Training manual for frontline animal extension service providers on antimicrobial resistance in poultry production

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Vétérinaires
Sans Frontières
Germany

Training manual for frontline animal extension service providers on antimicrobial resistance in poultry production

Capacity and Professional Development Towards Combating Antimicrobial Resistance in Uganda's Poultry Sector

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Contents

Tables

Figures

Foreword

Antimicrobial resistance is a situation where the disease-causing organisms that were responding to a given treatment can no longer respond to the same treatment. Infection prevention and control involves good management practices in poultry production that reduce or eliminate the risk of diseases.

This manual provides a brief overview of the basic needs of poultry which must be considered for better health and improved productivity. The training manual for frontline animal health workers on antimicrobial resistance (AMR) in poultry production is designed to enhance the knowledge of the target group on antimicrobial resistance, infection prevention and control in poultry production, and diagnostics. The National Action Plan for antimicrobial resistance is intended to guide the containment of AMR in Uganda. It has several strategic interventions among which are optimal use of antimicrobial medicines, detection, prevention and control of infectious organisms, and raising awareness of the AMR challenge and containment options.

The poultry value chain is a key enterprise with massive use of antimicrobials for disease prevention, treatment and growth promotion. The misuse of antimicrobials is aggravated by self-prescription, unrestricted access and wrong dosage, hence development of resistant microorganisms.

This training manual gives a basis for training the target groups; veterinarians and para-veterinarians, production officers and other actors involved in the development of intensive and small poultry farms at the village level. The expectation is that the trainers will extract the materials they need for training of farmers from this manual. Each module is categorized into; learning objectives and content of the topics covered, exercises and activities which are proposed to help the trainer prepare the training session in the most practical and participatory way.

The objectives of the training include; equipping trainers of trainees (TOTs) with knowledge and skills to prevent poultry diseases; creating awareness on mitigating the burden of AMR in poultry production; improving the knowledge, attitude and practices relating to AMR control and antibiotic use among poultry health service providers; refreshing the knowledge and skills of field animal health workers in syndromic diagnosis of important poultry diseases

A team of facilitators at national level will train a pool of trainers of trainees at subnational level who will roll out the training to other frontline animal health workers and farmers.

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In a special way, I acknowledge the contribution made by Dr. Eneku Wilfred, the consultant who compiled the manual.

All these contributions ensure that Uganda has a training manual that will guide the efforts towards slowing the threat of antimicrobial resistance and its associated impact on public, animal, and environmental health.

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Abbreviations

AMR	Antimicrobial resistance
AMS	Antimicrobial stewardship
AMU	Antimicrobial use
BfR	Bundesinstitut für Risikobewertung (The German Federal Institute for Risk Assessment)
BMZ	German Federal Ministry for Economic Cooperation and Development
BUILD	Boosting Uganda's Investment in Livestock Development
DVO	District Veterinary Officer
FAO	Food and Agriculture Organization of the United Nations
ILRI	International Livestock Research Institute
IPC	Infection Prevention and Control
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
NaLIRRI	National Livestock Resources Research Institute
NDA	National Drug Authority
RTC	Research Centre for Tropical Disease and Vector Control
UBOS	Uganda Bureau of Statistics
VSF-G	Vétérinaires Sans Frontières Germany
WHO	World Health Organization of the United Nations
Veterinarian	A person qualified to treat diseased or injured animals. He or she is also called a veterinary

Glossary

Agrovet	An end-to-end supply store for farmers, dealing in seed, fertilizer, animal feed and veterinary supplies. In general, a nonspecialized distributor of agricultural products.
Animal husbandry	The science of breeding and caring for farm animals.
Antibiotic resistance	This develops when bacteria change in response to the use of antibiotics (medicines). Bacteria, not humans or animals, become antibiotic-resistant. These bacteria may infect humans and animals, and the infections they cause are harder to treat than those caused by non-resistant bacteria
Antibiotics	Medicines that are used to treat bacterial infections in people, animals and crops. They either kill or inhibit the growth of bacteria.
Antimicrobials	A general term used to describe a diverse group of drugs (medicines) that target various microorganisms (i.e. bacteria, viruses, fungi and parasites). They include antibiotics, but also medication against other microbes (antivirals against viruses, antifungals against fungi and antiparasitics against worms, ticks, mosquitos, blood parasites.
Antimicrobial resistance:	Develops when microorganisms are able to overcome the effect of antimicrobials; they do not respond to treatment.
Antimicrobial stewardship	Antimicrobial stewardship is a coordinated program that promotes the appropriate use of antimicrobials (including antibiotics), improves patient outcomes, reduces microbial resistance, and decreases the spread of infections caused by multidrug-resistant organisms.
Biosafety	The term "biosafety" refers to the use of specific practices, safety equipment, and specially designed buildings to ensure that workers, the community, and the environment are protected from accidental exposure or unintentional release of infectious agents, toxins, and other biological hazards.
Biosecurity	Procedures or measures designed to protect the population (in this case of poultry) against harmful biological or biochemical substances.
Diagnosis	The identification of the nature (causes) of an illness or other problem by examination of the symptoms or samples taken to a laboratory.
Growth promotion	The term "antibiotic growth promoter" is used to describe any medicine that destroys or inhibits bacteria and is administered at a low, sub therapeutic dose (see sub-therapeutic meaning in the glossary). Some antibiotics promote anabolism as a side effect and are therefore used for growth promotion. This practice has arisen with the intensification of livestock farming and has been banned in many high-income countries.
Irrational drug use	According to the World Health Organization (WHO), "irrational use of medicines implies that patients get medications inappropriate to their clinical conditions ordoses that do not meet their requirements for the desired period."
Metaphylaxis	Treatment of a group of animals without evidence of disease, which are in close contact with other animals that have evidence of infectious disease. Usually treatment of an entire flock/herd once one or several animals get clinically sick. This is an approach to protect the rest of the herd/flock.

Microbes/Microorganisms	Microbes are organisms that are too small to be seen without using a microscope, they include things like bacteria. Sometimes viruses are called microbes.
Para-veterinarian	A person who assists veterinary surgeons in the performance of their duties or carries out animal health procedures autonomously as part of a veterinary care system.
Pathogen	A bacterium, virus, or other microbes that can cause disease
Poultry	Refers to domestic birds raised commercially for meat, eggs, and feathers. Chickens, ducks, turkeys, and geese are the common poultry kept.
Prophylaxis	Refers to an action taken to prevent disease.
Rational drug use	The process of appropriate prescribing and dispensing of drugs for the patient for diagnosis, prevention, and treatment of diseases.
Retail drug store	This is where drugs are compounded, dispensed, stored or sold or where prescriptions are filled and drugs are dispensed to the general public.
Stocking rate	Refers to the number of birds per unit area or the amount of area per bird.
Sub-therapeutic	Refers to a dose or concentration of a drug that is lower than that usually prescribed to treat a disease effectively.
Treatment	In relation to poultry health, it is the medical care given to poultry for an illness or injury.
Vaccination	It is the administration of a vaccine to help the immune system develop immunity from a disease. A vaccine is a preparation that is used to stimulate the body's immune response against diseases. Vaccination is a method of prophylaxis for preventing clinical disease (not infection).
Veterinarian	Is a person qualified to treat diseased or injured animals. He or she is also called a veterinary surgeon. He or she also offers services to keep animals healthy including advise on husbandry practices, vaccination among others.

Part I

Part I provides introduction on poultry industry in Uganda and introduces the manual design as well as the trainer's guidelines

Section 1: Background

1.1 Brief overview of poultry industry in Uganda

The poultry industry is rapidly growing in Uganda and the products from the industry are widely consumed by many the domestic and regional population. Chickens are the most widely distributed livestock among households in Uganda, 31% (3.4 million) households are engaged in poultry as a source of income and food (Annual Agricultural survey, 2019). The number of chickens has increased by 23% in recent years from 35.8 million chicken in 2016 to 44.2 million in 2020 (MAAIF statistical abstract, 2021).

According to the 2009 livestock census, 99% of the chicken owning households had indigenous chickens. These were mainly found in the Eastern and Northern parts of Uganda while the exotic chickens were more in the Central region. The exotic chicken population is estimated to be 850,000 chicks per week and 130,000-layer day-old chicks per week based on production capacities of the major hatcheries in the country (UDC, 2022). Other poultry species kept for meat or eggs include ducks, turkeys, guinea fowls, and pigeons and their population is estimated at 2.2 million. Despite the many advantages of rearing chicken, some people have abandoned the business due to unforeseen challenges or production requirements that were not anticipate. Some of the challenges include; persistent disease outbreaks, poor flock performance (low production) and inability to recover investment costs.

Chickens are frequently exposed to disease causing agents within the environment including the household, introduced from outside by caretakers or other animals due to weak biosecurity measures and overstocking. These challenges lead to indiscriminate use of antibiotics in poultry throughout the production cycle; a phenomenon that has greatly contributed to antimicrobial resistance. Farmers use antibiotics for treatment, prophylaxis and growth promotion and many of them access and administer antibiotics to chicken without prescription. This has led to increased cost of production through heavy expenditure on antibiotics and loss of stock.

Antibiotic resistance is a major threat to the poultry industry in Uganda and multidrug resistant bacteria from farms have been reported. According to Kakooza et al., 2021, in their retrospective study at the central diagnostic laboratory, multidrug resistance was established for *E. Coli and Salmonella* spp in poultry). The resistant organisms may contaminate human food and water sources and cause infections in humans that are difficult to treat. The waste from poultry houses with resistant bacteria is a potential source of contamination of crops such as vegetables that are grown using chicken manure.

Good production practices are key in reducing the burden of diseases, frequency of drug use, reduce production costs overtime and minimize the risk of microorganisms becoming resistant to antimicrobial drugs. The adage of "prevention is better than cure" is much applicable in poultry production.

1.1.1 Purpose of the manual

This training manual is intended to refresh the knowledge and skills of frontline animal extension workers on good practices in poultry production to minimize antimicrobial use and hence resistance. The manual will be used to harmonize the delivery of AMR trainings in poultry production across the country.

1.2 Training manual objectives

The objectives of this training manual are therefore, to:

1. equip trainers of trainees (TOTs) with relevant knowledge and skills to prevent poultry diseases through the production stages
2. create awareness among frontline animal extension service providers on their role in mitigating the burden of AMR in poultry production
3. improve the knowledge, attitude and practices relating to AMR control and antimicrobial use among animal extension service providers
4. refresh the knowledge and skills of field animal-health workers in syndromic diagnosis of important poultry diseases

At the end of the training, the trained frontline workers will work to sensitize farmers on adoption of practices that minimize antimicrobial use in poultry farms and application of good management practices in poultry production.

Section 2: Overview of training modules and content

2.1 Module orientation

This section of the training manual provides an overview on the organization of the modules. It provides orientation and outline of the three modules and subsections. The three modules are organized to ensure participatory learning and adoption of practices intended to address infection prevention in poultry and reduce antibiotic use. It also provides content and references for replication of the intended knowledge and practices across different locations.

2.2 Module outline

Each module consists of 5 parts. These parts are:

1. Module introduction and learning outcomes—the module context and what trainees are expected to learn
2. Duration—The amount of time required to deliver the module; this may be split into short interactive sessions
3. Learning aids—the materials and facilities required to deliver the module
4. Facilitator's guideline also called activities and exercises—These are a mixture of interactive learning activities with brainstorming sessions, field visits, plenary discussions and summary by the trainer
5. Module content—a reference text/handout for the module, which may be printed and issued as additional learning resource at the end of a module

Table 1: Overview of the modules

No.	Module	Need addressed	Expected training outcomes	Duration
1	Understanding antimicrobial resistance	Inadequate knowledge on antimicrobial resistance and reports on rampant irrational antibiotic use	• Increased knowledge on antibiotics, their use and how to prevent irrational use among animal health workers • Increased level of antibiotic stewardship among animal health workers	3 hrs
2	Principles of infection prevention and control (IPC) in poultry production	Inadequate knowledge and skills on prevention of infections in poultry flocks	• Increased understanding of functional anatomy of chicken for better care of the flocks • Improved husbandry practices for prevention of diseases in poultry flocks	16 hrs (split sessions, see Annex 1 for training program)
3	Poultry disease diagnostics	Inadequate knowledge and skills on recognition of common chicken diseases	• Improved knowledge on common chicken diseases among animal health workers • Improved adoption of diagnostic skills of chicken diseases	5 hrs (split sessions)

Section 3: Training design

3.1 Training of frontline animal health extension workers

The targeted frontline workers include veterinary officers, veterinary paraprofessionals, animal husbandry officers and private veterinary practitioners. The required minimum qualification is a Diploma in Animal production. Participants should be committed, willing and available to undertake the training.

3.1.1 Training duration

The training for the frontline animal extension service providers for the 3 modules requires 32 contact hours (One week) including introductory parts and hands-on practicals.

3.1.2 Delivery of the training sessions

The training is participatory and uses different delivery methods.

3.1.2.1 Teaching methods

The facilitators use different approaches to make the sessions interactive and enable trainees to appreciate the course content. These are described in section 4.4.

3.1.2.2 Assessment and award

The trainees will be subjected to pre and post-test assessments based on the learning outcomes of the module. Trainees will use an assessment form to evaluate every trainer to identify areas of improvement in course delivery. Trainees will also have an opportunity to give feedback on the course content. The participants will receive a certificate of participation upon successful completion of the training. The evaluation template is shown in Annex 9.

3.2 Flow of the training session

The following is the flow of the each training module; 1) The trainer administers pre-training assessment 2) introduces the module; 3) receives participants' expectations; 4) relates participants' expectations with module objectives or learning outcomes; 5) employs the activities and exercises including farm visits and plenary discussions as described in the manuals; 5) administer post-test assessment 6)evaluate the module using participatory approaches e.g. one participant reads one summary message and its application; and (7) distribution of handouts to participants.

Section 4: Facilitator guidelines

These guidelines are intended for the trainers of frontline animal- health workers for reference during the training.

4.1 Number of participants per training

For good content delivery, participants should be in manageable numbers and not exceed 20.

4.2 Preparation of training venue, sites and trainees

The training venue comprises the training room, field demonstration sites and any other facilities to be used during the training. The following should be taken note of:

- Training room should have adequate space for 20 participants sitting with front view of the class without obstruction
- LCD projector should be available
- Demonstration site should be easily accessible by the participants. The operators should be informed in advance about the visits.
- The trainees should be selected and informed at least 2 weeks before the start of training.
- Medical first aid should be planned for to manage health emergencies during the training period.

4.3 Training program

The proposed training program consists of the actual training modules and the activities, including health breaks. The training program is attached in Annex 1.

4.4 Training methods

The training will be participatory in nature and will involve a blend of the following methods:

Table 2: Training methods

Training Method	Description and relevance of the method
Plenary presentations	Use of power point or flip chart presentations and plenary discussions in situations where knowledge and opinion or consensus is required
Group exercises, visits and demonstrations	To be considered where sharing and trying of skills are needed.
Role plays and problem-solving exercises	Assignments that require solutions tailored to the local context and will be considered where attitude is an issue
On-farm practical demonstration	To be considered where hands-on practical skills are acquired through sharing and demonstration

Module 1:Understanding antimicrobial resistance

This module provides the background to understanding what microorganisms are, antimicrobial resistance; from the discovery of antimicrobials, importance to mankind and how they should be safe guarded to maintain their efficacy for the benefit of humans, animals and the environment.

1 Learning objectives

At the end of this module, the participants should understand:

- Basic physiological and structural biology of microorganisms.
- What antimicrobials are and their mode of action
- Importance of antimicrobials
- What antimicrobial resistance is
- How antimicrobial resistance occurs
- When does anti-microbial resistance occur?
- How anti-microbial resistance can be prevented
- Who is affected a by anti-microbial resistance and how?

2 Duration

4 hours and 30 minutes

3 Training materials and learning aids

Flip charts, pens, notebooks, training manuals, pictorials of containers of antimicrobials, labels or packages of drugs, drug inserts, pictorials of bacterial growth and resistance in the lab, short video clips of chicken with diseases, posters and transcribed interview messages, computers and projector

4 Activities and exercises

Please include an elaborate plan about trainings i.e. a facilitator delivers a brief lecture on AMR as per the learning objectives above to the participants.

Introduction (30 min)

The trainer will introduce the topic and ensure participants understand what microbes are, their mode of action and their importance to human, environmental and animal health. The trainer should clearly and simply define antimicrobial resistance and the mechanisms through which it occurs and demonstrate to safeguard antibiotics to preserve their effectiveness.

The trainer should have an open discussion with the participants on how and why antimicrobial resistance spreads and identify key drivers and lastly discuss the practices or methods to reduce antimicrobial resistance (emergence and spread).

Farm walks (60 min)

Note: this farm walk can be merged with the farm walk for housing and equipment in module 2.

Participants should conduct a farm walk to observe the farm setup and practices to identify gaps and discuss interventions that would minimize AMR. Farm visits should be conducted in sub-groups and participants should try to identify different drugs and chemicals used on the farm. The trainer can provide different categories of drugs and chemical for participants to see and discuss about them. Participants should identify the good and bad practices of farming systems, drug use and disposal of drugs on the farms. They should also enquire about the disposal of wastes from the birds that received those treatments.

The following questions/areas may be addressed:

- How does the farmer keep his/her chicken healthy?
- What treatments are given to the birds? Are the birds currently on any drugs? Which ones?
- How does the farm prevent diseases or the birds from dying?
- How is the expired or unused drug disposed of?
- Who administers the drug?
- How are drugs stored?
- Biosecurity checklist
- Procurement of antibiotics
- Vaccination schedule
- How does the farmer access advice on diseases and treatment?
- How does the farmer access information on products being used on the farm?
- Source of information about farming practices?

Reconvening and discussion (60 min)

One participant from each sub-group will present their findings and subsequently discuss the good and bad practices identified, what drugs were used, how they are used and disposed and any risks identified. The groups will then discuss the results, focusing on what could be improved. The presentations focus on the good and bad things identified about drug use, storage, disposal, observance of withdrawal periods and alternative management methods to reduce drug use.

Group work and discussion (20 min)

The trainer gathers photos or videos on the chicken types, feather cover and normal excreta of the birds. Videos on how birds behave in hot weather or uneven light distribution in a house should be available and shown to participants. The trainer then summarizes the discussions and emphasizes the importance of providing for the birds according to their specific needs. Participants will be asked to answer questions on the following areas:

- Importance of the environment; cool for old birds? and warm environment for chicks?
- Do farmers provide grits to chicks and laying birds?
- Importance of water to chicken? (Relate to urates and water conservation).
- Why should chicken be given less fibrous feed?

Summary by the trainer (10 min)

The success (good production at reduced costs) of the farmer is associated with taking care of the biological and behavioral needs of the birds. The trainer summarizes the importance of providing for the needs of the birds for them to grow and be productive. Table 2 provides a guide to areas that needs emphasis on the body systems of the bird.

Table 3: Areas for emphasis on body systems of birds

System	Emphasis
Digestive	• Beak conformity and debeaking • The length of the intestine in relation to digestion of (high fiber) feeds • Importance of gizzard stones in relation to digestion, origin of the stones and importance of feed particle size
Skin	The relation between feather coverage and environment (temperature). Effects of environmental temperature and feed intake on production and egg quality
Respiratory	Highly efficient system and highly sensitive to environmental irritants. Need for good house orientation and design (ventilation, stocking density)
Urinary	Excretion of uric acid; need for water supply
Reproductive	Risk of egg tract infection if no nests available or eggs laid on fecal contaminated litter.
Heart	Chicken hearts beat faster than for domestic mammals. They therefore need high energy diets to keep alive and produce eggs/meat
Nervous	Need vitamins to keep healthy
Immune	Importance of vaccination to boost immune function
Musculoskeletal	Calcium reserve for egg production, nutrition is vital for good growth and production

5 Content

The reading material for this part I of module 2 is in Annex 3.

Part II

Part II provides structured to highlight the principles of animal husbandry practices that caters for the different stages or production cycle in poultry

Part II: Animal husbandry practices

This part is structured to highlight the principles of animal husbandry practices that caters for the different stages or production cycle in poultry. Each principle requires actions/designs for infection prevention and control. These principles include:

- Housing and equipment,
- Stocking (breeds and breeding methods),
- Feeding (feeds and feeding methods),
- Healthcare (routine deworming, vaccinations and disease prevention measures),
- Routine activities and records and
- Marketing

These principles constitute major intervention points for infection prevention and control. Implementing them together, that is from house preparations to stocking, feeding, healthcare practices up to disposal (marketing) of the entire batch constitutes all-in, all-out practice which is a biosecurity measure for disease control. Biosecurity as a disease prevention method can be integrated in aspects of animal husbandry.

This part of the module is restructured into four subparts. a), housing and equipment, b) starting stock (breeds), c) feeds and feeding methods while d) healthcare and disease management in poultry. Marketing of poultry may serve as portal of inducing drug residues to consumers especially if the flocks have been treated with antibiotics and the withdrawal periods not observed. Additionally, methods of selling chicken such as allowing traders to select chicken from poultry houses and returning from markets to farms of birds that have not been sold is a risk to introduction of diseases and should be avoided.

a Housing and equipment

This part describes the elements to be considered when designing and building a poultry house adapted to the production objectives of poultry keepers. It also describes the required poultry equipment such as watering and feeding troughs, nests, lighting sources and perches.

1. Learning Objectives

After completing this module, participants will

- understand why housing is very important in infection prevention in poultry farming
- know different types of housing
- know the specifications of a good poultry house adapted to the needs of their chickens

- know the materials used in the construction of poultry houses, and their sources
- be able to design and build or improve their poultry houses

2. Duration

3–4 hours (this part can be split into two-days' trainings)

3. Learning Aids

- Drawings of different housings and equipment for chicks and adult birds (the illustrations presented in this manual can be printed in large format)
- Photos of a good and bad poultry house
- Common materials used in the construction of simple protections and housing (targeting the rural areas where chicken are on free range system)
- Poultry farms or homesteads that are easily accessible by participants for group work (see Part D).

4. Activities and Exercises

Introduction (20 min)

The trainer asks the participants to work in small groups and together answer the following questions: 1) why do poultry need physical protection, such as chicken houses? 2) what are the characteristics of a good house/shelter? or what are the characteristics of a bad house?

On equipment in poultry house, the following questions may be asked: 1) what equipment do you use for your poultry? 2) what is it made of? 3) why is the different equipment important in poultry house?

Farm walks or demonstration session (50–60 min)
This visit may be combined with that in Module 1 or may be repeated for specific issues that arose from the previous discussions. Each participant-subgroup visits one or two farms close to the training site and looks for good and bad examples of housing/shelter and equipment. While at the farms, they are required to identify the good and bad measures and management practices used to protect the poultry during the night and during the day. In addition, they should note the materials used for the poultry houses and equipment in or around the house. Finally, the participants will observe the conditions in the external environment of the house, that are related to the construction and use of the housing or other protections for the poultry. The following checklist can be used by the participants to observe poultry houses/shelter and equipment:

- Kind of housing/shelter or equipment is used
- Location? Challenges that may result for the location such as poor drainage, dampness etc. Orientation of the house in relation to sunrise and sunset
- Materials used for the wall, roof and the floor
- Size of the chicken house (m^2) and number of chickens it accommodates
- Protection of the birds from predators, thieves and bad weather
- Biosecurity- Is there disinfectant bath at the entrance? How is it prepared and replaced?
- Ventilation- ss the house well ventilated?
- Lighting- is the house well-lit?
- Floor finishing- Is the floor smooth enough for easy cleaning and disinfection?
- Cost of construction- Did the farmer pay for any construction? If so, what did they construct and how much did it cost?

- Fencing- Is there a fenced area where the chickens can roam free inside? If so, what is the size of the fenced area (m2)?
- Equipment- do the chicken houses/farm have equipment such as feeders, drinkers, nests, heating source for chicks, lighting devices and perches?
- What are the feeders, drinkers and nests made of? are they available locally? Can a farmer fabricate his/her own, and if yes what would be the cost?
- Is there a screen for protection from wild birds? Observe feed storage, water quality and waste disposal methods on the farm and note your findings
- Isolation unit for sick birds in place
- Is appropriate litter in place?

Reconvening by the participants and discussion (60 min)
One participant from each group will make an oral presentation and/or simple drawings of the poultry houses and equipment they have seen. The groups will then hold a discussion, focusing on observations made and necessary improvements.

Group work and discussion (40 min)
The trainer gathers examples of materials commonly used in the construction of appropriate chicken houses and making of equipment. Different house/equipment designs are presented by the trainer (a drawing, or better still a house/equipment built with locally available materials). Participants will then be asked to answer the following questions for each type:

- Can this be done locally? What would be the cost?
- Are there alternative materials that can be used?
- How much work and skills are involved in building chicken houses or equipment?
- Pros and cons of each approach?

Summary by the trainer (20–30 min)
The trainer summarizes the importance of housing in providing a conducive environment and emphasizes the dangers to poultry health when not properly built (with requirements of the chicken in mind). The drawings presented in this subpart can be used to illustrate the important functions of poultry houses and equipment.

5. Content

The reading material on housing and equipment is available in Annex 4.

b Starting stock

This session describes the type of birds the farmer starts with. It can be used for training individuals involved in breeding chicken for sale of chicks. To some extent, this session guides the trainees on how to avoid introducing diseases on farm through sick starting stock. Starting with the "right" breed gives an advantage in feed-conversion ratio and reduced risks of undesirable traits.

1. Learning objectives

This module focuses on selecting the best breeds and starting stock for rearing. After completing this module, participants will:

- understand the characteristics of good chicken breeds

- know the breeds available and are adapted to the rearing environment
- how to select brooded or grown-up pullets as startup
- know the measures to be taken to avoid introduction of hatchery infections on the farm

2. Duration

1–2 hours

3. Learning aids

- If possible, the training site should be close to poultry farms that can be easily accessed by participants for farm walks
- Photos of different types of breeds, showing good and bad chicks/breeds
- Pictures of chicks and poultry or living examples of chicks/poultry

4. Activities and exercises

Demonstrations or group work (60 min)

Participants are provided with photos and tasked with identifying chickens of different breeds and ages that are locally available. They will identify good and bad characteristics of these birds and may discuss with the peers the strengths and weaknesses of the different breeds. The following questions may be addressed during the group work:

- Which breeds are available in the area? What are these breeds used for? What are their characteristics, in terms of size, plumage, height of legs, comb type, and wattles?
- Are there preferred chicken breeds in the area? Why are these types of birds popular? What are the advantages and disadvantages of this breed?
- At what age do they develop distinct sexual characteristics, and what are they?
- At what age do they attain the market weight?
- When do they lay eggs? How many?
- What is the price of the chicks and other ages?
- Where do you obtain the birds, or do you produce your own breeding birds?

Group presentations (30 min)
The sub groups will present their findings and subsequently discuss the advantages and disadvantages of chicks or brooded birds as starting stock. Some of the questions addressed in the farm visit can be discussed more in depth by the group.

Finally, the trainer will summarize using the drawings in the content part.

5. Content

The reading materials on starting with a clean flock of chicken is in Annex 5.

c Nutrition (feeds and feeding methods)

Feeding is a major cost in poultry production, constituting up to 70% of the recurrent production costs. Under-feeding in terms of quantity and nutrient quality results in reduced survival, growth and production. Drugs should not be used to substitute feeds and do not increase growth and production in absence of feeds. Therefore, the required nutrient levels

and amounts for each growth stage of the chicken should be provided to achieve optimum growth and production. Weak, under-fed birds are susceptible to diseases. Access to feeds by provision of adequate feeding space (on feeders) should be ensured. Users are advised to consult other books for insight as the specific nutrient requirements and feed formulations are beyond the scope of this manual. This section guides the users on the nutritional value of feeds, types of feeds, what to feed, how much to feed and seasonal calendar for feeds in relation to availability and costs.

1. Learning objectives

After completing this module, participants will:

- understand why it is important to give different types of feeds to chicken
- identify locally available feed suitable for chickens
- know the relative nutritional value of various poultry feed
- know the quantities and times to feed

2. Duration
   3–4 hours
3. Learning aids
4. If possible, the training site should be close to nearby poultry farms that can be easily accessed by participants. Also available should be different types of chicken feeds. The participants may also be asked in advance to bring with them samples of feeds they use at their farms.
5. Activities and exercises
   Short introduction (5 min)
   The trainer will shortly introduce the day's theme and the purpose of the farm walks.

Farm walks (30–45 min)
Subgroups of participants should go to the nearby households that keep chicken and find five different feeds, which they think are suitable for chickens. Sub-groups may also ask local farmers or bring feeds, which they use or imagine could be a good chicken feed. The exercise may be planned by asking participants to bring feeds with them to the day's session.

Practical group work on feed types (60 min)
The subgroups of participants are asked to group the collected feeds according to the main type of nutrients as shown in Figure 1: energy feeds, protein feeds (strength), minerals (hardness) or vitamins (disease protection). Figure 1 illustrates how feeds can be categorized:

Figure 1: Participants divide the collected feeds into groups of nutrients

Source: Riise et al. (2004)

Participants' presentation and discussion (30 min)
Two or more subgroups will make oral presentations of the types of feed that belong to the different nutrient group. The feed found during the farm walk should be used to support the presentations. Finally, the trainer will summarize and identify the subjects, which need further attention. The discussion should include the following questions:

- What do chickens eat when scavenging in the villages?
- Do you feed the chickens in the household? What do you feed them on?
- What are suitable feeds for chickens?
- What feeds are also used for human food and how does that affect their use for chickens?
- Are there other uses of some of the feeds or example for other animals, cash crop?
- Of the identified feeds, which one's supply protein, energy, vitamin and minerals, respectively?
- Is there an option to grow crops as feed for chickens?

Trainer's summary (15 min)
The trainer should explain why it is important to give supplementary feed and how feeds can be characterized according to their nutritional content. Participants should understand that chickens need feeds from all nutrient categories. The trainer should also explain the premixed feeds with the different nutrients sold commercially. Some companies import premixed components of feeds and sell to farmers as concentrates. The concentrates contain proteins, minerals and trace elements that the farmer mixes with the energy sources, which are purchased separately. Advice on feeds and feeding will be different for free-range and intensive production systems due to different economic situations. In this session, the focus will be on intensive and improved free-range systems and discuss the importance of feed requirements, feed types, feed mixing, and feed costs.

6. Content

The reading materials on the nutritional requirements of chicken is in Annex 6.

d Diseases and healthcare management in chicken

This module covers the healthcare needs of the poultry. The health of the birds largely depends on the environment and minimizing exposure of the birds to the disease-causing agents.

1. Learning objectives

At the end of this session, the participants will:

- Understand the route of entry of infections in poultry
- Know the signs of ill-health in flocks
- Know the importance of disease diagnosis and the procedures involved
- Control of diseases on farm
- Know the disease prevention measures by vaccination

2. Duration
   3–4 hours

3. Learning aids

- Drawings or photos of healthy and sick birds, disease calendars and vaccination charts
- Vaccine carriers, vaccines and administration tools
- Illustration charts on Biosecurity
- Access to poultry farms for group work

4. Activities and exercises

Introduction– Brainstorm (30 min)
Participants are asked to name characteristics of healthy and diseased birds and how diseased birds in a flock are identified Other areas to be covered include how chicken get infected; preventing diseases from entering poultry flock; vaccines used and scheduled when they are administered; how vaccine are handled and who decides the treatment for the birds.

Group work (45 min)
Participant subgroups each visit a farm and assess the chicken flock using simple observational sheets. Biosecurity measures should be observed. Participants should record the number of healthy and unhealthy chickens seen. The approximate age of the affected chickens should be noted. The participants' subgroup obtain from the farmer information on how sick/unhealthy birds are managed. Participants should observe the preventive measures taken at the farm, identify methods of disease prevention, management, hygiene measures, or their absence The subgroup should look at good local ideas and also look out for poor hygiene, poor housing and diseased birds. The owners should be asked what they use for prevention or treatment against diseases.

Participants´ presentation (30 min)
A member from each group should present their findings from the farm visit verbally and list the disease symptoms they observed (if any). Together, the participants can then make a list of most important disease symptoms and which age groups seems to be affected the most. They should also list the local names of the diseases. The trainer should now follow up the presentations by suggesting which diseases they are probably talking about. He/she should also explain briefly about the prevention and treatment methods. This is a difficult task as many poultry diseases have similar symptoms. The trainer should make it clear to the participants that it is important to call a veterinarian or health worker in order to take the right action against the disease. The most important diseases, such as Newcastle, Gumboro, Infectious bronchitis (IB), Fowl Pox, common bacterial infections, internal (coccidiosis and worms) and external parasites should be mentioned together with their symptoms, and which age groups they mainly affect. Locally it could be other diseases than those mentioned here, in which case those diseases should be dealt with instead.

Discussion (30 min)
The participants and the trainer should now discuss the following questions:

- Which type of diseases (symptoms) seems to be the most important in our area?
- How are these diseases prevented and controlled?
- Which prevention and treatment methods are recommended by veterinarians?
- How are sick birds handled?

The trainer should also mention that a very important factor in order to avoid disease outbreaks is the daily monitoring of the chickens for good hygiene, access to clean water, feed and feed supplements and adherence to biosecurity measures on farm.

Note: After all the discussions, the trainer should endeavor to get back to the farm with disease occurrence and provide advice.

5. Content

The reading materials this session is found in Annex 7.

The list of poultry drugs registered in Uganda with their withdrawal times is in Annex 10.

Module 3: Poultry disease diagnostics

This part covers the importance of disease diagnosis, the diagnostic procedures for poultry diseases and recognition of diseases by syndromes. Diagnosis involves taking the history of the case, taking note of the clinical signs and syndromes as well as postmortem, sample collection and laboratory confirmation of the disease. This section is intended for veterinarians and veterinary paraprofessionals with at least a Diploma in Animal Production and/or laboratory science. Prior veterinary medical background is a requirement for participation in this module.

1. Learning objectives

At the end of this module, the participants will:

- Understand the importance of poultry disease diagnosis
- Understand diagnostic procedures for poultry diseases including postmortem and bacterial culture and characterization.
- Recognize common chicken diseases by syndromes or clinical signs.
- Understand procedures related to antimicrobial susceptibility testing

2. Duration
   4 hours

3. Learning aids

- Illustrations or photos of healthy and sick birds
- Postmortem kits, personal protective equipment, petri dishes, 70% ethanol, sample container, cool box, sample submission form, biohazard bags, sample labels, swabs and sample media
- Poster of postmortem procedure in chicken
- Bucket with soap and disinfectant
- Paper towels for drying hands
- Sick and healthy chicken for demonstration purposes
- Waste disposal bins
- Standard operating procedure for postmortem examination
- Postmortem report forms and laboratory request forms
- Laboratory standard operating procedure for pathogenic bacteria detection

4. Activities and exercises

Introduction– Brainstorm (30 min)
Participants are asked to name common diseases of poultry. The following are some questions that can be used to guide the discussion; How do they recognize the specific diseases? What diagnostic procedures are available to differentiate the diseases? How do they decide what treatment is given to sick birds? Are they able to describe the postmortem procedure in poultry? Are they able to describe the process of Antibiotic susceptibility testing?

Group work (2hr 30min)
The facilitator takes the participants through the diagnostic procedures (briefly) and uses the available samples for demonstration. Participants are then grouped by the facilitator basing on capabilities detected and background competencies. Groups should be mixed; a group should not comprise of only bachelor's degree holders when Animal husbandry officers with diplomas are present. . Participant subgroups are provided with both a healthy and sick chicken so that they can be able to compare the appearance of normal and abnormal internal organs. Participants are provided with postmortem forms that provide for history taking, signs of ill-health, identification and description of lesions on affected organs. They should be allowed to clinically examine the birds, decide on the diagnostic procedures to take and carry on with it. During the training, participants should be provided with post mortem SOPs, kits and sample collection tools for microbiological work and allowed to carry out postmortem under supervision. They should write a report using the format in Annex 8. What are the procedures for cleaning the working surface and surgical tools before and after postmortem? How do you dispose of the carcass after examination? Participants should be trained on donning (putting on PPE) and doffing (removing the PPE after work).

Participants' presentation (1hr)
A member from each group should present their reports from the postmortem and describe the lesions observed. Based on the lesions, what are the most likely diseases? What samples are needed for further tests and which tests? How should these samples be packaged and transported and under what conditions? What tests are required to confirm the disease? The trainer now follows by summarizing the findings and discusses the morphological features of the organs and tentative diagnoses and the confirmatory diagnostic procedures available? What recommendations to give to the farmer to manage the disease at hand.

Discussion (1 hr.)
The participants and the trainer should now discuss the following questions:

- Which diseases (symptoms) are common in the area?
- During what period do the diseases occur: Dry or rainy season, or always?
- Which diseases affect different age groups?
- What factors could be associated with these diseases? Is it feeding? housing design? Hygiene? Spacing? hatchery conditions of poultry litter? roofing?
- What is the treatment regime and type of drugs? Is it Herbal? Or manufactured drugs?
- Was it the right treatment given?
- How are these diseases prevented and controlled?
- Which prevention and treatment methods are recommended by veterinarians?
- How do the farmers respond to such disease?

5. Content

The reading materials for diagnosis of diseases, diagnostic procedure and post-mortem techniques in poultry are detailed in Annex 8.

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Annexes

Annex 1: The training program

Training of trainers on antimicrobial resistance, infection prevent and control in poultry production
Training program (for residential training)

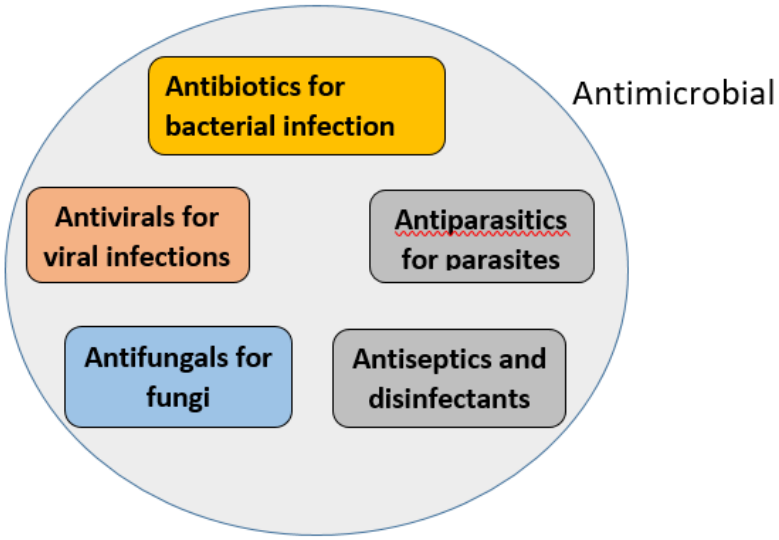
Day	Morning (8–10am)	Break	Mid (10:30am to 12:30pm)	Lunch	Afternoon (2–5pm)
Day 1: Arrival, settling in and location of training venue					
Day 2	Introductions, setting rules for the training, code of conduct, election of class leaders, sharing training expectations, fears, logistics, and official opening remarks	Group Photo	Envisioning, overview of poultry production in Uganda-the current status and outlook. The challenges and opportunities of poultry production		Understanding Antimicrobial resistance: objectives, participatory activities, discussions and the facilitators summary.
Day 3	• Principles of Infection prevention and Control (Part I and II) • Part I: Understanding the body and function of chicken for proper care		• Part II: Animal husbandry practices (overview) • a: Housing and equipment (objectives and activities, exercises including farm visit)		• a) Housing and equipment (Plenary discussions and facilitators summary--- 1hr) • Subpart b) Breeds (starting stock----2 hours) • State the course objectives, use learning aids to demonstrate, discussions and summary
Day 4 (Wednesday)	c): Nutrition (Feeds and feeding methods, 2 hrs.). Learning objectives, activities and exercises. Identifying feeds and their nutrient values, seasonal variations		Subpart c): Nutrition (Feeds and feeding methods, 2 hrs.)- feed formulations, how much to feed and discussions		d) Diseases and healthcare management in chicken (3 hrs.)- Learning objectives, activities and brainstorming discussions- with emphasis on common diseases, prevention methods by vaccination and biosecurity measures
Day 5 (Thursday)	Principles of poultry disease prevention and control. Vaccinations- practical demonstrations from handling to actual administration		Poultry disease diagnostics- epidemiological, clinical and Laboratory methods		Necropsy procedure and sample collection from Poultry
Day 6 (Friday)	Practical demonstrations		Practical demonstrations		Training evaluation, post training assessment, and official closure
Phase 2: Monitoring the implementation of training items and assessments of progress (Visit the trainees at their training sites and visit farms to assess level of adoption of the training contents, 2–3 months post training)					

Annex 2: Understanding antimicrobial resistance

Antimicrobials

These are medicines, including antibiotics, antivirals, antifungals and anti parasitics – used to treat infections caused by microbes in humans, animals and plants. The most common group of antimicrobials used to treat sick chicken are the antibiotics (those that kill or inhibit bacterial growth). Both disinfectants and antiseptics are also called antimicrobials.

Figure 2: The broad categories of antimicrobials



Antimicrobials and their importance

Before the discovery of antibiotics, many humans and animals died of infections, that are now readily treated. The first antibiotic discovered was penicillin in 1928 by Alexander Fleming, which saved many lives. Since then, several antibiotics were discovered by scientists for the treatment of different bacterial infections. The discovery of these drugs is expensive, approval for use takes long and their development requires a lot of expertise. Such resources are currently very limited in Uganda and many parts of Africa.

Antibiotics are important in treating diseases caused by bacteria in humans and animals. Several bacterial infections of the throat, respiratory system and urinary tract infections are treated with antibiotics. Some of these bacterial infections can become generalised in the body (sepsis) and are life-threatening if not treated. In animals, antibiotics are also used to treat a variety of bacterial diseases (examples of which are in Module 2, Subpart IId). Without them, animal production would be nearly impossible due to abundance of some bacteria in the environment. This would have significant effects on food security and survival of mankind. Antibiotics are also being used to treat bacterial crop diseases, although on a lower scale compared to the use in livestock production (Haynes et al., Fera Science Ltd. 2020). The list of antibiotics approved for use in Uganda can be accessed on the website of the National Drug Authority (NDA) (https://www.nda.or.ug/drug-register-downloads/) and the essential veterinary drug list is accessible at https://www.agriculture.go.ug/wp-content/uploads/2021/10/EVMLU_Uganda.2020.pdf

Antibiotics cannot treat diseases caused by viruses or pathogens other than bacteria. Therefore, their use should be sanctioned after diagnosis of the disease and proof that the bacteria is susceptible to the antibiotics being prescribed. Most of the antibiotics used in humans and animals belong to same family of drugs. The discussion on drug families is out of the scope of this manual. Readers are advised to seek additional information from online resources.

Understanding basic physiology and structural biology of microorganisms

Microbial physiology can reasonably be defined as "structure–function relationships in microorganisms, especially how microbes respond to their environment".

What is antimicrobial resistance?

Antimicrobial resistance occurs when bacteria, viruses, fungi and parasites change over time and no longer respond to medicines that used to kill them making infections harder to treat and increasing the risk of disease spread, severe illness and death. AMR is a significant threat to human, animal and environmental health. If not appropriately addressed, common infections, minor injuries could be associated with life-threatening risk. When microbes like viruses, fungi and bacteria no longer get killed or inhibited by the same drug that used to work in the past, it is termed as antimicrobial resistance. These resistant germs have been found on several farms in Uganda and have caused significant losses on those farms. Some of the contributing factors include irrational drug use as identified by a baseline study we conducted here.

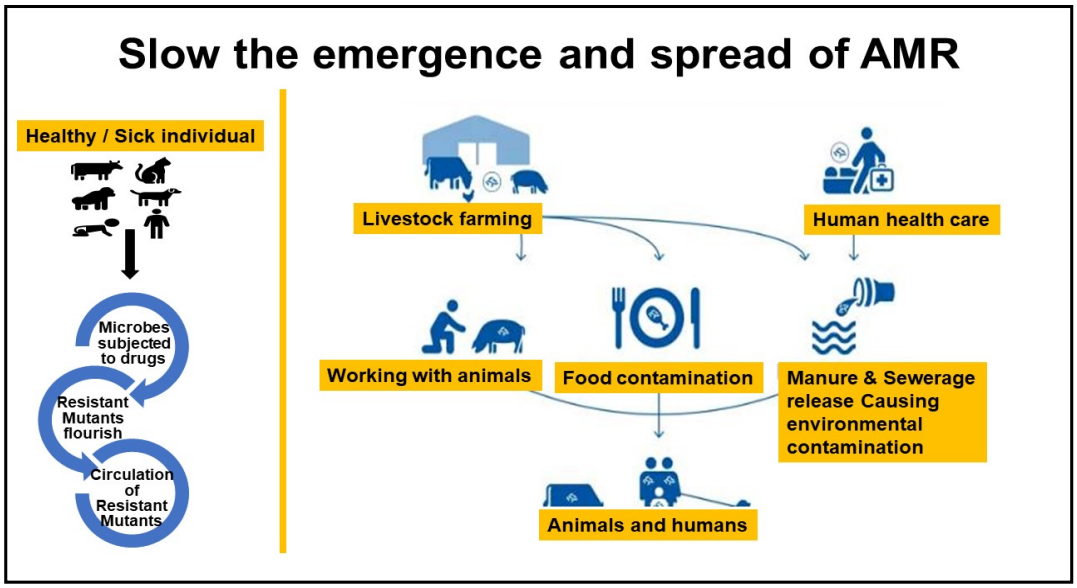
This part focuses on antibiotics as they are the most commonly used antimicrobials.

How does antibiotic resistance develop in bacteria and spread out?

Bacteria tend to adapt to substances to which they are subjected by changing part of their genetic make-up. Bacteria develop resistance to antibiotics in two major ways; 1) some bacteria are preprogrammed to be resistant to certain types of antibiotics, this is called intrinsic resistance; for example gram negative bacteria with a cell wall that can physically block some antibiotics from working, 2)some bacteria can acquire genes for resistance known as acquired resistance.

If drugs are not given in the correct doses to eliminate the germs at once or if we overuse these drugs, germs may adapt to them. The germs will continue to grow in the organs of poultry or even humans, despite the presence of the drug. These adaptations are inevitable as these organisms also find ways to survive. When the organisms become resistant, they can therefore spread between animal populations to environment and even to humans. The environment may get contaminated by uncontrolled waste disposal, such as litter from a poultry flock with resistant germs. Figure 3 explains the emergence and different pathways humans, animals and the environment get exposed to antimicrobial resistant organisms. The two phases comprise of AMR emergence (left) and, sources and spread (right).

Figure 3: Understanding the emergence, sources and spread of resistance



Emergence: Frequent use of antibiotics will make bacteria develop mechanisms to resist the intended action of the drug. When a healthy or sick bird receives antibiotics, the drugs will kill the naïve bacteria and if there exist bacterial communities with genes for resistance, these will not be wiped out. In the long run, they become dominant in the birds' intestinal system and are passed out in feaces, ending up in the environment (soil, water, air).

Sources of resistant bacteria include human waste and secretions; animal products (eggs, meat, milk) and waste (feces); and the environment including soil, water, air (say in dusty poultry house). The spread of these resistant bacteria can be through manure or sewerage release into the environment. Humans or animals can also acquire the resistant bacteria through drinking, eating or breathing in contaminated water, food or air respectively. Therefore, the farmer and his animals are at risk of resistant germs.

What can be done to manage the emergence and spread of Antibiotic resistance from livestock production to humans?

Anti-microbial products are widely used in animal health and husbandry for various purposes including treatment and prevention of diseases. Farmers are responsible for ensuring the health and welfare of their birds. This is because in Uganda, livestock production and protection of animal health has largely been privatized, with government controlling a few notifiable animal diseases (see Animal Diseases Act).

Farmers often buy drugs over the counter with no prescriptions and administer them to their animals. This practice leads to drug misuse and abuse, a factor that promotes development of antimicrobial resistance. Response to treatments of sick animals are better when the treatment is targeted to eliminate the cause. Therefore, diagnosis of the disease by an animal health worker is important.

On the other hand, regulators should control the distribution chain of the drugs. It is therefore the responsibility of all stakeholders to protect the antimicrobials from irrational use, to guarantee efficacy. Efforts at farmer level should be directed towards infection prevention through good husbandry practices, biosecurity measures and routine vaccinations.

In October 2020, the BUILD project conducted a baseline study to evaluate the knowledge, attitudes and practices relating to antimicrobials, antimicrobial use, and antimicrobial resistance among different stakeholders in the poultry value chain in Wakiso and Soroti districts, Uganda. Overall, the survey revealed 73% knowledge deficit amongst poultry farmers on issues of AMR.

From the same study, 80% of the farmers did not know that bacterial infections in birds that are not responsive to antibiotics are a result of AMR More than half (60%) of the farmers did not know that resistant germs can be transmitted between birds. About 56% of the farmers did not know that AMR is a threat in Uganda and 77% had no idea that resistant germs can be found in meat and eggs. In both districts, farmers admitted to using human drugs for treating chickens and animals. This practice is dangerous and is likely to make antibiotics to become ineffective for both humans and poultry, as several bacterial diseases are shared between poultry and humans (zoonoses). Resistant germs may spread from poultry to humans (and vice versa) and will cause severe illness that is difficult to treat with the affordably and widely available antibiotics.

Examples of the resistant chicken bacterial diseases include salmonellosis, colibacillosis, erysipelas, campylobacteriosis among others identified. If these resistant organisms are passed to humans after encounter with chickens through farm work or consumption, the risk of losing the affected persons is high. This is because the antibiotics used in humans and animals are in the same family but purified differently or given with different dosages due to variation in body functions.

Conclusions drawn from the study indicate that farmers are not aware of the dangers associated with antimicrobial resistance. Ttherefore, policies that promote the rational use of antibiotics need to be implemented together with heightened surveillance activities and awareness creation, aimed at curbing AMR.

Annex 3: Basic review of the functional anatomy of poultry (i.e. chicken) in relation to infection prevention and control

The **digestive system** starts from the beak (the mouth), runs down through the oesophagus to the crop, then to the proventriculus, gizzard, intestines (with the pancreas attached), then to the cecum and ends in the cloaca. The whole length of adult chicken digestive system is about 1.5m long compared to that of a goat at 33 meters. This means the time it takes for feed to be broken down in the digestive system of a bird is short and therefore fermentation time is short, compared to cattle, sheep and goats. Therefore, the food given to chicken should be less fibrous and easily digestible for the digestive system to extract nutrients from the feed to sustain the bird. While other animals have teeth, to help with breaking down feeds, chicken have small stones (grits) in the gizzard. Chickens are not hatched with these stones; they acquire it from the environment as they feed. It is therefore necessary to provide grits to chicken at different stages of their life to aid breakdown of feeds for better digestion. Layer chicks are given grit in the 2nd week of life in form of fine grit or insoluble grit. Then older pullets can be given larger grit at 12 weeks. This will prepare the gut to handle large amounts of cellulose later in life. Feed hopers (troughs) with grit are alternated with those of food.

The **respiratory system** of the chicken is different and more efficient compared to that of mammals (taking into account that birds can fly). Flight, like running, is an energy consuming activity and so much oxygen is needed. The birds have no diaphragm as in mammals that demarcate abdominal and thoracic cavities, and aid in lung contraction. The lungs are embedded in the rib cage and so do not expand like in mammals. Air flow in birds is aided by additional structures called air sacs, whose compression aids air flow in lungs. Birds also have air-filled hollow bones (pneumatic bones) that relate to the air sacs to aid respiration. Fracture of these bones (for example during rough handling or transportation) affects normal breathing. The pneumatic bones include skull, humerus, clavicle, keel (sternum), pelvic girdle, and the lumbar and sacral vertebrae. Respiratory difficulties are among the most common signs of diseases reported in intensive poultry flocks in Uganda and the ones mostly treated with antibiotics. Respiratory diseases are made worse by unconducive environment such as congestion in the house leading to stale air (ammonia and carbon dioxide) and inadequate ventilation, leading to accumulation of dust particles with pathogens in the environment. Therefore, provision of well-designed shelters for several birds is a prerequisite for healthy birds right from the start (see section of housing in subpart (a) in this manual).

The **skin** of the chicken is loose and covered with feathers. Chicks' feathers are soft and little; so the body is not well insulated from coldness. In addition, their size, heat loss from the body is high. Therefore, chicks need an external heat source to enable them to balance their temperature and live comfortably. On the other side, adult chickens have more feathers that retain a lot of heat; more like wearing a jacket on a hot day. The chicken feathers are like a permanent jacket that cannot be removed. Excess heat from the environment in addition to the already high temperature of the chicken (42°C) adds stress to the birds and reduces feed intake with consequent poor production (low egg numbers, low egg weights, poor shell quality and even death in heat stress). Poor general growth means small sized birds and eventually less meat. Therefore, adult chicken need cool (but not cold) environment for a normal life (see ventilation under housing and equipment in part II of this module).

The **urinary system** of chicken consists mainly of the kidneys and ureters, but no urinary bladder like in other animals (mammals). As the mammals excrete urine as liquid waste, chicken excrete semisolid white material called uric acid (urate). The uric acid becomes more solid and may block small tubes through which urates flow in the kidneys. This happens during dehydration and other diseases that affect kidneys (like infectious bronchitis, Vitamin A deficiency). Causes of dehydration include poor or limited water intake (water access due to few drinkers or loss of appetite), salty feeds, diarrhoea or excessive loss through panting during hot weather. Therefore, chicken should be provided with abundant fresh water all the time, have well balanced feeds and cool environment.

Additional tip: poultry litter contains a lot of nitrogen and if collected, it can be used as a natural fertilizer.

The **reproductive system** of the bird is made up of the ovary and a tubular oviduct extending down to the cloaca. Only the left reproductive system is functional. The eggs laid by chicken are large, relative to their size and sometimes involves eversion of part of the lower reproductive tract. Egg shells are not impenetrable like stone. Microbes can get into the shells, as through the skin. If the eggs are laid on litter with heavy loads of faecal matter, the risk of contamination of egg tract becomes high. It becomes a source of disease as the birds begin to attain peak production and egg sizes increase. The egg-laying process also involves the contraction of the muscles of the oviduct which require calcium among other things. Therefore, for laying hens, adequate number of nests with clean litter are needed in addition to good supply of calcium, phosphorus and vitamin D in diet.

The **heart of chicken** beats faster than that of humans and larger animals. To maintain the heart rate and other body functions, chickens need daily supply of energy feeds (to keep them alive and strong). So, the feeds must be well balanced to supply energy for maintenance, growth and production. Other nutrients must also be supplied to build and maintain the body.

The **nervous system**; the brain and spinal cord that make up the central nervous system. Other nerves that originate from the brain and spinal cord to other body organs like the limbs are called peripheral nervous system. Deficiency of vitamins and minerals are among the common preventable diseases by proper nutrition. For example, crazy chick disease that affects the brain is preventable by providing good amounts of vitamin E in the diet throughout. Other infectious diseases to the brain are extension from other body organs, some can be prevented by vaccination.

The **immune system** of the chicken consists of the spleen, bursa of Fabricius, thymus and other small tissues associated with respiratory and digestive tract. Chicken do not have lymph nodes like mammals. Immunosuppression can result from stress from factors such as overstocking, dietary deficiencies and rough handling. It can also result from infections such as Gumboro disease which lowers chicken's immunity. Therefore, regular vaccinations are important to keep the immune system active to fight against diseases.

The **musculoskeletal system** in chicken is important because bones are a major reservoir for calcium, which is found in their inner hollow canals (called medullary bone). The medullary bone develops towards the start of laying. That means the pre-layer diet should have enough calcium to support the development of this bone, for proper egg-shell formation during the laying period. If this bone does not develop, there is likely going to be poor production, which cannot be improved by drugs (antibiotics). So, good nutrition is essential in chicken production.

Proper poultry management is therefore important in ensuring their productivity.

Take home messages: When chicken don't grow as expected, a farmer should first check if they can improve husbandry practices before administering antibiotics.

Annex 4: Housing and equipment

A Poultry house is a major capital investment in starting poultry enterprise. If the setup of the house and the farm are done correctly and appropriately, the business has the opportunity to be profitable. However, if the farm is not built well, this can lead to poor environment, increasing the likelihood of infections and mortality.

Why is housing important?

- In intensive systems, chickens spend their entire lives in a poultry house. The waste they excrete contains high amounts of microorganisms and nitrogenous waste that can release toxic gases (ammonia) when mixed with water.
- What affects their health therefore come from within the house (most common) or may be introduced from outside (less common)
- The most common diseases reported/diagnosed are related to hygiene or management. Examples include chronic coccidiosis often misdiagnosed as Marek's disease, colibacillosis (7 different syndromes), helminthiasis and other bacteria
- Less common in commercial poultry flocks these days but with devastating effects include Newcastle Disease introduced from outside the house
- It is therefore clear that housing & management systems have a great effect on the health and ultimate production of birds later in life
- Therefore, conducive environment is essential in alleviating stress to the birds.

Figure 4: Infections associated with poor housing.

The chickens in Figure 4, were presented by a farmer for diagnosis at the central diagnostic laboratory, college of Veterinary Medicine, Makerere university in June 2019. The chicken exhibited swollen eyes, had persistent flu-like signs and cheesy material covered the eye surface. Faecal bacteria (namely Escherichia coli) were isolated from the affected eyes and other organs. Moreover, bacterial strains were resistant to > 8 antibiotics and the farmer had lost a lot of chicken due to this infection. Further investigation revealed the chicken house had poor ventilation and direct sunrays in the morning hours, that encouraged excessive play and litter spoilage in the house. The dust raised contained chicken droppings, litter particles and urates, which got into the eyes and airways of the birds.

Other diseases associated with poor house design or management include Fowl cholera, staphylococcosis (including bumble foot), coccidiosis, brooder pneumonia (aspergillosis) and ectoparasites. See subpart IId for some disease syndromes.

What aspects should one consider when constructing and stocking a poultry house?

The following specifications must be taken into consideration when constructing a chicken house:

- Space allowance per bird/stocking rate
- Ventilation/humidity/temperature
- Lighting
- Hygiene/litter management
- Biosecurity

Space allowance/stocking rate

Do not overstock. Keep only the number of birds the house can accommodate.

The room will be heavily contaminated if overstocked. The more the birds in a limited space, the faster the waste build-up and risk of hygiene-related diseases. Chicken droppings have both the faecal matter (source of faecal bacteria) and uric acid (source of ammonia). Table 3 provides a guide to stocking rate in a deep litter system. To estimate the stocking rate of a house, obtain the area of the house and multiply it by the number of chickens recommended to fit in it. For example, a house that measures 10x5m will have an area of 50m^2 equivalent for 250 –350 adult layers above 19 weeks. At no point should this house be stocked more than 350 chicken on deep litter system.

Table 4: A guide to the stocking rate of commercial birds in intensive system are as below (MAAIF 2019 and Smith, 1990)

Poultry	Age	Estimated space requirement
Broilers	Day 1	0.46 sq meters or 5sq ft of brooder/100 chicks
	Week 1–4	1sq ft/bird or 20 birds/sq meter
	Week 5–8	2 sq ft/bird or 5–6 birds/sq meter
Layers	0–6 weeks	0.5sq ft/bird or 20 birds/sq meter
	7–13 weeks	1 sq ft/bird or 10 birds/sq meter
	19 weeks onwards	1–1.5 sq ft/bird or 5–7 birds/sq meter

In addition to floor space (stocking rate), Enough feeding troughs should be provided. Pecking order is common in birds, with the weak birds being outcompeted; leading to uneven growth rate or death from starvation/dehydration. Birds that have less access to feed are stressed, weak and less resistant to diseases. The feeding space also applies to the drinking space. Feeding space on equipment is provided in Table 4. For example, a 1.2-meter linear (wooden) feeder for adult layers, is 120 cm and will accommodate 10 hens (120÷12). Each side of the feeder takes 10 birds giving carrying capacity 20 birds per linear feeder in a day.

Table 5: A guide to feeding space requirements for different growth stages of chicken

Poultry Type	Age	Feeding space on a linear trough
Broilers	0–2 weeks	5 cm/bird
	3–4 weeks	7.5 cm/bird
	5–8 weeks	10.0 cm/bird
Layers	0–4 weeks	5 cm/bird
	5–8 weeks	7.5 cm/bird
	9–20 weeks	10 cm/bird
	Above 20 weeks	12.0 cm/bird

Laying birds also need additional space for nesting.

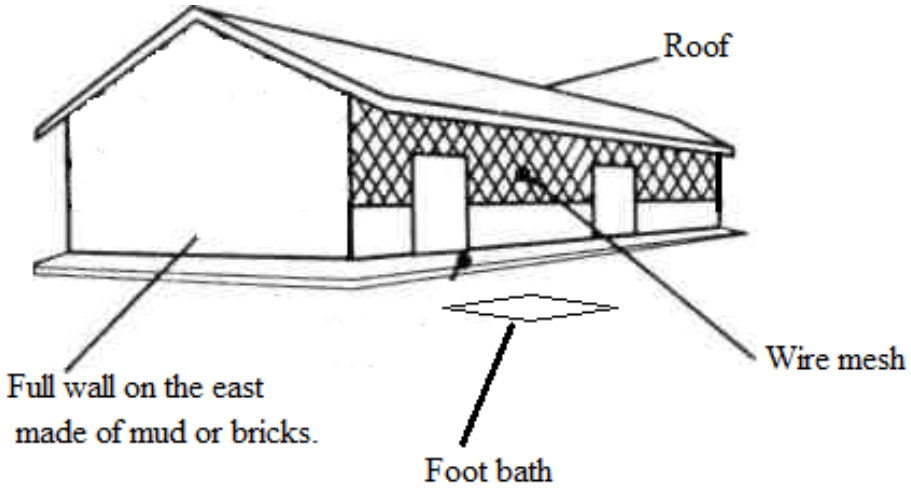
- Nesting space should be adequate to accommodate birds during peak production (25 to 44 weeks of age) to reduce floor laying and cannibalism
- There is reduced incidence of salpingitis (ascending infection of egg tract) in birds that lay in nests with relatively clean litter. The litter in the nests should be fresh, not the one from the floor of the house.
- Broody hens should regularly be removed from the nests to free the nesting space.
- Nest types
    - Communal nests are those that accommodate about 50-60 birds at once
    - Individual nests are those that only accommodate one bird at a time. Each individual nest serves about 5 to 6 birds per day.

Ventilation, humidity, temperature and light distribution in the house

- **Ventilation**
    - Ventilation is very important to ensure removal of stale air, excess heat and moisture from the house
    - In tropical areas (hot and humid), natural ventilation (normal airflow) it relied upon, therefore the poultry house design and stocking rate should be strictly observed
    - Natural ventilation is ensured by building the rearing houses to half wall on the long axis, that is, 0.6–1m high and the width does not exceed 9.0m.
    - Artificial ventilation is provided by fans that blow cool air across the house.
    - Space between parallel poultry houses should be at least 10m apart to allow for free air flow.
    - The walls should be tall enough to reduce heat load in the house
- **Humidity**
    - Moist conditions in the house promote growth of parasites (coccidia/worms) and fungus in the litter. Fungal spores in litter may cause brooder pneumonia, which is a disease of chicks without effective drug for treatment.
    - Coccidia require moisture, warmth and aeration for their development.
- **Temperature**
    - Excess heat decreases feed intake and results in low egg production and small egg sizes (due to much evaporation from the eggs).
    - In hot environment, birds pant (as shown by breathing with open mouths and spreading the wings apart), get dehydrated and lay thin shelled eggs.
    - Warmth is necessary for young chicks (as for any baby animal or humans).
    - Both humidity and temperature can be regulated by ensuring adequate ventilation.
- **Light intensity and distribution in the house**
    - Light stimulates activity in birds naturally, including in wild birds. Bright light makes birds active by increasing their playfulness and aggressiveness as well as feed and water consumption.

- Bright spots of sunrays that enter open-sided houses in the morning and evening hours attract chicken to play/sunbath. This causes more birds to gather in some spots, excrete more waste in those areas and litter gets spoilt in those spots. As chicken sunbath and play more in bright light, more dust with fecal bacteria enters their eyes and airways, predisposing them to respiratory diseases.
- Chicken houses should therefore have even light distribution (without direct sunrays). This is achieved by orienting (positioning) the house in east-west direction as shown in Figure 5. The full walls are in the East and West side while the short walls are in the north and south sides.

Figure 5: Example of rearing house



Source: Eneku and Waelti, 2020.

The side with the mesh is the length and be adjusted depending on the number of birds one intends to keep. The full wall without mesh is the width and it should not exceed 9 meters wide for natural ventilation. A farmer may construct a storeyed structure but with similar specifications as the ground floor house illustrated in Figure 5.

Hygiene & Litter management

- Rearing chicken on the floor is the most common in Uganda because it is cheap. Labour and space are not serious limiting factors at present. Various types of materials are used as litter including coffee husks, wood shavings, rice husks, crushed ground nut hulls, and chopped maize/sorghum stalks (stover) among others.
- The floor is first covered with the litter to a depth of 2-3 inches (5-8cm) (to avoid burial of chicks) and is gradually increased to 6 inches (15 cm), by adding more litter every 2-3 weeks.
- The litter should not be mouldy. The litter should be kept dry and friable (not caked) by replacing the wet part and raking daily.
- Raking should be done gently to avoid raising dust.
- All caked and dump litter should be removed and treated or composted before use in gardens.

Hygiene & Biosecurity measures on the poultry house

- It is important to limit entry of disease into the poultry house
- Biosecurity involves
    - Cleaning (removing organic matter and washing with a detergent)
    - Disinfection (of cleaned surfaces with a disinfectant)
    - Restriction of entry into the house and isolation of suspicious birds

- Therefore, the floor of the house should provide for easy cleaning and disinfection. In this regard, a concrete floor would be desirable.
- Foot baths/disinfectant sprays should be available at the house inlet.
- Gum boots should be used only for the chicken house.
- Wire mesh should restrict entry of unwanted birds/animals. People who are not workers in a poultry unit should not be allowed in
- It is thus recommended to fence off a poultry unit from any unwanted access and the entrance of the fence having disinfection points/tyre bath for farm workers, visitors, equipment or vehicles accessing the farm.
- Since biosecurity practices are rather behavioral, ensure compliance by sensitization of workers and visitors and putting barriers that are visible.
- Adoption of all-in, all-out system. This involves stocking a batch of chicken from same source at once in a house, feeding and maintaining healthcare together and disposing or marketing them at once. This allows the farmer to get rid of a disease situation all together.
- Acquire clean stock from clean hatcheries
- Ensure adequate waste and manure disposal
- Provide safe and clean water for drinking and use clean drinkers
- Do not add new birds
- Do not keep chicken with other poultry species

Note: Diseases introduced from outside tend to be contagious and may persist in the environment for long. For example, a farm that has experienced Gumboro disease outbreak in the past is likely to have repeated outbreaks. This is because of the persistence of the virus in a floor that is not well cleaned and disinfected or being carried on the gumboots to the house from a contaminated compound. Please consider biosecurity measures among the first line defense steps against infections. See the content of subpart (d) on ways of introduction of disease agents onto a farm and specific actions to prevent disease introduction.

Procedure for cleaning and disinfecting the house

- Remove all birds from the house (in case of disease outbreak) and move them to a clean unit, for example, move chicks from a brooder to finishing pens.
- Remove feeders and drinkers, have them washed thoroughly and dry in the sun. The equipment should also be disinfected.
- Remove the litter from poultry house and dispose in a composting site or pit before use in gardens.
- Soak the house (floor and walls by spraying with water) to loosen the dirt.
- Wash the house with a detergent to remove dirt. The waste water should be channeled through a drainage from the house to a soak pit.
- Rinse the house and allow it dry then disinfect with a recommended chemical disinfectant and carefully follow the manufacturer's instruction.
- Leave the house to rest for about two weeks before restocking it. Disinfection lime or wood ashes may be applied on the floor at this resting phase. By this time, a lot of diseases will be controlled.

Equipment in the poultry house

Equipment includes feeders, drinkers, nests, perches, heat source for chicks and other feed storage/transportation tools. The sizes and carrying capacity of the equipment have been discussed under space allowance per bird in house designs above (in this subpart I).

The participants should be involved in exercise of making their feeders or improvising drinkers. Creativity of the trainer and the participants is important in stimulating production of such tools.

The feeders should be constructed to meet the following requirements:

- Easy to clean and fill.
- Minimize feed spillage or wastage.
- It should not allow feed contamination by droppings (faecal matter).

Participants learn how to construct feeders from wood from iron sheets.
Source; Eneku and Waelti, 2020.

Buckets and platters purchased at the local market are used as drinkers.
Source; Eneku and Waelti, 2020)

Two slits are made at the mouth of the bucket about 3cm deep, to allow the water to come out gradually. This type of drinkers is good for chicken on free range system where use of modern drinkers is not common

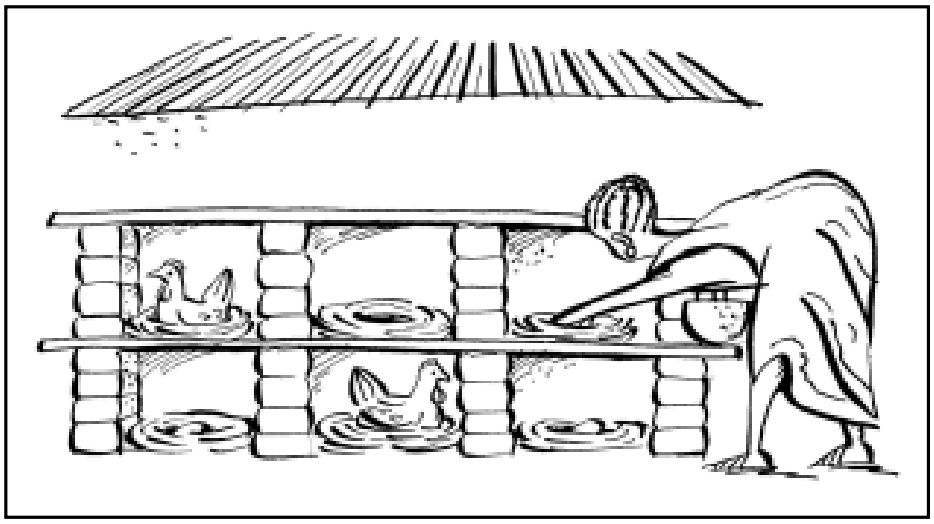
Conical drinkers and the wooden linear feeder are the commonly used feeding equipment in the poultry house.

The individual nest room as shown in Figure 6 measures 30cm long by 30cm wide by 30cm high. This accommodates about 6 hens per day. These are individual laying nests that take up one chicken at a time, and up to 6 birds in a day. They can be constructed locally and provide slightly dark conditions for the hens' "privacy" during laying. The privacy protects the hens from pecking and subsequent oviduct infections. Houses without nests are a big risk to laying birds, particularly during the peak periods as many and bigger eggs are being laid and often on the floor where a lot of fecal bacteria accumulates. In many chicken farms in Uganda, infection of the egg tract is a common cause of drop in production and laying of small-sized yolkless eggs.

Figure 6: Battery of individual nests

The above photos illustrate one with the right sized entrance (right) and another with wide entrances which is not ideal (left). Such nests can also be made of bricks as shown in Figure 7.

Figure 7: Battery of nests made of bricks



Source Riise et al. (2004)

Annex 5: Starting a poultry enterprise with a clean flock

Most commercial farmers in Uganda rear chicken for eggs and meat. The farmers obtain chicks from breeders (breed multipliers) to stock their farms. Because the farmer has no control over the breeding practices of the parent stock owner, the possibility of introducing hatchery-borne diseases into new stock is high. Some diseases that have been reported to arise from the parent stock/hatcheries include Salmonella pullorum and S. gallinarum, Mycoplasma, Avian encephalomyelitis and contaminants such as E. coli, Aspergillus among others. It is common practice among farmers to use antibiotics from day 1 in chicken flocks. Some hatcheries advise farmers to give antibiotics such as enrofloxacin to chicken during the first week of life. This is not a desirable practice as it constitutes irrational drug use and is likely to result in emergence of resistant bacteria.

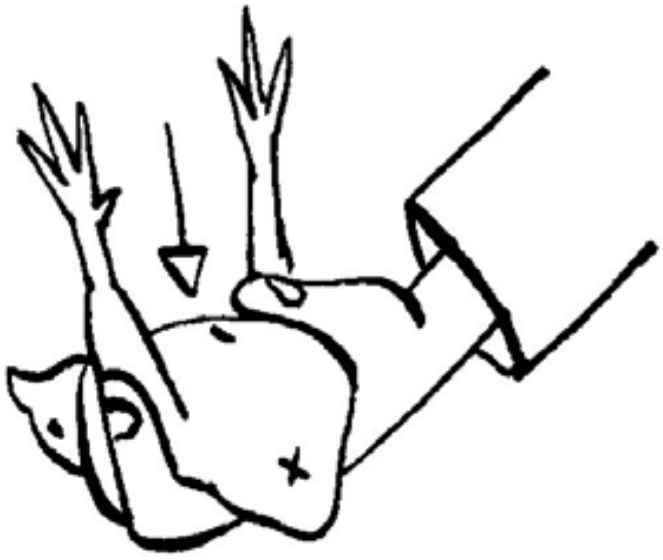
The farmers on free-range chicken rearing system often leave the birds to mate at random without any planned breed improvement measures. Consequently, bad effects of inbreeding, vertical disease transmission among others cannot be controlled. Therefore, temptations of using antimicrobials, particularly, human drugs (antibiotics and antivirals) for treatment and growth promotion of birds may arise.

Selection of start-up chicks

For the farmers in intensive production, a sample of chicks should be examined before accepting them. A healthy, newly hatched chick should have the following features:

- Well-developed body length and depth
- Shiny, dry and thick down feathers
- Soft belly
- Clean, dry navel as shown in Figure 8
- Thick shanks with spaced and straight toes
- Big clear eyes
- Lively behavior

Figure 8:Characteristics of a healthy hatched chick



Source Riise et al. (2004)

A healthy and good grower should have the following features:

- Should appear healthy and lively
- Feathering shiny and normal (may depend on the breed)
- Large size for the age
- Eyes clear and shiny
- Clean and dry beak and nostrils
- Clean feathers around the vent
- Straight legs and toes

The following are good practices to consider in order to have a good start and to avoid introduction of infections from hatcheries.

Note: starting stock are possible roots of disease introduction and so must be carefully considered.

- Only buy chicks from reputable breeders. Seek advice from veterinarians and fellow farmers about their experience with chicks from breeders.
- Do not use antibiotics in chicks without proper diagnosis
- Do not give antibiotics disguised as vitamins to chicks. Seek advice of a qualified veterinary practitioner to identify the composition of the drug written on the labels.
- Do not accept visibly sick, weak and tiny chicks. Do not accept chicks with swollen or poorly healed navels or multiple malformations. Therefore, observe the chicks uninterrupted in the crates/boxes, then check the chicks randomly by gently handling them and turning their ventral part up to see their abdomen and legs. Good hatcheries provide vaccination records for day-old chicks

Other activities of routine management in a brooder such as stocking densities, temperature regulation, ventilation and others are beyond the scope of this module. Users of this manual are advised to consult other references listed in the reference list to guide on good management of their flocks.

Annex 6: Nutritional requirements of chicken

What to feed?

- In general, poultry, like other animals, need feed containing energy and protein, as well as vitamins and minerals.
- The need for feed will change, depending on the age and status (chicks, grower, egg layer, broody hen) of the bird.
- The cheapest way to supplement the diet of poultry, is to use local resources.
- However, vitamins and nutrients are destroyed if stored for too long or under sub-optimal conditions, e.g. high humidity and heat. Knowledge of the quality and source of different feedstuffs is thus important, to reduce the risk of bad feed.
- The composition and availability of feeds will vary, depending on the season, site location and farming systems.

Types of feeds

The nutrients that must be present in feeds are

- water,
- carbohydrates
- fats and oils } Energy sources
- protein
- vitamins
- minerals

When all these nutrients are provided in adequate proportions, then it's a balanced diet. Depending on the type of feed, it will contain different quantities of the respective nutrients.

Sources of energy feeds

- Energy feeds are the most important feeds to maintain body temperature and exercise levels of the birds. The energy in feed is mainly supplied as carbohydrates ("sugars") but sometimes fats and oils as well.
- Cereals, grain, roots, and tubers are the most important energy feeds.
- The cereals and their waste products found in many parts of Uganda include maize, maize bran, rice, rice bran, millet, wheat waste, sorghum and kitchen/brewer's refuse from any of these.
- Root tubers include cassava, sweet potatoes, yams, plantain and banana meal.

Sources of protein:

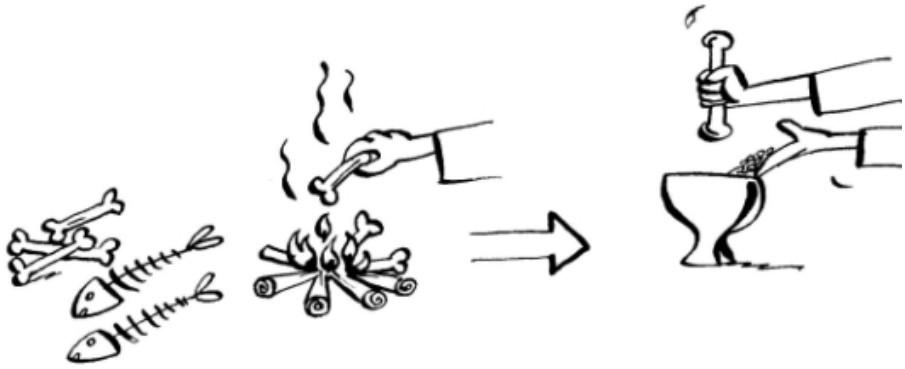
- Proteins are body (meat) building foods. They are needed for growth and keeping up a good health status.
- Normally no more than 1/5 of a diet is protein-rich feeds, as they are very expensive.
- Growth of birds like in other animals is rapid when they are young, and therefore good quality proteins should be supplied.

- Protein may come from either animal sources or plants. Plant sources of proteins include leguminous seeds such as cowpeas, beans, and oil cakes from e.g. ground nuts, cotton seeds, palm kernels, and coconuts. Animal sources of proteins include fish meal, meat-bone meal, blood meal, maggots and other insects.

Sources of minerals

- Minerals are important for bone and eggshell formation as well as good health.
- The most important minerals are calcium and phosphorous. To produce strong shells laying hens need free access to calcium (limestone or crushed shells). Adult birds are usually able to balance their intake according to their needs.
- Examples of sources for minerals are bone meal, crushed oyster shells, snail shells, common salt, premixes, lime and burned eggshells. Bone meal can be prepared for feed mixing by burning or pounding as in Figure 9.

Figure 9: Calcium-rich bone meal production



Source: Riise et al. (2004).

Vitamins

- Vitamins are nutrients required by animals in small amounts
- Deficiency of vitamins can lead to poor health, growth and reproduction
- Vitamins A, B2, D3 and E are considered very important because many problems arise when birds lack these vitamins.
- Vitamin sources include commercial premixes, multivitamins and green vegetables.
- Poultry farmers should make sure they buy the right vitamins without antibiotics in them.

Water

- About 60% of the bird's body and 65% of the egg is made of water.
- Clean water must always be provided to poultry.
- Lack of water can seriously retard growth and ruin egg production, especially in hot weather. In severe cases, lack of water can cause death in a day or two, in confined birds.

The mixing of these nutrient sources for a balanced diet is important, in addition to technical expertise. Readers are advised to seek further information from reference such Poultry training manual for extension workers in Uganda (MAAIF 2019) and the tropical agriculturalist (Smith, 1990).

The following are important points to consider in feeding chicken all year round:

- Step 1: Establish a feed calendar detailing the feeds that the birds consume at different times of the year
- Step 2: Calculate the amount of feeds are needed Step 3: Develop a budget for the feeds

More detailed information about planning for feeding poultry may be acquired from resource materials provided in the reference list of this manual.

How much to feed?

Tables 5 and 6 provides a guide to the quantity of feeds consumed by birds at different stages of growth. The quantities provided may vary with breed.

Table 6: Broiler feed consumption per bird and body weight gain for the common broiler stock

Age in Weeks	Live weight (kg)	Feed (kg)	Cumulative (kg)
1	0.14	0.13	0.13
2	0.36	0.27	0.40
3	0.65	0.44	0.84
4	1.00	0.62	1.46
5	1.42	0.82	2.28
6	1.80	1.01	3.39
7	2.30	1.19	4.48
8	2.70	1.35	5.83
9	3.10	1.50	7.33
10	3.50	1.63	8.66

Table 7: Light control and amount feed layer stock need as they grow

Age in Weeks	Light Duration Hours	Ration in grams per bird per day
1	24	12
2	24	25
3	24	30
4	24	30
5	22	35
6	18	40
7	14	45
8	10	50
9	8	55
10	8	55
11	8	60
12	8	65
13	8	70
14	8	70
15	8	70
16	8	75
17	8	85
18	9	85

Age in Weeks	Light Duration Hours	Ration in grams per bird per day
19	10	90
20	11	90
21	12	105
22–80	14–16	120–130

How to use the table: The assumption is that a farmer has e 1000 chicks, each eating 12g of feed per day in the 1st week. They need 12Kg (i.e.12g × 1000 chicks ÷ 1000g) of feed for all the birds per day. The birds will eat 84kg (12kg×7days) in a week.

As a group activity, the trainer may assign the groups to calculate the amount of feed needed per day for all the birds as above or get actual numbers of chicken and their ages on a farm and calculate the amounts of feed the farmer should plan for, say for a period of 2-3 weeks. The feed may be given to the chicken once or twice a day. This table is a useful guide especially where the feed given to the birds has adequate energy and proteins and is not fibrous.

Twelve simple rules for feed management

Before buying, mixing, and storing feeds, it is important to understand some underlying principles of good feed management. It is crucial to:

1. Use local feed ingredients for local birds (cheaper);
2. Know the quality and feed value and changing prices of each feed ingredient Quality challenges to look out for include adulteration with sand, sawdust, among others, but also include additives such as antibiotics.
3. Buy missing feed ingredients, such as vitamins or protein sources locally if available
4. Change the feed formulation depending on availability, quality or feed value, and changing prices;
5. Reduce the flock size during seasons of feed scarcity (to keep costs low);
6. Feed types and quantities should be changed gradually
7. Mix feed ingredients uniformly in relatively small quantities to avoid too long storage time;
8. Use locally available materials such as tins or matchboxes for quantifying the different ingredients to be mixed. Grams or percentages may be difficult to determine accurately;
9. Store mixed feed or feed ingredients separately upon a platform/crate approx. 30 cm(1feet) above the floor;
10. Stop the entry of rats, pigeons, or other type of birds into the feed store room;
11. Ensure enough ventilation of air so that the feed ingredients are not wet due to humidity;
12. Do not use feed ingredients, which are mouldy, discoloured or from which pests have eaten

Additional resources: For additional checklists on when to purchase feeds, please refer to the 17 Triggers developed by ILRI

Annex 7: Healthcare management in poultry

Birds that are well managed, well fed and vaccinated against the common diseases usually remain healthy and produce well. Drugs do not replace good management and will only keep down mild infections but are not a guarantee that disease outbreaks will not occur. When administering drugs, a farmer should always follow the instructions of the manufacturer or qualified veterinary personnel.

During disease outbreaks, always seek assistance from veterinary personnel as most poultry diseases present with general signs and may require further diagnosis. Good biosecurity measures should be maintained to avoid entry of diseases to the flock that may affect production or death.

Introduction of pathogens into poultry unit

Pathogens gain entrance to a flock from various sources, including:

Humans: They constitute one of the greatest potential means of disease spread through their mobility, duties, curiosity, ignorance or carelessness. Frequently, footwear and clothing are suspected as the biggest vehicles of disease. When an outbreak occurs in the neighborhood, there should be no movement of people and fomites between the two places. Farmers should restrict access to their poultry units. People who must enter the poultry houses should wear disinfected overcoats and step into a footbath at the entrance of the house and have their hands disinfected. The farmer should have designated gumboots for visitors. They should not enter the bird house with their own footwear.

Recovered carriers: carrier birds are those that have apparently recovered from a clinical infection but still retain the infectious organisms (germs) in their bodies. This is similar with COVID-19, where some people do not show signs of illness but have capacity to infect others. While carriers appear healthy, the germs (infectious organisms) continue to multiply in the body and to be excreted or released into the environment. Like actively infected flocks (those with disease signs), they can perpetuate a disease on a farm and so are threats to other birds. If a disease happens to persist on the farm, depopulate the whole flock, clean, disinfect and rest the house for some time (at least two months) and then restock. Do not mix different age groups of birds (adult birds and chicks), even in a sick bay. Practice all-in all-out system. All-in, all-out is a biosecurity measure to stock at once and remove the flock at once without mixing with different age groups within the same house (see the section on housing, biosecurity measures).

Mixed Species of poultry: One species that is naturally resistant to a disease may act as a carrier for species that are susceptible. An example is where chicken are carriers for a disease (histomoniasis) of turkeys which kills them very fast.

Hospital pen/cull pen: sick birds from different houses collected into one hospital pen (sick bay) and later returned after recovery to their respective houses may carry back more than the condition for which they were being treated. Therefore, these pens are not recommended. At least each house should have its own sick bay. Non laying hens in cull pens should not be taken back but rather disposed of.

Backyard and pet fowl: backyard poultry and birds kept as pets can carry and transmitting disease to commercial flock. Commercial poultry farmers should not keep such birds.

Poultry markets: When birds are taken to the market and they are not bought, they should be kept away from other stock as much as possible to reduce chances of disease spread. Contact between poultry traders and flocks should be limited, as much as possible.

Hatcheries-Many diseases like Pullorum disease, Avian encephalomyelitis, Avian leucosis and others can be got from hatcheries. The farmer should therefore start a new stock with birds from reputable breeders.

Characteristics of healthy and unhealthy birds

Figure 10 and Table 8 show the difference between healthy and unhealthy animals

Figure 10: Healthy and sick birds

Difference between healthy and sick birds

Table 8: Characteristics of healthy and sick birds

Healthy birds	Unhealthy birds
Alert and on guard	Tired and lifeless, listlessness, drowsiness
Bright eyes and comb	Dull eyes and comb
Walk, run, stand, and scratch continuously	Sit or lie down, droopy wings, body weakness
Eat and drink normally	Eat and drink less (anorexia) dehydration, emaciation (loss of weight)
Lay eggs normally	Lay less or stop laying eggs
Smooth and neat feathers	Ruffled and loose feathers
Soft compact droppings	Wet droppings with blood or worms, diarrhea (whitish or greenish faeces which may contain mucous) and dirty/matted feathers around the cloacae (vent).
Breath quietly	• Increased respiratory rate, laboured breathing, cough, sneeze and breathe noisily, mucous discharge from the mouth and nostrils • Bluish-purple (also called cyanosis) combs and skin due to oxygen deficiency in the blood
Normal wattles, sinuses, leg and wing joints	Swollen wattles, sinuses, leg or wing joints, footpads & sternal bursa.
No shivering	Fever as shown by shivering
Normal posture of the head or the body	Neck tilting (Torticollis), convulsions and tremors.
	Sudden death

Chicken diseases and their causes

This section describes the common causes of chicken diseases and the manifestations of these diseases that can aid diagnosis by necropsy. By going through the clinical signs and lesions detected at necropsy, a fair judgment of the disease at hand is possible. It also provides basic preventive measures and treatments for the specific diseases. Individuals with animal health training from Diploma and above may find this content useful in diagnosing chicken diseases.

Categories or types of diseases according to causes

Diseases of chicken can be classified into viral, bacterial, parasitic, fungal and other disorders (nutritional and poisoning) as shown in Table 8.

Table 9: Disease types and possible treatments (adapted from Riise et al., 2004)

Disease type	Possibilities for control or cure
Virus	Viral diseases cannot be cured but may be prevented or controlled if the birds are vaccinated before the disease occurs in the flock. If the disease is present in the flock at the time of vaccination, vaccinations might increase the severity of the disease, ultimately killing the birds. Culling should be considered as the ultimate control measure. Vaccination should only be done when the flock is healthy.
Bacterial	Many bacterial diseases can be treated with the use of antibiotics. It is important to diagnose the disease in order to choose the right antibiotic.
Parasites	Most internal parasites can be treated with traditional and conventional medicine (anthelmintics). Ectoparasites can be controlled by topical parasiticides combined with good housing measures.
Fungus	Fungal diseases might be treated with antibiotics and antifungals.
Nutritional diseases/ disorders	Nutritional diseases or disorders are caused by a wrong feed composition. Depending on the disease, it can be prevented by mixing the right feed with minerals and vitamins or giving access to a diversity of feedstuffs from the surroundings, e.g. green grass and fresh cow dung.

Disease prevention in poultry flocks

Vaccination

This is a very important method of disease prevention on the farms. It is a preventive measure and administered to healthy birds. It is not therapeutic (treatment method) during a disease outbreak. The vaccines may be live but weaker types of the organisms or live attenuated (weakened) or dead (killed). The birds produce antibodies against these vaccines. The antibodies defend the birds against pathogens like the ones in the vaccine and eliminate the infectious agent without causing clinical disease to the vaccinated birds. Antibody production in the body takes over a week and so, the effects of a vaccine are not immediate like a drug. The antibodies may persist in body for some time and the levels begin to drop. Therefore, healthy chicken should be vaccinated regularly to prevent disease outbreaks. A vaccination schedule adapted from several poultry reference materials is provided in a table of vaccination program in the next page. Vaccines may not give 100% protection but will increase the numbers of resistant birds to a particular disease in a flock. When you vaccinate chicken in disease outbreak or stress, vaccination failure may occur. Most vaccines are live germs and so must be kept in cold storage to remain effective. Sometimes, farmers believe the vaccine failed them yet the birds died from something else. So, whenever disease occurs in poultry flocks, diagnosis is important to for appropriate action to take.

Vaccination methods and Vaccine handling

There are four fundamental ways of vaccinating birds as shown in Table 9:

Table 10: Vaccination methods and sites

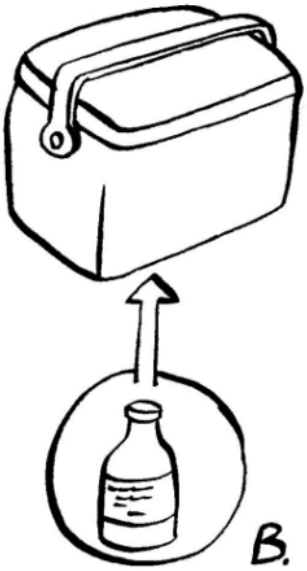
1. Eye drops	Most vaccines in Uganda are administered by this route. Sometimes by nose or mouth drops. Examples of vaccines given as eye drops include Newcastle disease, Gumboro disease and infectious bronchitis
2. Injections	The vaccines of chicken given by injections below the skin of the neck, breast muscle or the thigh include Marek's disease vaccine and Fowl typhoid vaccine.
3. Skin piercing	In this category, we have only fowl pox vaccine. It is injected in the skin of wing web using a forked needle
4. Orally (in feed or water)	Any of those that are administered by eye drop can be administered in drinking water. For scavenging poultry, farmers should avoid mixing vaccines with drinking water or feed, as it is difficult to give the right dose. Research have shown that protection against e.g. Newcastle Disease is highly variable if vaccine is given through water or feed. Giving the right dose is essential for the vaccine to work properly.

A high dose of a live vaccine may kill a young chick, whereas a low dose will not give adequate protection. Thus, it is important to consult a veterinarian for further advice before carrying out vaccination.

Most vaccines must be kept in the refrigerator between 4 and 8°C and never frozen.

- When going to the field, vaccines must be stored in a cool box or wrapped in a damp cloth, and not exposed to sunlight as shown in Figure 11
- Vaccines should not be used after the expiry date
- Once a vaccine has been opened, it should be used immediately and not stored for use the following day

Figure 11: Cool box



How to administer vaccine by eye drop (example for Newcastle disease)

- There are about 16 Newcastle disease (ND) vaccine brands currently in use in Uganda including Hipraviar-B1/H120® (ND & IB), Hipraviar-S® (ND), Newcastle Disease Vaccine® , ORNIPEST, ORNIPRIM and others. Generally there are many trade names of ND vaccines and they keep changing overtime with entry of new stockists. Therefore, only asking for Newcastle disease vaccine for the number of birds owned is usually enough to buy the vaccine plus the diluents
- For local chicken, vaccines should be given either early morning, before letting the birds out of the chicken house or when the birds are easy to catch resting in the trees
- Correct dilution of the vaccine is critical. The necessary diluent is sold together with the vaccine with the instruction to dilute. Please carefully follow these instructions.

Figure 12: Administration of Newcastle disease vaccine

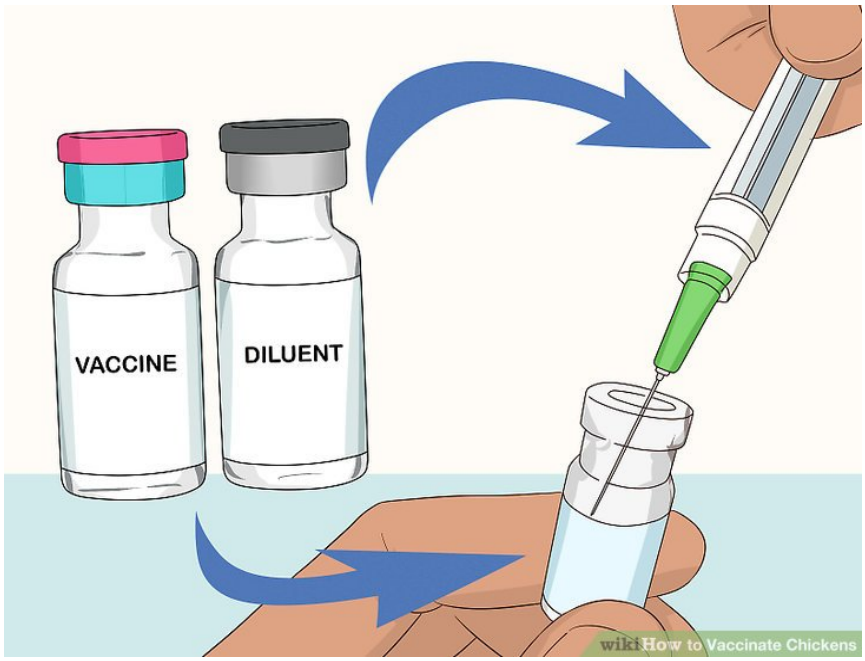
Eye drop administration. When using an eye-dropper, hold it in a vertical position as shown in Figure 12. They are calibrated according to the size of the drop that forms when a dropper is held in a vertical position (source Riise et al., 2004)

- Immunity does not develop immediately after administration of the vaccine. One to two weeks is required for full immune response to occur.
- Immunity will diminish if chickens are not revaccinated.

Procedure for vaccination against fowl pox

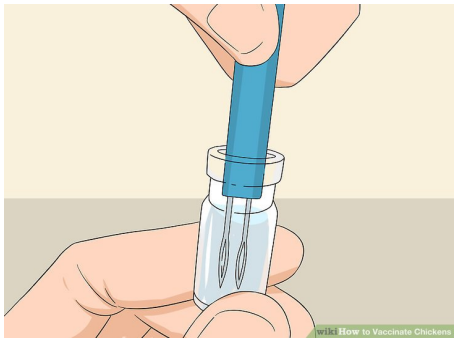
- Fowl pox vaccines currently in use in Uganda include Hiprapox®, Fowl Pox Vaccine® and others. The brands keep changing overtime, but during purchase, one needs to ask for fowl pox vaccine. The vaccine is sold together with the water for dilution and forked needle as shown in Figure 13.
- The common vials on the market are for 500 and 1000 chickens.
- The following procedure must be followed to dilute the vaccine

Figure 13: Preparation for vaccination



- Draw 20 mls of the water for dilution into a clean syringe.
- Transfer the water into the solid vaccine in the bottle by piercing through the rubber cap.
- Once dissolved, draw all the content with the syringe and mix thoroughly.
- Transfer the mixture into a clean cup and keep in cool box with ice.
- With the help of an assistant holding the chicken, stretch the wing, dip the forked needle eyes into the vaccine and pierce through the wing web, taking care to avoid feathers, bones, and large blood vessels (Figure 16).
- This procedure should be repeated until all the birds are covered
- Check the injection site in some selected birds after three days to see whether the vaccination was effective; when well done, there will be small swelling at the injection site but none when not properly done.
- One well done vaccination is enough for the lifetime of the chicken. Vaccinations should be only be conducted for young or new stock

Figure 14: Vaccine administration



Place injection by piercing the skin of the wing as shown in Figure 14. The wing web is located near the bone where the wing connects to the body. You may pluck a small patch of the feathers so that you can properly administer the vaccine (source Riise et al. 2004 and wikihow)

Vaccination failure

This happens when a vaccine fails to provide protection to the birds against the disease(s)of interest

Properly vaccinated birds will provide protection from diseases vaccinated against. Some undesirable practices that may damage the vaccine and lead to vaccination failure include:

- Improper storage –vaccines should be stored in a refrigerator with a temperature monitor at usually 2–8 °C. Vaccines should be transported in vaccine carriers and should not be in direct contact with ice. Vaccines should be used promptly (within 2½ hours) after reconstitution and should not be stored after dilution. Avoid vaccinating using syringes of bigger capacity, than what is recommended. By the time the vaccine gets over from the syringe, the temperature would have risen. Use syringes of 2½ to 3ml capacity and needles of 20–22 gauge for dropping vaccines. Alternatively, use vaccine droppers of 5mls or less capacity for vaccination by eye drops.
- Reconstitution should not be done using water that has chlorine (e.g. tap water and mineral water) or other disinfectants. Use distilled water or water for injection.
- Exposure to sunlight
- Piercing or damage to vials or containers causing loss in required dose
- Use of expired vaccines
- Failure to give adequate dozes
- Wrong route of administration.
- Vaccinating during stress or periods of disease outbreaks
- Vaccinating birds at wrong age (too young or too old) and not following recommended vaccination schedule

Vaccination titre monitoring

It is now possible to determine the levels of vaccine induced antibodies in one laboratory in Uganda. It helps in ruling out vaccination failures. RTC Laboratory located at college of Veterinary Medicine is the current sole provider of this service. Serum from at least 18 chickens is what is required to by the lab to measure the antibody levels. This information provides guidance on when to revaccinate. Tables 11–13 show the vaccination program for broilers, broilers breeders and commercial layers.

Table 11: Vaccination Program for broilers

Vaccine	Age	Comment	Administration
Marek's disease	-3 to 1 day	HVT, SB-1, Rispens	Subcutaneous Injection or in ovo
Infectious bursal disease (Gumboro disease)	-3 to 1 day	Variant strain	Subcutaneous Injection or in ovo
Infectious Bronchitis	1 day	Mild Mass-Conn	Eye drop or Coarse spray (100 micron)
Newcastle disease	1 day	B1-B1	Eye drop or Coarse spray (100 micron)
Infectious bursal disease	7 days	Classic/Variant strain	Eye drop or coarse spray or drinking water
Infectious bronchitis	14 days	Mass-Conn	Eye drop or Coarse spray (100 micron)
Newcastle disease	14 days	B1-B1	Eye drop or Coarse spray (100 micron)

Table 12: Vaccination Program for Broiler Breeders

Vaccine	Age	Strain (type)	Route of Administration
Marek's Disease	1 day	HVT, SB-1, Rispens	Subcutaneous injection (dorsal neck)
Infectious Bronchitis	1 day	Mass-Conn	Eye drop or Coarse spray (100 micron)
Newcastle disease	1 day	B1-B1	Eye drop or Coarse spray (100 micron)
Reovirus	7 days		Subcutaneous injection
Infectious Bursal Disease (Gumboro disease)	14 days	Intermediate classic	Eye drop or Coarse spray or drinking water
Infectious bronchitis	14 days	Mass-Conn	Eye drop or Coarse spray (100 micron)
Newcastle disease	14 days	B1-B1	Eye drop or Coarse spray (100 micron)
Infectious Bursal disease (Gumboro disease)	28 days	Intermediate classic	Eye drop or Coarse spray or drinking water
Infectious Bronchitis	35 days	Mass-Conn	Eye drop or Coarse spray (100 micron)
Newcastle disease	35 days	B1-B1	Eye drop or Coarse spray (100 micron)
Reovirus	6 weeks	Live or Inactivated	Subcutaneous injection
Infectious Laryngotracheitis	7-8 weeks	In problem areas	Eye drop or drinking water
Infectious Bursal Disease	8 weeks	Classic + variant	Eye drop or coarse spray or drinking water
Poxvirus	12 weeks	Fowl/Quail Pox Combo	Wing web stab (piercing)
Av. Encephalomyelitis	12 Weeks	Combined with pox	Wing web stab (piercing)
Infectious Bursal Disease	12 weeks	Inactivated	Subcutaneous injection
Reovirus	12 weeks	Inactivated	Subcutaneous injection
Fowl cholera	12 weeks	Inactivated	Subcutaneous injection
Infectious bronchitis	13 weeks	Holland	Eye drop, medium spray or drinking water
Newcastle disease	13 weeks	Lasota	Eye drop, medium spray or drinking water
Fowl Cholera	18 weeks	Inactivated	Subcutaneous injection

Adapted from Porter 2006 and MAAIF 2019

Table 13: Vaccination Schedule for Commercial Layers

Vaccine	Age	Strain (type)/ Comment	Route of Administration
Marek's Disease	1 day	HVT, SB-1, Rispens	Subcutaneous injection (dorsal neck)
Infectious Bronchitis	1 day	Mass-Conn	Eye drop or Coarse spray (100 micron)
Newcastle disease	1–7 day	B1-B1	Eye drop or Coarse spray (100 micron)
Infectious Bursal Disease (Gumboro disease)	14 days	Intermediate strain	Eye drop or Coarse spray or drinking water
Infectious bronchitis	14 days	Mass-Conn	Eye drop or Coarse spray (100 micron)
Newcastle disease	14 days	B1-B1	Eye drop or Coarse spray (100 micron)
Vaccine	Age	Strain (type)/ Comment	Route of Administration
Infectious bursal Disease (Gumboro disease)	14 days	Intermediate strain	Eye drop or Coarse spray or drinking water
Infectious bursal disease (Gumboro disease)	28 days	Intermediate strain	Eye drop or Coarse spray or drinking water
Infectious bronchitis	28 days	Mass-Conn	Eye drop or Coarse spray (100 micron)
Newcastle disease	28 days	B1-B1	Eye drop or Coarse spray (100 micron)
Infectious bronchitis	6 weeks	Mass-Conn	Eye drop or Medium spray (50 micron)
Newcastle disease	6 weeks	Lasota	Eye drop or Medium spray (50 micron)
Fowl Pox	6–8 weeks	Live virus	Wing web stab (piercing)
Infectious Laryngotracheitis	7–8 weeks	Optional	Eye drop or drinking water
M. gallisepticum	8–10 weeks	F strain or 6/85	Eye drop or fine spray (20 microns) or Subcutaneous injection
Infectious bronchitis	12 weeks	Holland	Eye drop or fine spray (20 microns)
Newcastle disease	12 weeks	Lasota	Eye drop or fine spray (20 microns)
Pox virus	12 Weeks	Fowl/Quail Pox Combo (Repeat, optional)	Wing web stab (piercing)
Av. Encephalomyelitis	12 Weeks	Combined with pox	Wing web stab (piercing)
Infectious coryza	12 weeks	In problem flocks	Subcutaneous injection
Fowl typhoid	12–14 weeks	In problem flocks	Subcutaneous injection
Infectious bronchitis	Every 8 weeks	Mass-Conn	Eye drop or Medium spray or drinking water
Newcastle disease	Every 8 weeks	B1-B1	Eye drop or Medium spray or drinking water

Adapted from Porter 2006 and MAAIF 2019

Treatment of diseases

The Animal Disease Act 2000 (as amended) mandates the veterinary officer to carry out disease diagnosis, treatments and take appropriate action to control spread of disease with specific actions including restriction of movement of sick animals. Farmers are not supposed to self-medicate. They should isolate all the sick birds into a hospital pen as they wait for laboratory results.

Once a diagnosis of disease is obtained, targeted treatment or control options should be instituted. This may include curative drug administration and supportive care. There is no need to treat animals that have no evidence of infection by antibiotics. The term used to describe the state of treating of both healthy and sick animals in a herd is called metaphylaxis. Often, drug therapy alone is not enough if the conditions that precipitated the occurrence of the disease are not removed. So, environmental (housing) conditions and management practices should be improved as well. This may require advice from a qualified person or experienced peers.

Note: Observe drug withdrawal periods as stated on the insert or description on the packaging. This will minimize unnecessary drug residues in poultry products. See the next section on drug withdrawal periods.

Drug Withdrawal periods

Drug withdrawal time is the period from when the last dose of a drug is administered to when the drug concentration in animal products falls below maximum residue limit. Drugs administered to poultry can potentially remain as residues in their tissues such as skin, muscles, fat, soft organs and eggs. The residues are likely to be consumed by humans.

Undesirable effects of drug residues consumed by humans include acute allergic and toxic reactions. For instance, 1 in 10 persons are believed to be allergic to penicillin. Other abnormal reactions range from a rash to anaphylaxis (severe acute allergic reaction). Antibiotic resistant bacteria may develop from low exposure to antibiotic residue in poultry products

Consumers should be protected from drug residues in chicken products. Chicken should not be sold or slaughtered for consumption if they have been on antibiotics for at least 7 days particularly for the common antibiotics on the market.

See Annex 2 for the withdrawal periods of antibiotics and anthelminthics listed on the veterinary drug register of National Drug Authority of Uganda

Every approved poultry drug has a withdrawal time, which only applies when the drug is used according to the labeled directions. Having a labeled withdrawal time does not mean there will be no drug residue in the edible tissue or food product. It means that if there are residues, they will be at or below the established tolerance level. If a drug is used in any manner different from the label, the withdrawal time is affected. For example, if a higher than labeled dose is used, it can dramatically change when the residue concentrations fall below the tolerance levels. Owing to this, the only way a drug can legally be used contrary to the instructions on the label is when it is prescribed by a veterinarian, who must also issue an extended withdrawal interval. Extended withdrawal interval must have scientific basis.

See Annex 2 for the withdrawal periods of poultry drugs approved for use in Uganda by NDA (NDA Veterinary drug register, April 2022).

Annex 8: Disease diagnosis, diagnostic procedure and common disease recognizable syndromes in poultry

Diagnosis of diseases

Why disease diagnosis is important

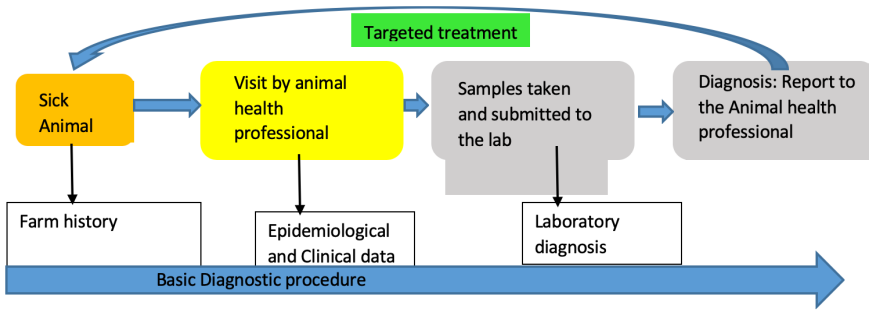
- Enables quick and effective treatment
- It saves costs on unnecessary treatments by focusing your efforts on managing the situation at hand thus minimizing losses. From the history of samples submitted to the Central Diagnostic Laboratory at the Makerere College of Veterinary Medicine, over 60% of cases diagnosed as upper intestinal coccidiosis were using antibiotics. The common antibiotics reportedly used by farmers were oxytetracycline, enrofloxacin, doxycycline, and Penicillin among others. Sometimes these antibiotics were used concurrently with anticoccidials, without paying much attention to breaking coccidia lifecycle by litter management. This is not only wasteful but also irrational drug use that can facilitate development of resistance. So other factors must be considered such as routinely changing the litter as well as keeping it dry (See litter management in Module 2, Subpart a, Annex 3)
- Diagnosis can help in early detection of hatchery transmitted diseases in case the farmer chooses to seek compensation for dead chicks.
- It eases the psychological stress of the farmer as some diseases such as Avian leukosis, Marek's disease, do not require treatments but isolation and culling.
- According to the Animal Diseases Act 2000 (as Amended), it is mandatory to report certain diseases (e.g. Avian influenza and Newcastle Disease) to the state for control and regulation purposes. Therefore, confirmatory diagnosis is important. The notifiable poultry diseases according to the World Organization for Animal health (WOAH) include Newcastle disease, Avian Influenza, salmonellosis (Pullorum disease and fowl typhoid), Mycoplasmas and Avian Chlamydiosis (psittacosis).

Note: It is important that diagnosis should be performed by a qualified veterinarian

Diagnostic procedure

There are three major components: Epidemiological, Clinical and Laboratory diagnosis

Figure 15: Diagnostic procedure



Epidemiological diagnosis involves collecting information from the environment and neighbourhoods where the affected chicken (animals) lived, what they were fed on, housing, treatment given, vaccinations carried out, the system of production, how widespread the problem was on the farm or the neighbourhoods and the times/seasons in which the disease occurs. It also involves identifying the species, breeds, age groups and sex, flock size, number and age

at risk, and the number affected in a particular period. The animal owner or attendant plays a key role in helping the diagnostician with this information. The duration of the illness from the start of signs to recovery or death is another piece important information that the caretaker should provide.

Clinical diagnosis involves identifying the signs shown by the affected poultry by closely observing them or measuring them. It involves examining the body systems of the birds including the respiratory, digestive, integuments, nervous, urinary and skeletal. The parameters measured or observed include the respiratory rate, temperature nature and frequency of faecal matter voided (semi-solid, bloody or watery), nasal and oral discharge, inflamed combs, loss of appetite, coughing lameness, huddling, isolation among others.

Laboratory diagnosis is intended for confirmation of the disease. Here, the causative agent or the body's response to the agent is detected. The causative agents include bacteria, viruses, fungi, worms, protozoa, chemicals and other physical agents. The infectious agents also induce antibodies in the poultry that can be detected to inform about the disease circulating in the flock. Therefore, the real cause of the disease is identified. This is a very important practice to adopt for appropriate treatment or advice. For instance, a flock maybe with antibiotics when the disease is caused by a virus. Then the treatment will not work, mortalities may persist in the flock. The farmer might blame it on the drug or resistance but they are not giving the right treatment.

The laboratory tests used either detect the causative agent or the effect of the causative agent in the body, the antibodies. Agent detection is usually done in the acute phase of the disease before the bird produces enough antibodies to fight the agent. Tests for agent detection are direct tests while the one for antibodies are indirect tests.

1. Agent detection (direct tests)- The tests that detect the causative agent include culture and isolation for bacteria, viruses and fungi, direct observations and smears for parasites, and detection of genetic material of the agent by molecular tools like PCR. Serotyping of isolated organisms is also used to identify the pathogen antigen group (O-H antigen).
2. Antibody detection (indirect tests)–Indirect tests that detect the effect of the causative agents include antibody detection tests such as ELISA and other serological techniques. Lesions detection at necropsy are also indirect methods of disease detection. Antibodies are detected when a disease has persisted in the flock or after convalescent phase. Lesions are morphological alterations caused on organs by disease agents and can be used for diagnosis as some lesions are more characteristic for certain pathogens.

Samples for agent detection (direct tests) include whole blood, swabs from mouth or cloaca, organs (at necropsy) and excreta. The sample required for antibody detection is serum. Tissues/organs or excretions are collected by the animal health worker and submitted to the laboratory. Here, samples that are representative of the flock situation should be the ones collected. At least 3-4 whole birds are required for comparison of disease situation in a flock of birds. Sick or freshly dead birds (with no signs of rotting like greenish abdomen) should be submitted. Whole birds may be submitted by a caretaker. Tissue/organ and excretions for laboratory diagnosis should be aseptically collected and transported in appropriate packaging and temperature. The tests are performed by specialised laboratories and the results usually sent back to the submitter. In cases of tests that involve bacteria, drug sensitivity tests should be requested, if the laboratory has the required capacity.

Where/how can you find a laboratory?

There are animal laboratories in Uganda;

1. National Animal Disease Diagnostics and Epidemiology Centre (NADDEC) found in Entebbe. This is a National reference government laboratory belonging to the Ministry of Agriculture, Animal Industry and Fisheries. It is mandated to diagnose animal diseases and services are free of charge. Clients are advised to contact the principal veterinary laboratory officer for further details as necessary.

2. Central Diagnostic Laboratory (CDL) at the College of Veterinary Medicine, Animal Resources and Biosecurity, Makerere University, Kampala. Prices vary depending on the test to be conducted. Clients can contact the laboratory on telephone + 256-41-4534191 Mobile: 0779623911, 0758528597 for further details.

The two laboratories offer post-mortem and microbiology diagnostic services to poultry farmers, mostly from the central region of Uganda. The laboratories however also receive samples from other districts in the country.

There are regional Veterinary laboratories that are functional, and these include Mable, Mbarara, Gulu, Arua, Moroto, and Masaki. These also offer post-mortem services. Other laboratories that offer parasitological and post-mortem examinations are found at the District Veterinary Offices.

Post mortem procedure in chicken

Post-mortem examination is an important diagnostic method for poultry diseases. Post-mortem is a step by step procedure of dissection of a dead bird to determine the cause of ill health or death. Some diseases produce characteristic lesions that aid in their diagnosis. Clinical signs and lesions observed at post-mortem are good tools for syndromic diagnosis and surveillance. Using lesions for disease diagnosis requires a background knowledge of general pathology and poultry diseases. In this regard, this section is only suitable for animal health workers with a minimum of Diploma in animal husbandry but at best for those with Bachelor's degree in Veterinary Medicine.

The procedure laid hereunder can be printed as a poster and placed in a diagnostic room or laminated as a field guide

The materials shown in Figure 16 are needed to conduct a post-mortem,

1. Knife
2. Necropsy shears (kitchen shears)
3. Scalpel blade (with handle)
4. Forceps
5. Scissors
6. Sample container- Sterile Petri dish for microbiology
7. Sample container- Formalin container for histopathology
8. A cutting surface (a tray can serve the purpose too).
9. Gloves
10. Water
11. Disinfectant
12. Disposable bags

Figure 16: Materials required for Necropsy in chicken

Preparation of the fixative (10% Neutral Buffered Formalin), 10L

1.	Sodium dihydrogen phosphate monohydrate (NaH2PO4.H2O)	40g
2.	Sodium Hydrogen Orthophosphate anhydrous (Na2HPO4)	65g
3.	Water	9L
4.	Formalin (Formaldehyde solution 37-40%)	1L

The Post-mortem procedure for poultry

1. Preparation of the chicken for Post-mortem

- **Killing:** If still alive, kill the bird by snipping the spinal cord by hand at Atlanto-occipital junction as shown in Figure 17. Control the legs and wings by one hand and hold the head and the neck by another hand. Bend the head backwards while pulling forwards, until a snip is felt.

Figure 17: Humane killing of a sick bird for necropsy

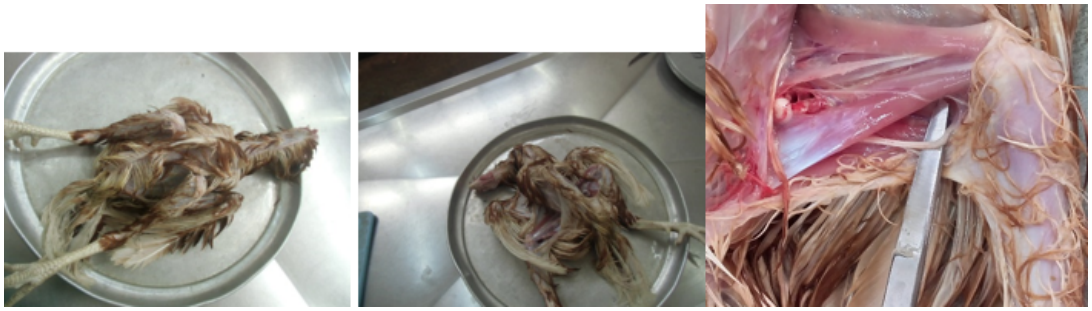
- Disinfection: The dead bird (whether found dead or killed by the prosecutor) should be immersed (dipped) in disinfectant solution or just soapy water while holding the head outside the water as in Figure 18. This is to minimise feathers from floating around and controlling spread of pathogens. Holding the head outside the water prevents disinfectants from entering and killing pathogens in respiratory tract if culture of the respiratory system is to be done.

Figure 18: Disinfection of the carcass before necropsy

2. Positioning the carcass

Place the carcass on its back on a tray and examine the skin for abnormalities. Cut the skin between the legs and the body on both sides and open legs outwards. The sciatic nerves can be examined by separating the musculature of the thighs and checking for the cross striations as shown in Figure 19.

Figure 19: Positioning the carcass for necropsy and sciatic nerve examination



3. Skinning

The skin is removed from the neck to the vent and reflected to the side as in Figure 20. Check for haemorrhages, inflammatory response and discolorations on the musculature. Examine the body condition and muscle mass for nutritional status. Also, using the back of the hand, tap the fascia on the surface of the exposed carcass to determine the hydration status. Stickiness of fascia indicates dehydration.

Figure 20: Skinning the carcass

4. Opening the body cavities

Using the scissors, an incision is made on the abdominal wall just after the end of the keel bone as shown in Figure 21. With the shears, the abdominal wall is cut transversely through the rib cage and the clavicle up to the thoracic inlet, on both sides.

Figure 21: Opening the body cavities

5. Examination of the visceral organs

After removal of the sternum, the organs are now in full view as in Figure 22. Observe in situ for lesions of the air sacs, liver, heart, lungs, intestines and ovarian follicles (in hens). Samples for microbiology can be collected at this point (before manipulating the organs).

Figure 22: Examination of visceral organs in situ

6. Removal of visceral organs

Cut the lateral commissures of the beak to free the oesophagus and trachea. The viscera can be removed by gentle traction of the oesophagus and trachea while detaching tissue attachments with a closed scissor, up to the vent (cloaca) as in Figure 23.

Figure 23: Removal of the visceral organs

7. Check the organs

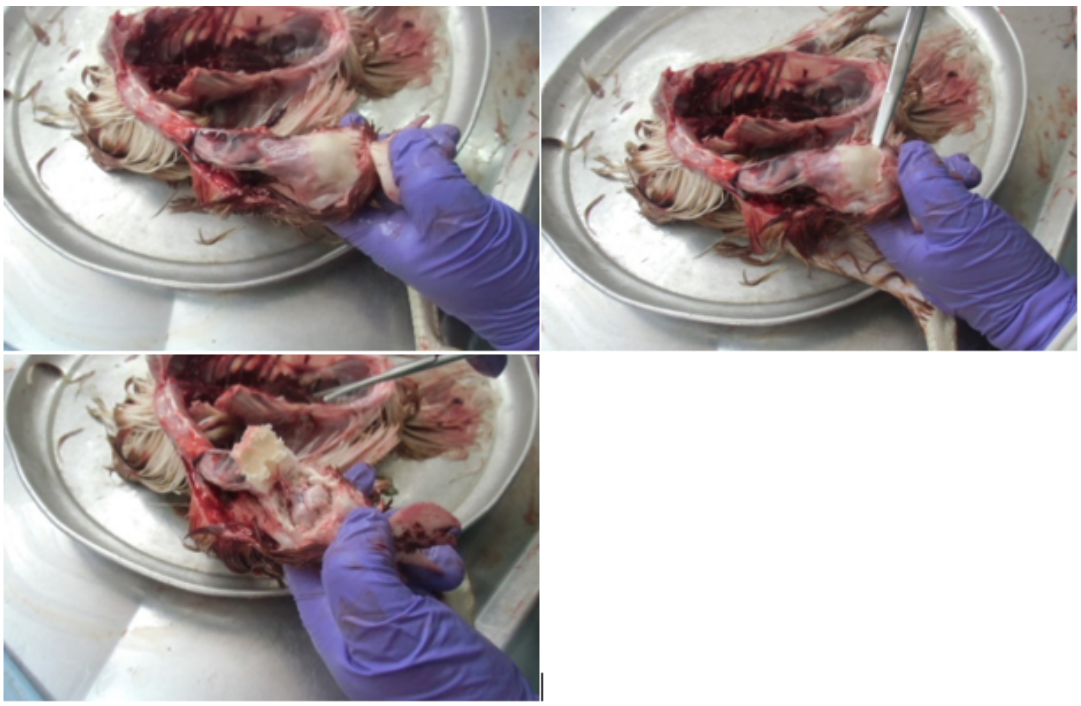
After removing the viscera, the kidney remains attached to the back wall and should be examined and collected as in Figure 24. The roots of the sciatic nerves can now be examined too. Place the organs on a cutting board and examine each organ (system by system).

Figure 24: Internal organs

8. Brain Extraction

Remove the skin of the head from the atlanto-occipital junction and reflect it forwards to expose the skull behind the eyes to the start of the neck as in Figure 25. With the tips of scissors or shears, nip the skull from behind the eye to the caudal border of the skull on both sides. Then raise the skull and open it upwards. Remove the meninges and cut off the nerves and attachments of the brain, starting from the olfactory nerves down to the nerves of the brain stem. Once loosened, turn the head upside down and the brain falls into your hand.

Figure 25: Brain extraction



9. Samples to be collected

Samples and how they should be collected is shown in Figure 26. These include, liver, heart, spleen while in the capped bottle are samples for histopathology in 10% formalin.

- Bacteriology
    - Swabs of fluids or exudates from any part of the body
    - Organs Liver, heart, spleen, lungs, brain and any other abnormal feature
    - Faecal material
- Histopathology
    - Liver, spleen, heart, lungs, kidney, intestines (duodenum, jejunum, ileum and cecum), pancreas, brain, proventriculus and Bursa of Fabricius.
    - Anything that does not look normal. For example, discoloured tissues, swellings, inflamed parts and shrunken tissues
    - Samples should reflect the clinical signs. For instance, if the birds had nervous signs, the brain is an important sample and if respiratory signs, the trachea, air sacs and the lungs are important.
    - For histopathology, the tissues should promptly be fixed in 10% buffered formalin at ratio of 10:1 of formalin to tissue.

Figure 26: Samples collected at necropsy

10. Necropsy report writing

A post-mortem report must be written detailing the findings. The report should include name, address and contacts of the owner or the submitter, the date of submission, the species, breed, age, sex and other details of clinical history and lesions as shown in the generic report sample below. The report should accompany the samples submitted to the laboratory for confirmatory diagnosis. This report can be reproduced on a headed paper of the animal health workers' organisation and used for routine necropsy procedures.

Table 14: Sample of Post-mortem report. This is only a guiding template to report the gross findings

Post-mortem Report				
Necropsy done by:			Rec. No.	
Submitter Name/Title/Address				
Owner Name/Address/Location				
Date of Submission				
Species	Breed	Age	Sex	Name & ID
Date and time of death (died/euthanized):				Date and Time of Postmortem:
No. of flock/herd:	No. sick:	No. dead and period of time:		
Case History (signs of sickness, effects on growth and production, how widespread is the disease and treatments so far given):				
Degree of autolysis:				
External appearance:				
Appearance of body cavities:				
Digestive System:				
Respiratory System:				
Cardiovascular System:				
Immune organs (spleen, lymph nodes, bursa):				

Post-mortem Report	
Urinary tract:	
Reproductive tract:	
Nervous System:	
Muscles, bones, joints:	
Other findings:	
Morphologic Diagnosis:	
Diagnostic possibilities (potential diseases for the lab to investigate based on your gross findings):	
Advice given to the farmer for action.	
Signature, stamp and date:	

Common Poultry Diseases recognizable by syndromes in Uganda

Viral Diseases

Newcastle disease (NCD)

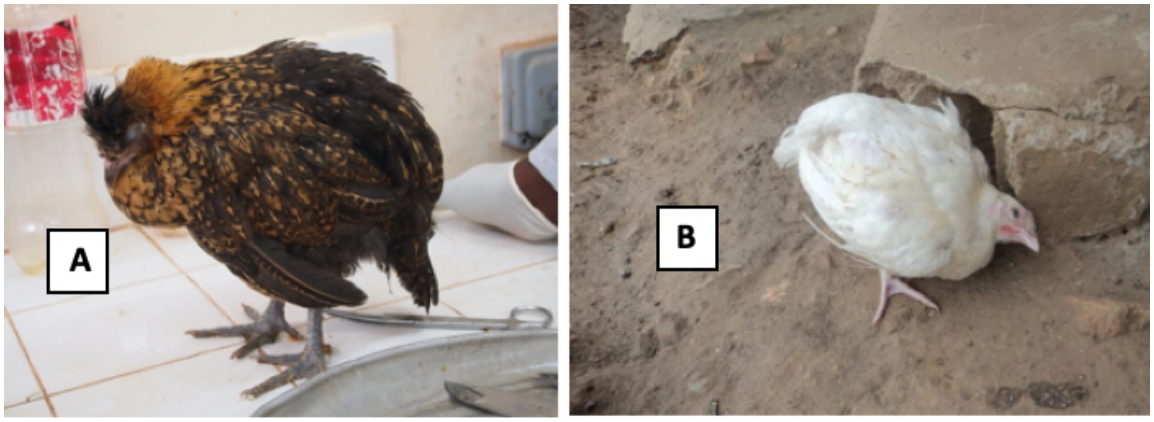
Definition: Newcastle disease is an acute, rapid-spreading, contagious disease of birds of all ages. It is characterized by lesions in the respiratory tract, visceral organs, and brain. It causes minor to severe mortality in susceptible flocks. The disease is common in local poultry and some commercial farms in Uganda.

Cause: it is caused by a virus in the group of Paramyxoviruses. This virus is in the same family with the causative agent of Pestis Petit de Ruminates (PPR) in sheep and goats, rinderpest (now eliminated) in cattle and Measles in humans.

Transmission: The virus is present in the discharges from the respiratory and intestinal tracts. Therefore, the infectious New Castle Disease virus (NCDV) can be transmitted by aerosol droplets, contaminated feed and water, movement of commercial poultry, and infected wild birds. The greatest potential for spread of Newcastle disease is by humans and contaminated equipment.

Clinical Signs: There are four strains of strains of NCD virus, but two strains (velogenic viscerotropic and velogenic neurotropic forms) cause severe disease. Velogenic forms spread rapidly through a susceptible flock. Birds may be found dead without any signs. Initially, birds are observed depressed as in Figure 27, with increased respiration. There is progressive weakness and prostration. The birds develop a watery greenish diarrhea. A marked cough and gasping respiration, nasal and eye discharge are often present. The combs and wattles may turn dark and bluish, and the birds may develop swollen heads. Birds that survive the initial acute phase show involvement of the nervous system. For example, birds may present with torticollis (twisted necks) as in Figure 27 (B). Egg production drops sharply and deformed eggs are present. The mortality is usually over 90% in a susceptible flock.

Figure 27: Severe depression in chicken A and neck twisting in chicken B (broiler)



Gross lesions: The velogenic strain causes varying degrees of congestion and hemorrhages in visceral organs, including the proventriculus, ceca, and small intestines. Necrosis and hemorrhages of the Peyer's patches in small intestines are more characteristic of the severe form of Newcastle disease.

In the mesogenic form, hemorrhages may occur in the proventriculus and less commonly in the small intestines. Clear fluid may be present in the nasal passages, larynx, and trachea.

Figure 28: Haemorrhages of the proventriculus and Peyer's patches (arrow) of small intestines in viscerotrpic Newcastle disease

Diagnosis: A presumptive diagnosis can be made based on the clinical signs, lesions, and serology tests as in Figure 28. A positive diagnosis of the causative virus can only be made by isolation or PCR tests (available at NADDEC and CDL).

Treatment: There is no effective treatment against the NCD virus.

Prevention: This involves having a sound farm biosecurity program and an effective vaccination program. Unauthorized personnel should not be allowed into the poultry house and good cleaning and disinfection procedure should be maintained. Frequency and timing of Newcastle vaccination depends on the type of bird and the incidence of Newcastle disease in the area.

Gumboro disease (Infectious bursal disease)

Definition: Infectious Bursal Disease (IBD), often referred to as Gumboro disease, is a highly contagious viral disease of young chickens characterized by high mortality, anorexia, diarrhea, and depression in 3 to 6-week-old birds. The virus prefers lymphoid tissue, primarily the Bursa of Fabricus. The subclinical form of the disease may cause prolonged immunosuppression of chickens infected at an early age.

Cause: The causative agent of IBD is a virus belonging to the genus Birnavirus,

Transmission: The IBD virus is very stable and persists for long periods in poultry houses, in some instances up to 2 years. This is one of the reasons why it is important to clean and disinfect and rest the chicken house for 2 weeks before introducing a new flock. The virus spreads within a flock by direct contact, by inhalation, or contaminated feed and water. The darkling beetle can spread the virus.

Clinical signs: The affected birds are depressed and sleepy even in a noisy or new environment as in Figure 29. High number of birds are affected in a very short time (morbidity of >90%), with peak of mortality being around the third day after onset of clinical signs. Persistent cloacal contractions with white pasty diarrhoea in the vent area and vent pecking are common. The affected chicken is dull and reluctant to move. The disease is more severe in younger flocks than older ones.

Figure 29: Chicks submitted for post-mortem after suffering from Gumboro disease

Lesions: The carcass is dehydrated and hemorrhages of the skeletal muscles (thighs and pectoral muscles) are common as shown in Figure 30. Sometimes the hemorrhages of the proventriculus and marbled spleen can be seen. The Bursa of Fabricius is swollen and hemorrhagic or edematous and surrounded by gelatinous fluid. The Bursa atrophies to approximately 1/3 of the original weight by day 8 post infection. The kidneys are often pale as in Figure 30 due to urate retention in the ureters and kidney.

Figure 30: Haemorrhages of the thigh muscles and swollen and oedematous Bursa of Fabricius

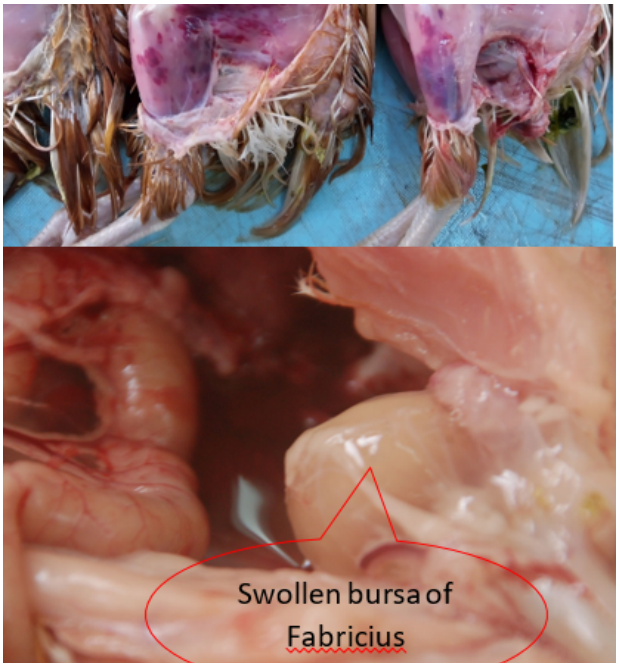


Figure 31: Pale kidneys (nephrosis)

Treatment: There is no specific treatment. The only care is supportive, including provision of warmth, glucose, multivitamins and broad spectrum, non-nephrotoxic antibiotics. Guidance from a veterinarian is very important.

Prevention: The only preventive measure is by strict vaccination practices and biosecurity measures (restriction of entry of unauthorized persons and cleaning, plus disinfection of the house).

Gumboro disease in Uganda

Table 15 shows the numbers of farms with confirmed Gumboro disease diagnosis over the last five years. The diagnosis was done at the Central Diagnostic Laboratory, College of Veterinary Medicine, Makerere University. The disease frequently occurs on farms, often with repeated outbreaks in subsequent flocks.

It has significant effect on profitability due to:

- Excess mortalities and
- immunosuppression leading to co-infections and increased antibiotics use.

Table 15: Cases of Gumboro disease diagnosed by syndromes at the Veterinary Pathology lab, Makerere university between 2017–2021

Year	Number of IBD affected flocks/farms	Number of farms that submitted chicken	Proportion (%)
2017	17	178	9
2018	22	205	11
2019	11	145	7
2020	2	60	4
2021	17	197	9

Fowl pox

Definition: Fowl Pox is a relatively slow-spreading viral disease of domestic birds (chickens, turkeys, pigeons, and canaries) characterized by scab-like lesions on the skin, combs, wattles and inside the mouth, as well as diphtheritic or plaque-like lesions in the mouth, esophagus and the upper part of the trachea.

Cause: A virus belonging to the poxvirus group causes fowl pox.

Transmission: Infection occurs to the injured or lacerated skin through mechanical transmission of the virus. Mosquitoes have been shown to spread the disease in chicken and layer flocks. Flies can deposit the virus in the eye or in open wounds or lacerations. The mucosa of the upper respiratory tract and mouth are highly susceptible to the virus, and infection can occur in the absence of skin trauma or injury.

Clinical signs/Gross lesions: The disease has two forms: cutaneous (dry) and membranous (wet) as shown in Figure 31. In the cutaneous form there is the formation of nodules/scabs on the comb, wattle, eyelids, and other unfeathered areas of the body. In the wet form, thick white cheesy material may be found lodged in the oropharynx. The wet form suffocates the affected birds and usually results into high mortality. Higher house temperatures are associated with high mortality rates in the wet form fowl pox because the birds tend to hyperventilate to release excess core body heat.

Diagnosis: The scabs on the head are quite characteristic for fowl pox.
Treatment: There is no specific treatment that is effective against the poxvirus. Good management will reduce stress in infected flocks.

Control: Vaccination is presently the only method of controlling fowl pox. The vaccination is done by wing web piercing. The vaccination can be done at 4–8 weeks of age.

Infectious bronchitis (IB)

Definition: Infectious bronchitis is an acute, contagious viral disease of chickens that primarily causes respiratory disease. It is characterized by rales, nasal discharge, coughing, and sneezing. In susceptible laying flocks, there is a drop in egg production and an adverse effect on egg quality.

Cause: IB is caused by a corona virus. This virus is in the same family with that which causes COVID-19 in humans. The virus of chicken does not cause disease in humans.

Transmission: The virus spreads rapidly among a flock of chickens by inhalation (aerosol transmission). The virus can also be spread by means of contaminated equipment and personnel.

Clinical Signs: Initially, there are mild respiratory symptoms, such as sneezing, snicking, gasping and moist rales. In addition, a nasal discharge may be observed. Young chicks are depressed and will huddle near a heat source. There is decreased feed consumption and poor feed conversion. In older birds, the disease may spread through the flock with only a mild cough observed. Birds affected with the nephrotropic strains of IB appear depressed, dehydrated, and have ruffled feathers. Eggs that are laid can be thin-shelled, wrinkled, and irregularly shaped as in Figure 32.

Figure 32: Irregularly shaped egg from chicken that tested positive for IB

Figure 33: Chicken head with scabs around the eye in the left photo (cutaneous fowl pox) while on the right side, the trachea obstructed by a cheesy plug

Lesions: Infected birds will have serous or caseous exudate in the trachea, hyperemic tracheal mucosa, nasal passages and sinuses. Usually, a cheesy plug may be found in the lower trachea or at the bifurcation of the bronchi as shown in Figure 33 and 34.

Figure 34: Trachea with adherent fibrin in the lumen

Diagnosis: Requires further laboratory tests

Treatment: There is no specific treatment effective for Infectious Bronchitis. Providing a comfortable environment and reducing stress as much as possible will help reduce the severity of the disease.

Prevention: Control of IB infection is by an effective vaccination program and good management practices such as strict restriction to the farm; all-in all-out bird movement; and thorough cleaning and disinfection of the poultry house. Unfortunately, prevention can be difficult because of the variation in field strains and the ability of the virus to change antigenicity.

Bacterial diseases

Colibacillosis

Definition: Infectious disease in which Escherichia coli is the primary pathogen or a secondary invader causing septicemia, peritonitis, cellulitis, omphalitis, salpingitis and air sacculitis.

Cause: Escherichia coli (E. coli).

Epidemiology: Ubiquitous, present in intestine of birds and mammals and is disseminated infeces. E. coli infections often result from management failure; often a secondary infection. Fecal contamination is the most important.

Transmission: Birds infected by direct contact with dirty litter and hatchers or contaminated eggshells. This is an environmental disease. Not transmitted from bird to bird.

Clinical signs: Nonspecific and include ill-thrift, ruffled feathers, enlarged and swollen navel, decreased appetite, depression, diarrhea and pasting of feathers around vent.

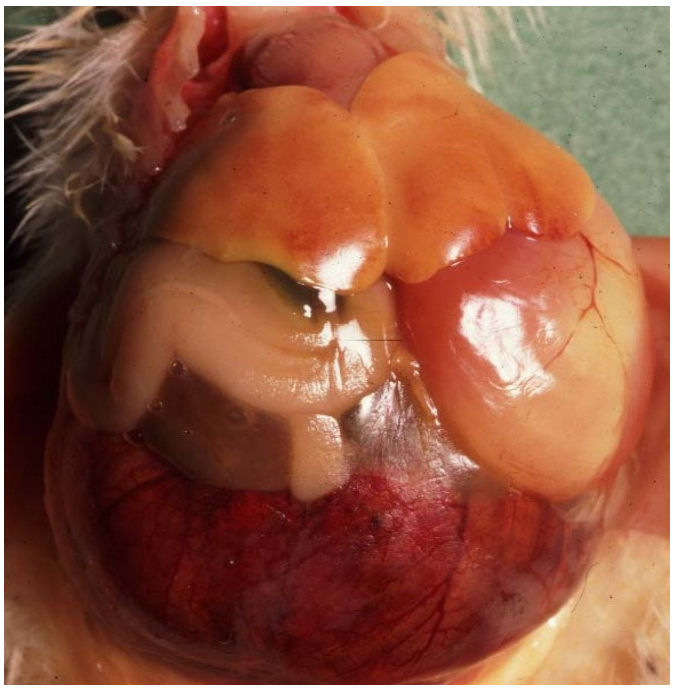
Lesions: The disease has about 7 different manifestations (airsaculitis, omphalitis, colisepticemia, salpingitis, hypopyon, arthritis and cellulitis) depending on the age and site of infection as shown in Figures 28–34.

Figure 35: Thick adherent fibrin covering liver and heart. This is seen in severe cases of colibacillosis

Figure 36: Cheesy white material covering the eye surface

This is common in poorly oriented houses and poor ventilation.

Figure 37: Inflamed (reddened) yolk sac (omphalitis)



Chicks with this lesion are often weak, depressed and have pasty vents. Although the omphalitis is not specific for colibacillosis.

Prevention and control: Requires proper stocking rate, ventilation and dry, dust-free litter. Good hatchery practices and proper chick handling. Antibiotic therapy, best with test and sensitivity. Therefore, proper housing is important in preventing many production systems related diseases.

Salmonellosis

There are two important types of Salmonellosis transmissible from mother to chicks through the eggs. These are Pullorum disease (Bacillary white diarrhoea) and Fowl typhoid.

Pullorum disease

Definition: An infectious, egg-transmitted disease affecting chicks, often associated with white diarrhea and high mortality in young birds. The adults are usually asymptomatic carriers of infection.

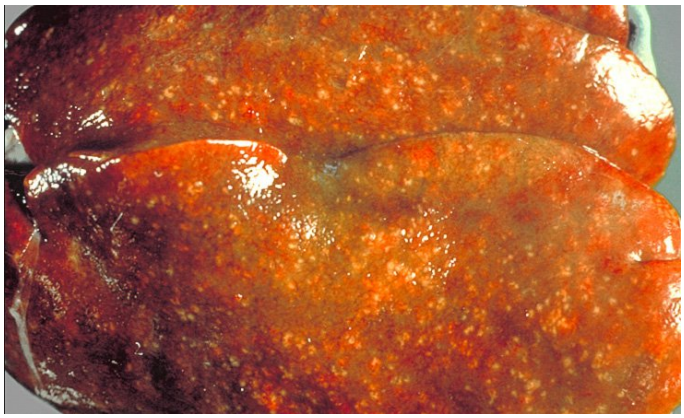
Cause: Salmonella pullorum

Transmission: The disease is primarily egg-transmitted. It can also spread in contaminated hatcheries, chick boxes, equipment and carrier birds.

Clinical Signs: Peak mortality at 2–3 weeks after hatching, but high mortality in chicks < 10-days-old. Dead chicks may be seen in the hatchery. Pasty white vent (cloaca), birds don't eat and huddle near heat source.

Gross lesions: Old chickens usually have no lesions. The lesions seen in chicks include marked dehydration, multifocal necrotic foci on the liver as shown in Figure 33, enlarged spleen and cecal cores. Similar necrotic foci are seen in fowl typhoid in older birds.

Figure 38: Multifocal white necrotic foci on the liver



Protozoal diseases

Coccidiosis

It is a serious disease that affects mainly chicken of 3 to 18 weeks of age. The disease may occur in older birds where there is dampness of litter and the immunity of chicken is low. It has two major forms, that is, acute and chronic.

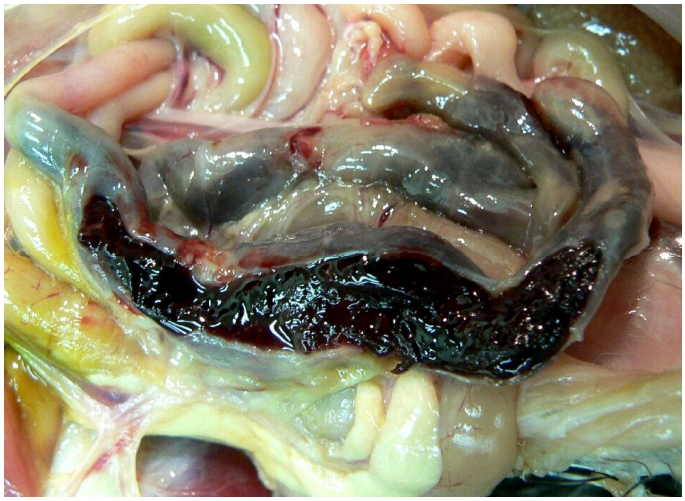
The acute form

Cause: Eimeria tenella

Signs: The acute form manifests with bloody diarrhoea and high mortality in a flock of chicken. Birds die quickly after a short course of illness.

Lesions: The main lesions seen are pale carcass (anaemia) and haemorrhagic contents of the cecum as shown in Figure 39.

Figure 39: Marked haemorrhage in the cecum



Such a bird dies quickly from anemia.

Treatment: The best treatment involves a drug that combines Amprolium, Sulphamethoxazole and Vitamin K1.

Chronic coccidiosis

Cause: It is caused by several Eimeria species that affect the small intestines (duodenum or jejunum or parts of ileum).

Signs: The birds become dull, sleepy and pass out diarrhoea (large faecal mass) consisting of poorly digested feeds. The chicken progressively lose weight, become lethargic and at this stage, many die, despite treatment. Due to persistence of the signs and poor response to treatment, many farmers often misdiagnose this form of coccidiosis as Marek's disease in Uganda.

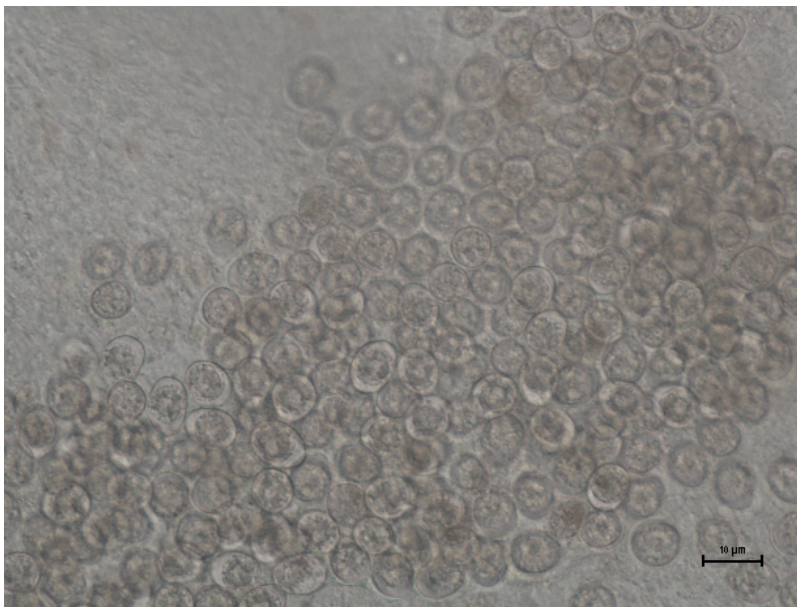
Lesions: The affected chicken are often emaciated, with prominent bones of the keel and joints as in Figure 35. The visceral organs appear reduced in size, but the intestines are often distended, with visible white necrotic foci from the serosa as in Figure 39. The intestines develop rough surface and may progress into secondary clostridial infection called necrotic enteritis as shown in Figure 40.

On microscopic examination, with intestinal scrapping and wet mount, large numbers of coccidian eggs are in Figure40.

Figure 40: Emaciated carcass with little breast muscle

Figure 41: Distended intestinal segments despite the emaciated body condition in Figure 35

Figure 42: Numerous coccidia oocysts in intestinal scrapping at necropsy (400x)



Prevention and control: Good hygiene of litter is required. Good hygiene includes providing dry litter (15–30% moisture content) in the house, removing damp litter and controlling water (rain) entry into the house. Avoid locating deep litter houses in swamps where the litter can get damp by ground water.

Internal Parasites

Worms

Causes and signs: The most common internal parasites in chicken are round worms (nematodes). They are found in the small intestines and irritate the intestinal lining. In heavy infestations, the worms may obstruct the intestinal lumen as in Figure 43 and cause retarded growth, illness and even death of some birds, particularly the young chicken.

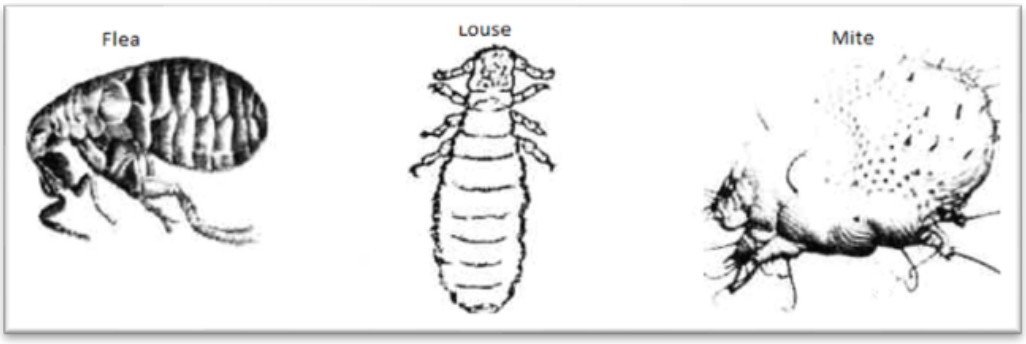
Figure 43: Round worms blocking the lumen of small intestines in chicken

Prevention and Control: Routine deworming, often once in a month in deep litter systems using levamisole or piperazine will suffice. It is better to alternate between the dewormers to reduce the risks of anthelmintic resistance development. When tape worm infestations are confirmed (by the presence of segments in droppings or the worms in intestines at post-mortem), albendazole or fenbendazole should be used as a dewormer.

External Parasites

Common causes: The common external parasites include fleas, lice and mites shown in Figure 44. The most common mites of poultry include feather mites, scaly leg mites, red mites, and many others. All these parasites suck blood and cause discomfort to the birds.

Figure 44: The common external parasites of chicken



Source: Eneku and Waelti, 2020

Signs of external parasites: The affected birds keep scratching themselves as in Figure 45 which disrupts them from feeding due to the irritations and subsequent drop in production.

Figure 45: Signs of parasites in chicken

Treatment and Prevention: Ashes and sulphur powder may be used where the hens do dust bathing. Nests may be protected by putting a few tobacco leaves mixed with ashes in the nest. Dust the birds with available anti-parasitic powders like Sevin dust, shown in Figure 46. Ideally, this should be done in the evening when the birds are going to sleep.

Replace the litter (in heavy infestation) and dust the house with insecticide, ash or oil, paying attention to the cracks and crevices.

Against fleas: Smear some vaseline mixed with little paraffin directly on the fleas. Avoid getting paraffin into contact with the eyes, or apply a little pye-grease on the affected parts.

Figure 46 A) Chicken with fleas around the eyes and B) Organophosphate powder for treating external parasites

The Organophosphate can be applied directly on the body of the chicken or on floor in the house.

Fungal diseases

Aspergillosis (Brooder pneumonia)

Definition: This is a fungal infection of the respiratory system in chicken that usually occurs from brooding stage.

Cause: It is caused by a fungus called Aspergillus fumigatus or less often A. flavus.

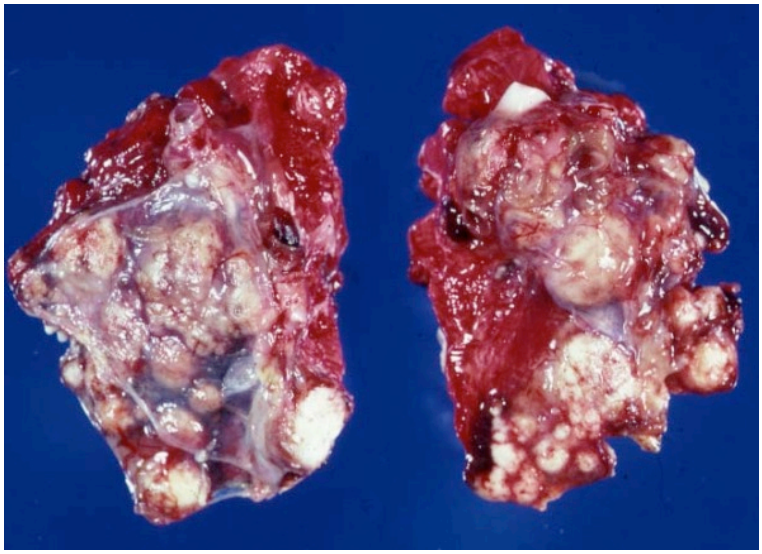
Transmission: The fungus is ubiquitous in environment (litter and feed) in varying concentrations. Aspergillus can penetrate egg shells and infect embryos. Infected eggs contaminate incubator or hatchery environment when broken. Sick chicks can be obtained from the hatchery. The infection is usually caused by inhalation of large number of fungal spores. The disease is not transmitted from bird to bird. It is got through:

- Spore inhalation
- Contaminated eggs in incubator
- Dusty litter and ranges

Clinical signs: Gasping, dyspnea, increased respiration and high mortality in chicken with clinical signs. Neurologic signs may be seen if infection spreads to the brain.

Gross lesions: Multifocal, friable grey to yellow nodules or plaques in air sacs, lungs, and surrounding tissues as shown in Figures 47.

Figure 47: Lungs of chicken with white nodular foci on the surface



The nodular foci is a case of brooder pneumonia.

Figure 48: Granulomas on the heart and lungs of 6–days old broiler

The chicks could have acquired the infection from the hatchery as granulomas take time to emerge.

Antibiotics cannot treat fungal infections.

The chicks in Figures 47 and 48 were from the same batch.

Diagnosis: Can be made from the signs, gross lesions and histopathology.

Treatment: There is no effective treatment. Farmers should not attempt to treat with any antibiotics. They should seek Veterinary advice.

Prevention: Husbandry; Clean and fumigate hatching eggs before setting them in the hatchery, thoroughly clean and disinfect hatchers and setters; clean air ducts and evaporative coolers in the hatchery; use clean, dry litter in the brooding house. If chicks die of aspergillosis at less than seven days, then a contaminated hatcher is prime suspect.

Metabolic diseases

Gout

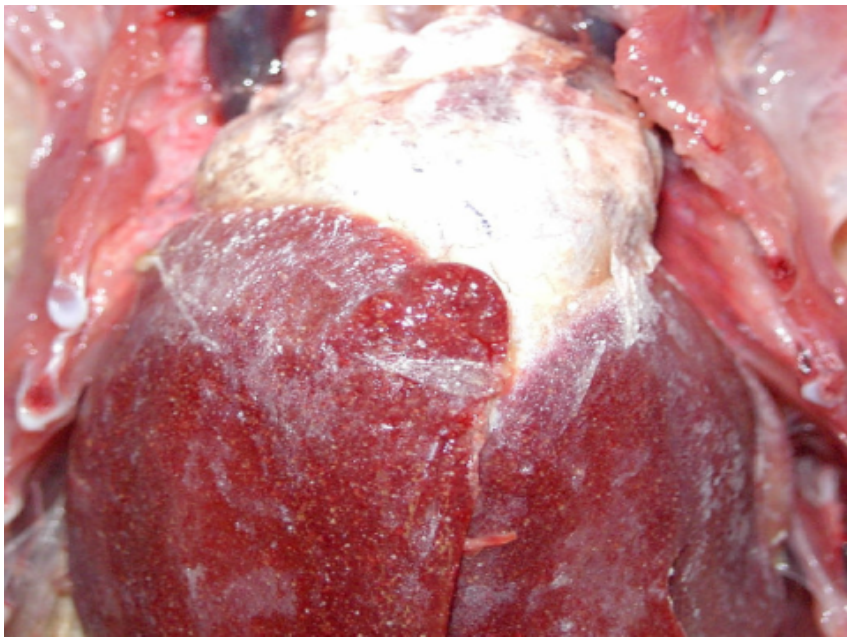
Definition: This is the deposition of urates in tissues of birds. The common form in chicken is visceral gout in which urates are deposited in many soft tissues of the body, particularly in the thoraco-abdominal cavity. It is more common in older layers though younger birds are affected too. Occasionally, gout can significantly contribute to flock mortality, sometimes as high as 0.5 % per week.

Cause: It is associated with kidney failure. Kidneys can be damaged by dehydration (water deprivation or excessive water loss), low phosphorus diets at any age, high vitamin D3 in the ration, or excessive calcium before sexual maturity (15 to 16 weeks). Kidney damage by nephrotic form of Infectious Bronchitis also results into gout.

Clinical signs: Birds with gout usually show no clinical signs before death or may be extremely thin.

Gross lesions: The affected birds have diffuse urate deposition on surfaces of organs and air sacs in the thoraco-abdomen. The joints of the legs are also affected. In severe cases, the subcutis will also have urate deposition. The kidneys are swollen, pale and rough. Sometimes the kidney disappears (atrophies). The ureters are often distended with thick solid urate deposits as shown in Figure 49.

Figure 49: Visceral gout



Widespread chalky white urate deposits on the surface of liver and heart.

Prevention: Gout can be prevented by providing the proper nutrition of calcium and phosphorus throughout growing stage and avoiding water deprivation at housing.

Annex 9: Training evaluation

The following questions on Likert scale are suggested for evaluation at the end of the training;

1. The objectives of the training were clearly defined
   1=Strongly disagree 2=Disagree Agree 3=Neutral 4=Agree 5=Strongly agree
2. Participation and interaction were encouraged
   1=Strongly disagree 2=Disagree Agree 3=Neutral 4=Agree 5=Strongly agree
3. The topics covered were relevant to me
   1=Strongly disagree 2=Disagree Agree 3=Neutral 4=Agree 5=Strongly agree
4. The content was well organized and easy to follow
   1=Strongly disagree 2=Disagree Agree 3=Neutral 4=Agree 5=Strongly agree
5. This training experience will be useful in my work
   1=Strongly disagree 2=Disagree Agree 3=Neutral 4=Agree 5=Strongly agree
6. The trainers were knowledgeable about the training topics
   1=Strongly disagree 2=Disagree Agree 3=Neutral 4=Agree 5=Strongly agree
7. The trainers were well prepared
   1=Strongly disagree 2=Disagree Agree 3=Neutral 4=Agree 5=Strongly agree
8. The training objectives were met
   1=Strongly disagree 2=Disagree Agree 3=Neutral 4=Agree 5=Strongly agree
9. The time allotted for the training was sufficient
   1=Strongly disagree 2=Disagree Agree 3=Neutral 4=Agree 5=Strongly agree
10. The meeting room and facilities were adequate and comfortable
    1=Strongly disagree 2=Disagree Agree 3=Neutral 4=Agree 5=Strongly agree
11. What did you like most about this training?
12. What aspects of the training could be improved?
13. How do you hope to change your practice as a result of this training?
14. What additional trainings would you like to have in the future?
15. Please share other comments:

Annex 10: Drug withdrawal periods

Poultry Drug Use Guide

The following listing of approved poultry drugs for Uganda is intended to provide a general guide of dose and pre-slaughter withdrawal time. When calculating withdrawal time, each day is a full 24 hours long, starting with the hour the bird last received the drug. The listing is neither inclusive nor exclusive and may change. Many of the listed drugs are approved for use in combination with other drugs.

Active Ingredient	Route	Withdrawal time in meat (days)	Dose and Administration	Brand Name Examples
Antibiotics and antibacterial				
Ampicillin Trihydrate + Collistin Sulphate	Water	1	1 gm per 2 litre for 3–5 days	Collie- Am
Colistin Sulphate + Erythromycin Thiocyanate	Water	6	125 g per 100 litres of drinking water for 3–5 days	Eryconor®
Doxycycline + Neomycin	Water	7	1 g of powder per 5 litre of drinking water for 3–5 days continuously	Ashidox-N
Doxycycline Hyclate	Water	8	100–225 g per 1,000 litres of drinking water for 3–5 days	Doxyvet 500
Doxycycline Hyclate+Tylosin Tartrate	Water	7	1 kg per 1000–2000 litres of drinking water for 3–5 days	Doxin 200 Ws, Kx-Doxytylosin, Tylo-Dox Powder
Doxycycline Hyclate+Tylosin Tartrate+Vitamin A Acetate+ Cholecalciferol+Vitamin E +Riboflavin + Cyanocobalamin + Calcium Panthothenate +Nicotinamide +Vitamin K3 + Ascorbic Acid +Thiamine Hydrochloride +Pyridoxine	Water	15	100 g per 200–400 litres of drinking water daily, for 3–5 days	Doxy Tylovet Plus
Doxycycline Hydrochloride + Colistin Sulfate + Ambroxol Hydrochloride	Water	7	1 gm/4 litres of drinking water daily for 3–5 days.	D. Colinor Extra
Enrofloxacin	Water	5	50 mg/L drinking water for 5 days	Interflox Oral, Enrosol-S, Ashienro 10%, Enprotil, Sequenro Oral, Limited Floxinor, Enrotril-100, Enrocure, Kx-Enro
Erythromycin + Oxytetracycline +Streptomycin + Colistin + Vitamins (A + D3 + B1 + B2 + B6 + B12 + C) + Calcium + Vit K3 + Nicotinamide + Inositol	Water	7	1 kg per 1000 litres of drinking water for 5–7 days	Aliseryl Ws, Keproceryl Wsp
Erythromycin Thiocyanate	Water	4	100 g per 200 litres of drinking water daily, for 3–5 days	Erythromycin Thiocyanate
Erythromycin Thiocynate + Bromhexine Hydrochloride	Water	4	100 g per 200 litres of drinking water daily, for 3–5 days	Eryxin

Active Ingredient	Route	Withdrawal time in meat (days)	Dose and Administration	Brand Name Examples
Oxytetracycline + Neomycin + Vitamins(A + D3 + E + B1 + B2 + B6 + B12 +C) + Calcium + Vit K3 + Nicotinamide + Folate + Methionine + Lysine	Water	7	1kg per 1000 litre drinking water for 5–7 days	Nemovit WS (Egg Formula), Neo-Oxy Egg Formula WSP
Oxytetracycline Hcl+Neomycin (As Sulfate)+Vita Min A+Vitamin D3+Vitamin K3+Vitamin B1+Vitamin B2+Vitamin B6+Vitamin B12+Nicotina Mide+Ca Pantothenate +Folic Acid+Vitamin C+Methionine +Lysine	Water	14	10 g/20 litres of drinking water for 3–5 days	Hanegg-Plus
Oxytetracycline Hcl+Vit A+Vit D3+Vit E+Vit C+Ferrous So4+Magnesium So4+Zinc So4+Copper So4	Water	7	5 g (1 tsp) per 4.5 ltr.of drinking water for 5–7 days consecutively	Oxyvitamin
Oxytetracycline Hydrochloride + Neomycin Sulphate + Vitamin A+Vitamin D3+Vitamin E+Vitamin B1+Vitamin B2+Vitamin B6+Vitamin B12+Vitamin C+Calcium Pantothenate +Vitamin K3+Nicotinamide+Folic Acid+Methionine+Lysine+Copper Sulphate	Water	7	100 g per 100 litres of drinking water for 3–5 days	Vitranor-Egg Formula® WSP
Oxytetracycline + Colistin	Water	7	0.5 g per litre of water for 3–5 days	Tetracolivit
Oxytetracycline Hcl + Vitamins; A + D3 +B2 +B12 + E +K3 + Nicotinamide + Calcium Pantothenate	Water	7	5 g (1 tsp) per 4.5 ltr.of drinking water for 5–7 days consecutively	Ashoxy Egg Formula, Poltricin Mayai Formula, Occtan-D
Oxytetracycline Hydrochloride	Water	7	200 g per 1,000 litres of drinking water for 3–7 days	Tetranor® 25% WS, Limoxin-400 WS Ashoxy 20%, Oxytetravet 50%, Kx-Oxy WSP, Vetoxy 20, Tetramed
Oxytetracycline Hydrochloride + Neomycin Sulphate + Vitamin A + Nicotinamide + Vitamin K3 (Menadione Sodium Bisulphite) +Calcium Pantothenate	Water	7	100 g per 100 litres of drinking water for 5–7 days	Oxy Plus (Water Soluble Powder)
Oxytetracycline+ Vit A+ D3 + E + K3 + B2 +B12 + Calcium + Nicotinamide	Water	7	5 g (1 tsp) per 4.5 ltr. of drinking water for 5–7 days	Ashoxy Chick Formula, Poltricin Chick Formula
Sulfaclozine Sodium Monohydrate	Water	14	2.5 g per litre water for 5 days	Esb30
Sulfadimidine Sodium + Diaveridine	Water	5	1gm/2 litres of drinking water for 5 days or for 3 consecutive days, stop treatment for 2 days, then give for another 2 days	Anticox
Sulfaquinoxaline Sodium + Trimethoprim	Water	10	1g per 1 litre drinking water, for 3–5days	Typhocostar

Active Ingredient	Route	Withdrawal time in meat (days)	Dose and Administration	Brand Name Examples
Sulphadimidine Sodium	Water	15	1 kg per 2000 litres of drinking water for 3 days, or according to the 3–2–3 scheme: 3 days on, 2 days off, 3 days on	Intradine Poultry, S-Dime 16% Solution
Tiamulin Hydrogen Fumarate	Feed	5	200 g/ton, 1 week per month	Denagard 10% Feed Premix
Trimethoprim + Sulfadiazine	Water	5	1 kg per 1500–2500 litres of drinking water for 4–7 days	Trisul 80/400 WSP, Supermed Ts 1, Ashtrisul, Primovet, Vapcotrim Powder
Trimethoprim + Sulfamethoxazole	Water	5	320–525 mg/L drinking water for 3–5 days	Biosol WDP, New-Pacprim
Tylosin Tartrate	Water	5	1 kg for 1500–2000 litres of drinking water for 3–5 days	Macrolan WS, Ashtyl
Tylosin Tartrate + Gentamicin Sulphate	Water	8	100g to medicate 400 litres of drinking water for 3–5 days	Gentylo
Anticoccidials				
Amprolium	Water	0	13-30 mg/kg PO, 1.25 cc/L in drinking water for 5–7 days	Amprolin-300 WS, Coccid, Ampronor 300mg®, Asampro, Ampromed, Amprolium 20
Amprolium Hydrochloride + Sulfaquinoxaline + Vitamin A + Vitamin K3	Water	14	20 g per 20–40 litres of drinking water for 5–7 days	Amprocox WS
Diclazuril	Water	5	50–100ml Diclacox per 200 litres of drinking water for 48 hrs	Anticox, Diclacox, Kx-Dic
Toltrazuril	Water	18	5ml per 5 litre of drinking water, continuous medication over 48 hours	Toltracox, Vazuril, Baycox, Coccitoltrazol, Kx-Toltra, Medacox
Dewormers				
Levamisole Hydrochloride	Water	9	50ml per 20litres of drinking water for 2 days	Terazole 30%, Levacide Poultry, Levalap
Piperazine Citrate	Water	2	1 kg per 1000 litres of drinking water for 2 days	Piperin WS, Ascarex Worm Powder, Ascazine, Ashpirazine, Piperanor
Multivitamins				
Multivitamin/Amino Acid, contents stated as multi-ingredient in the NDA veterinary drug register. They have no antibiotics included	Water	0	100 g per 200 litres of drinking water daily, for 1 week	Vitaflash Aminoacid Wsp, Vitapower, Aminovital
Vitamins A + D3 + E + B1 + B2 + B6 + B12 +C) + Ca + Vit K3 + Nicotinamide + Folate + Biotin + Cl + FeSo4 +MnSo4 + ZnSo4 + NaCl	Water	0	1 kg per 4000 litres of drinking water for 3–5 days	Introvit A+ WS

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