.
11. Nartey Michael N. N., Jisaka M, Karim P Nishimura K, Shimizu K, and Kazushige Y Prostaglandin D₂ added during the differentiation of 3T3-L1 cells suppresses adipogenesis by dysfunction of D-prostanoid receptor P1 and P2. *Life*, 2022 (In press, MDPI Journal)
12. Osman, A., Bashiru, U. I., Agbesi, D., Abdul Aziz, Y., Amoah, K. O. and Osafo, E. L. K. (2022). Effects of the dietary inclusion of varying levels of paper mulberry (*Broussonetia papyrifera*) leaf meal on growth performance, nutrients digestibility and carcass characteristics of grower rabbits. *Animal Research International*, 19(1): 4354 – 4366

13. Ofori, J. A., Bakari, S. M., Bah, S., Kolugu, M. K., Aning, G. K., Awandare, G. A., Carrington, M. and Gwira, T. M. (2022) longitudinal two-year survey of the prevalence of trypanosomes in domestic cattle in Ghana by massively parallel sequencing of barcoded amplicons. PLoS Negl Trop Dis 16(4): e0010300. <https://doi.org/10.1371/journal.pntd.0010300>
14. Osei, D. Y. Apori, s. O. Hagan, J. K. Asuming Bediako, N. Amedorme, D. Asiedu, P. (2022). Sensory characteristics of meat from rabbits fed concentrate diets containing *Brassica oleracea* outer leaves and *Musa paradisiaca* leaves. Ghana Journal of Science, Technology and Development [8.2].
15. Ohene Larbi, R., Adeapena, W., Ayim-Akonor, M., Ansa, E. D. O, Tweya, H., Terry, R. F., Larbi A. and Harries, A. D. (2022) Antimicrobial, multi-drug and colistin resistance in Enterobacteriaceae in healthy pigs in the Greater Accra Region of Ghana, 2022: A cross-sectional study. International Journal of Environmental Research and Public Health 19:10449
16. Salifu, S., Abdul-Rahman, I. I., Ansah, T., Hagan, B. A., Sulleyman V. A., Shaibu, M. T. (2022) West Africa Dwarf sheep management systems and exposure to potential stressors in the savannah agroecological zone of Ghana. Ghana Journal of Science Technology and Development. 8(2): 114 – 130.
17. Aikins-Wilson S, Bohlouli M, Engel P, König S (2022). Effects of an herbal diet, diet x boar line and diet x genotype interactions on skin lesions and on growth performance in post-weaning pigs using a cross-classified experiment. Journal of Livestock Science, 2022, doi.org/10.1016/j.livsci.2022.105010

Conference Papers

1. Kruenti F., Okai A. M., Lamptey K. V., Adu-Aboagye G., Oduro-Owusu A. D., Suurbesig B. (2022). Age effect on the relationship between quality traits of fertile Japanese quail eggs. CSIR 33rd RSA Annual General Meeting and 4th Scientific Conference book of abstracts. Pg 21
2. Ameleke G. Y., Mantebea C., and Munkaila, L. (2022). Profiling fee-paying participants of livestock production training programmes: The case of CSIR-Animal Research Institute. Paper presented at the 4th CSIR-RSA Annual Conference at Soil Research Institute, Kwadaso, Kumasi, Ghana.
3. Ofori, J. A, Kwofie, K. D, Ladzekpo, D, Boateng Yeboah, K, Beyuo, J, Keleve, A. V, Tawiah-Mensah, C, Ansah-Owusu, J, Dadzie, S, Wallace, P. A, Tsuji, N and Takeshi, H (2022). Metagenomic profiling of tick microbiome across the coastal savannah zone of Ghana. 2022 WACCBIP Research Conference, July 20-22, 2022, Pp 185

Technical Reports/Papers

1. Hamidu K, Osie Adjei K, Oduro-Owusu A.D, (2022) Encyclopedia of Meat Sciences: Poultry Waste Management- Manure. 3rd Edition Section 6/00142. (In press)

Newspaper Paper Article

1. Osei, D. Y. (2022). Kindling and Care of Rabbit Kits (Part II). The National Forum Newspaper. March 15, 2022. Page 6.
2. Osei, D. Y. (2022). Rabbit nutrition (Part I). The National Forum Newspaper. April 19, 2022. Page 6.
3. Osei, D. Y. (2022). Rabbit Nutrition (Part II). The National Forum Newspaper. April 26, 2022. Page 6. Osei, D. Y. (2022) Forages Used for Rabbit Feeding. The National Forum Newspaper. May 10, 2022. Page 6.

Thesis

1. Oduro-Owusu, A.D (2022). Haematological, biochemical components and sensory characteristics of weaner pigs fed graded levels of moringa leaf meal. Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED), Mampong-Ashanti, Ghana. Mphil thesis 153pp

FOR ANY ENQUIRIES CONTACT:

**COUNCIL FOR SCIENTIFIC &
INDUSTRIAL RESEARCH
(Animal Research Institute)**

**P. O. Box AH 20,
Achimota, Accra**

Telephone:

+233 302 912 178/ + 233 302 912 179

Website: <https://ari.csir.org.gh>