Managing Coccidiosis in my Poultry Flock

Adapted from the *Managing Coccidiosis in my Poultry Flock* Website

About the Project

The Knowledge Translation and Transfer program was set up by OMAFRA to promote exchange and presentation of knowledge between academia and industry, with a collaborative link between these two stakeholders. This presentation of knowledge is an objective, "agenda-free" form of education, with equal input from many collaborators from many different groups.

Through our work and discussions with several poultry veterinarians, we have found that coccidiosis remains a problem in the poultry industry. However, the problem of coccidiosis is mostly due to a lack of understanding of the parasite leading to confusion in how to deal with it and how to properly manage the problem.

Main Goal

The main goal of this extension project is to foster proactive coccidiosis control management in the poultry industry by developing a self-guided, interactive educational tool that includes a feature film and this website (which has been adapted into this manual).

How This Project Can Help You

This project will provide a basic understanding of the parasite and its methods of control in a production system similar to yours and, may assist with parasite management (in addition to knowledge from your poultry veterinarian and poultry industry representative).

The information presented does NOT intend to replace proper veterinary care, but rather provides end-users with reliable, focused education.

Growing Forward 2 Ontario Canada

List of Contributors

Funding for this project

Ontario Ministry of Agriculture, Food and Rural Affairs – U of G Partnership Knowledge Translation and Transfer program

Committee Members

Kayla R. Price (Dept. Pathobiology, University of Guelph)
Laura Bowers (Poultry Industry Council)
Kobus Van-Heerden (CEVA Santé Animale)
Dr. Michele T. Guerin (Dept. Population Medicine, University of Guelph)
Dr. Gregoy Bedecarrats (Dept. Animal and Poultry Science, University of Guelph)
Dr. Csaba Varga (Ontario Ministry of Agriculture, Food and Rural Affairs)
Dr. John R. Barta (Dept. Pathobiology, University of Guelph)

Special thank you to our contributors

CEVA Santé Animale

Poultry Industry Council

Ontario Ministry of Agriculture, Food & Rural Affairs

University of Guelph Poultry Club

Dr. Kathleen Becher
Oren Birch (Wallenstein Feed & Supply Ltd.)
Marina Brash (University of Guelph)
Julie Cobean (University of Guelph)
Al Dam (Ontario Ministry of Agriculture, Food & Rural Affairs)
Derek Detzler
Peter Gazdzinski
Jurgen Haas
Walter Haas
Richard Hanna
Dr. Thomas Jeffers
George Jeffrey (Vetoquinol Canada)
Eamon Kinahan
Paul Leatherbarrow
Edward Malek (Canadian Food Inspection Agency)
Dr. Marie-Anne Paradis
Dr. Mike Petrik
Dr. Cynthia Phillipe
Dr. Joanne Rafuse (Zorra Veterinary Services)
Brad Rogers
Janet Schell (Wallenstein Feed & Supply)
Dave Vandenberg
Larry Vanderbent
Dr. Lloyd Weber

In-kind contribution of 3D coccidiosis life cycle animation video

CEVA Santé Animale

DVD and Video Production

Sceneskape productions

Cost of Coccidiosis

Coccidiosis continues to burden the poultry industry worldwide (1). This disease is one of the most frequently reported disease worldwide and is present wherever poultry are raised (1,2). The annual cost of coccidiosis globally is estimated to be approximately $2.4 billion (2). However, each country and local city has different costs associated with coccidiosis. The cost of coccidiosis and impact on poultry production is due to the cost of coccidial control (e.g. medication and vaccination), predisposition to secondary disease, sickness (e.g. decreased performance due to impaired growth rate, poor feed conversion or temporary reduction in egg production) and mortality (3).

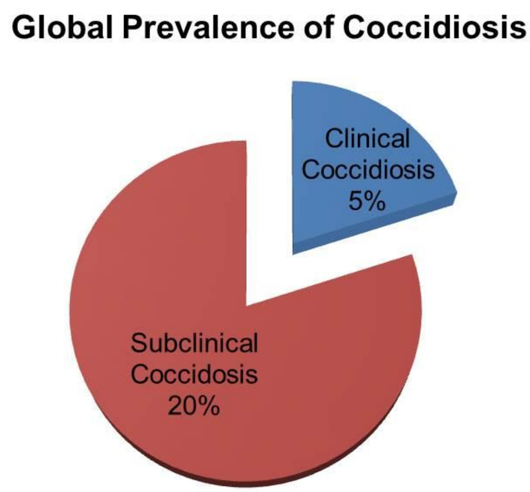

Figure 1. The global prevalence of reported clinical and subclinical coccidiosis in commercial chicken flocks (2).

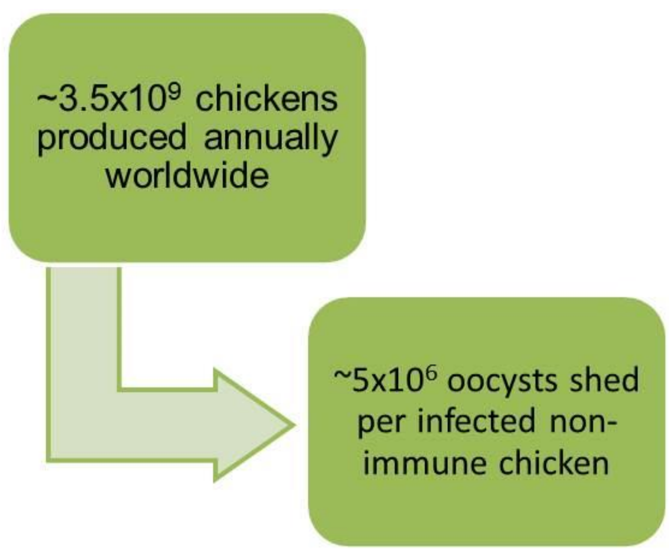

Figure 2. Estimation of the number of chickens produced worldwide and the number of oocysts shed per infected non-immune chicken (2).

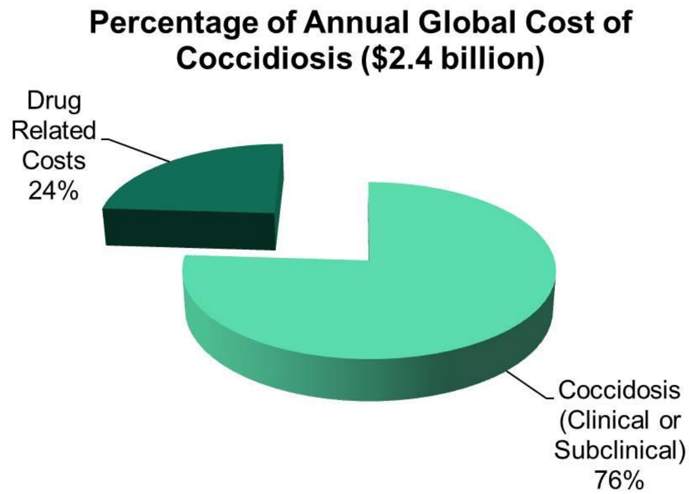

Figure 3. The percentage of drug related and coccidiosis diseases costs of the approximate global cost of coccidiosis - $2.4 billion (2).

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1. Price, K.R. Use of live vaccines for coccidiosis control in replacement layer pullets. Journal of Applied Poultry Research 21:679-692. 2012.

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Table of Contents

Managing Coccidiosis in My Poultry Flock – DVD

As part of this Knowledge Translation and Transfer project, a self-guided educational DVD was created in addition to the information presented in this manual. These DVD's were distributed to poultry producers and service industry representatives across Canada, in an effort to educate producers on Coccidiosis and aid them in proactive Coccidiosis control management.

Copies of the DVD are no longer available; however, the video footage can be found at the links below.

Coccidiosis Management explained - from the parasite, to the bird, to the barn

Coccidiosis Management: Introduction

Coccidiosis Management: Broilers

Coccidiosis Management: Pullets

Coccidiosis Management: Turkeys

Coccidiosis Management: Game Birds and Small Flock

Coccidiosis Management: Monitoring

Coccidiosis Management: Conclusions and Credits

Parasite Biology

Life Cycle

The environmentally resistant oocyst contains 4 sporocysts with 2 infective sporozoites per sporocyst, and is transmitted fecal-orally. Sporozoites will then exit the sporocyst to infect a host intestinal epithelial cell and undergo asexual replication for a pre-determined number of cycles. Then sexual replication occurs to produce an uninfective oocyst (1). Sporulation occurs outside of the host because only when the oocyst is in the environment at the right temperature, oxygen level and relative humidity does it become infective (2). Sporulation for most *Eimeria* species takes about 48 hours to occur (1). During the patent period, you will see maximum oocyst shed around 6 to 8 days post inoculation and this will taper out around 10 days post inoculation (3).

The number of *Eimeria* parasites ingested will determine the amount of damage to the host (4). Depending on the *Eimeria* species, "a few" oocysts would cause an unapparent infection, "thousands" could cause clinical signs and "tens of thousands" could result in severe coccidiosis and perhaps mortalities in birds that have never been exposed to the disease before (4).

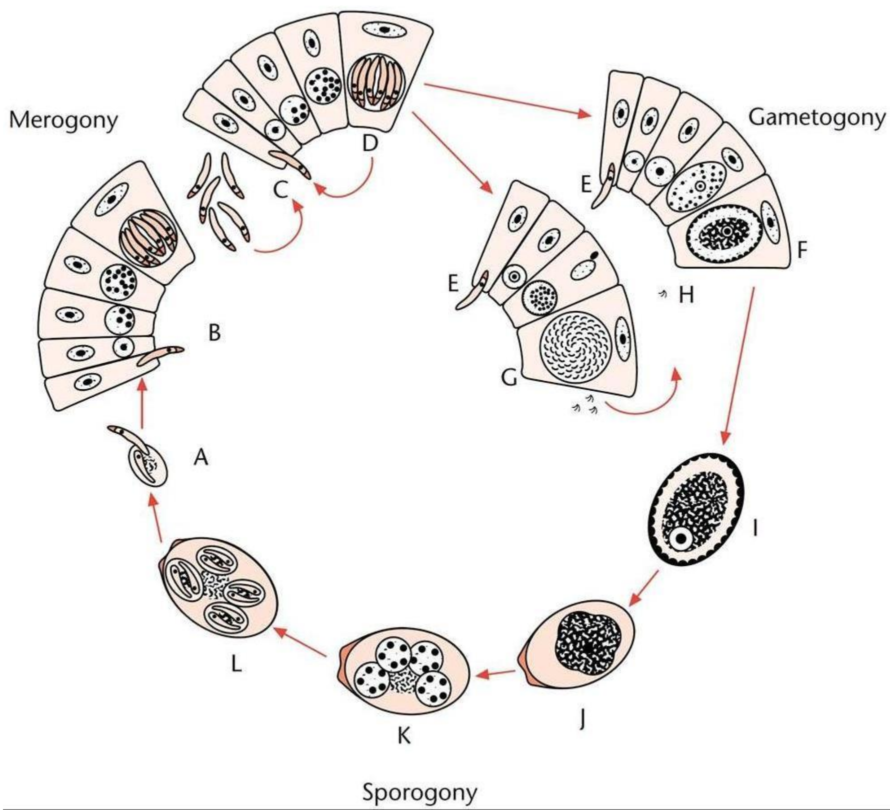

Figure 4. The life cycle of a typical *Eimeria* species. Sporozoites (A) excyst from sporocysts in the intestinal tract of poultry. Sporozoites infect a host intestinal epithelial cell and initiate asexual replication (B-D). Asexual replication forms motile stages that exit and infect neighbouring host intestinal epithelial cells for a pre-determined number of cycles (C-D). After asexual replication, sexual replication occurs (E-G) where an unsporulated oocyst is formed (H) and is then shed in the feces (I). Sporulation occurs in the environment to produce a sporulated, infective oocyst (I-L) (1).

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3. Kheysin, Y.M. Life Cycles of Coccidia of Domestic Animals. University Park Press, Baltimore, MD. 1972.

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Characteristics of *Eimeria* species

Eimeria species are highly host-specific so different species will infect chickens, turkeys and game birds with limited cross-infection (1). Regardless, each species is unique in terms of level of pathogenicity and location of infection along the host intestinal tract. While each species can infect their host separately, they can also infect a bird simultaneously. In the field, birds are usually infected with more than one *Eimeria* species (2). Scroll down for chicken, turkey and game bird *Eimeria* species.

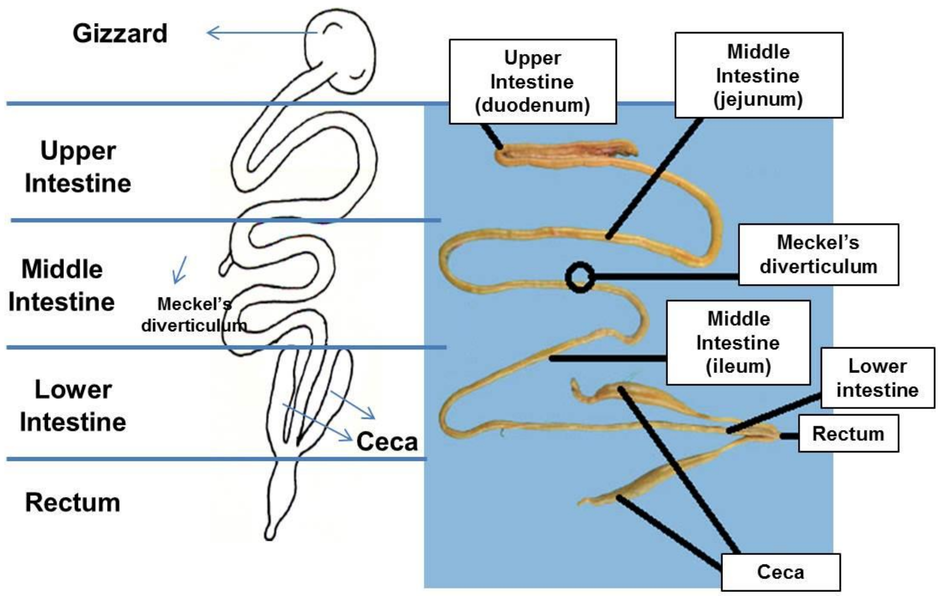

Figure 5. Normal poultry intestine with important sections and markers labelled (3, 4).

Chicken *Eimeria* species

Nine *Eimeria* species have been described for chickens but only five to seven species (*E. acervulina, E. brunetti, E. maxima, E. tenella, E. necatrix, E. praecox, E. mitis*) are commonly associated with disease in commercial production (3).

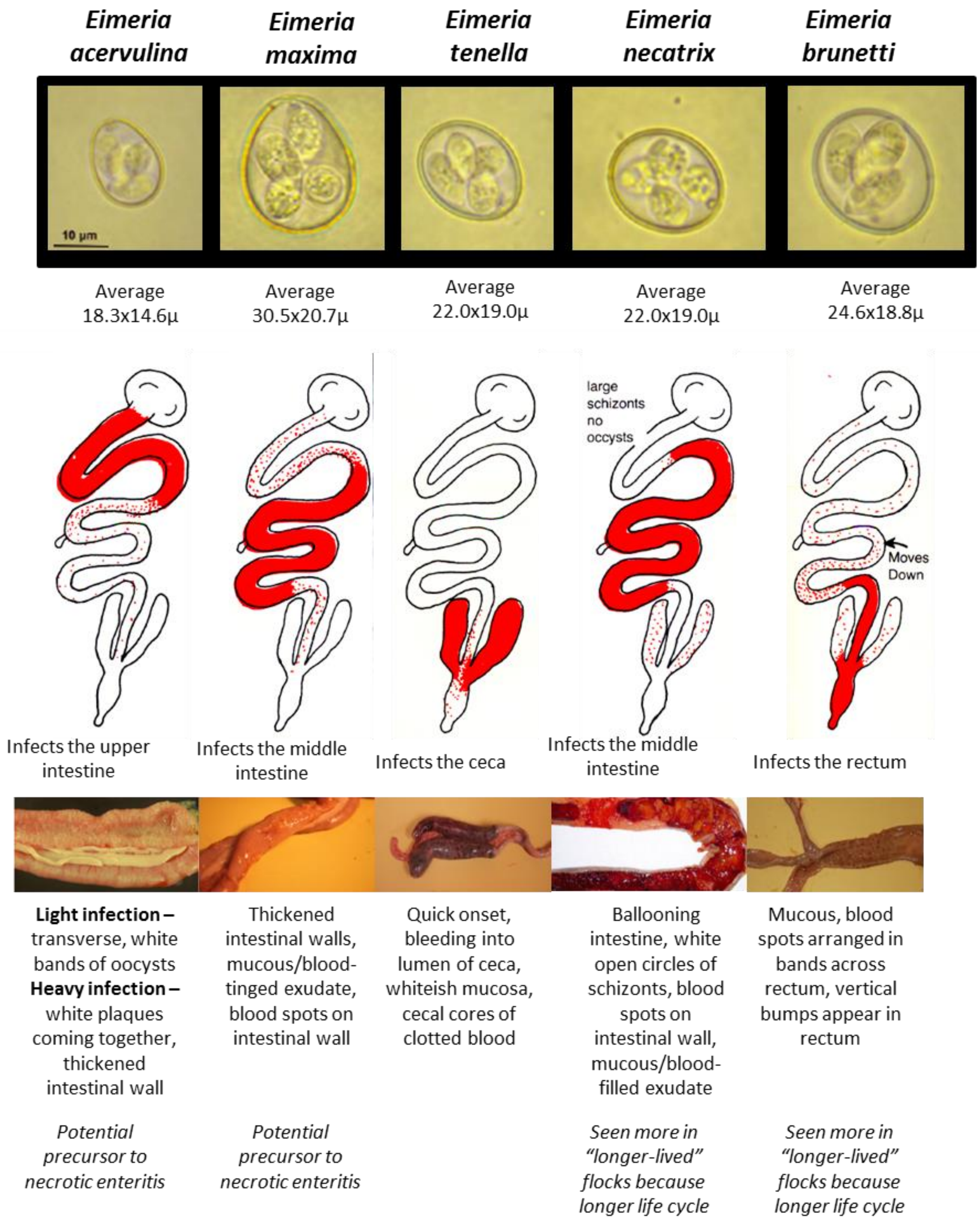

Figure 6. Five chicken *Eimeria* species commonly associated with disease. *Eimeria* oocysts, location of infection along the intestine and lesions per species are shown (3, 5).

Turkey *Eimeria* Species

Seven *Eimeria* species have been described for turkeys but only five species (*E. adenoeides, E. meleagrimitis, E. meleagridis, E. gallopavonis* and *E. dispersa*) are encountered commonly in commercial turkey production (6). *Eimeria adenoeides* and *E. meleagrimitis* are considered the most economically important species contributing to coccidiosis in turkeys.

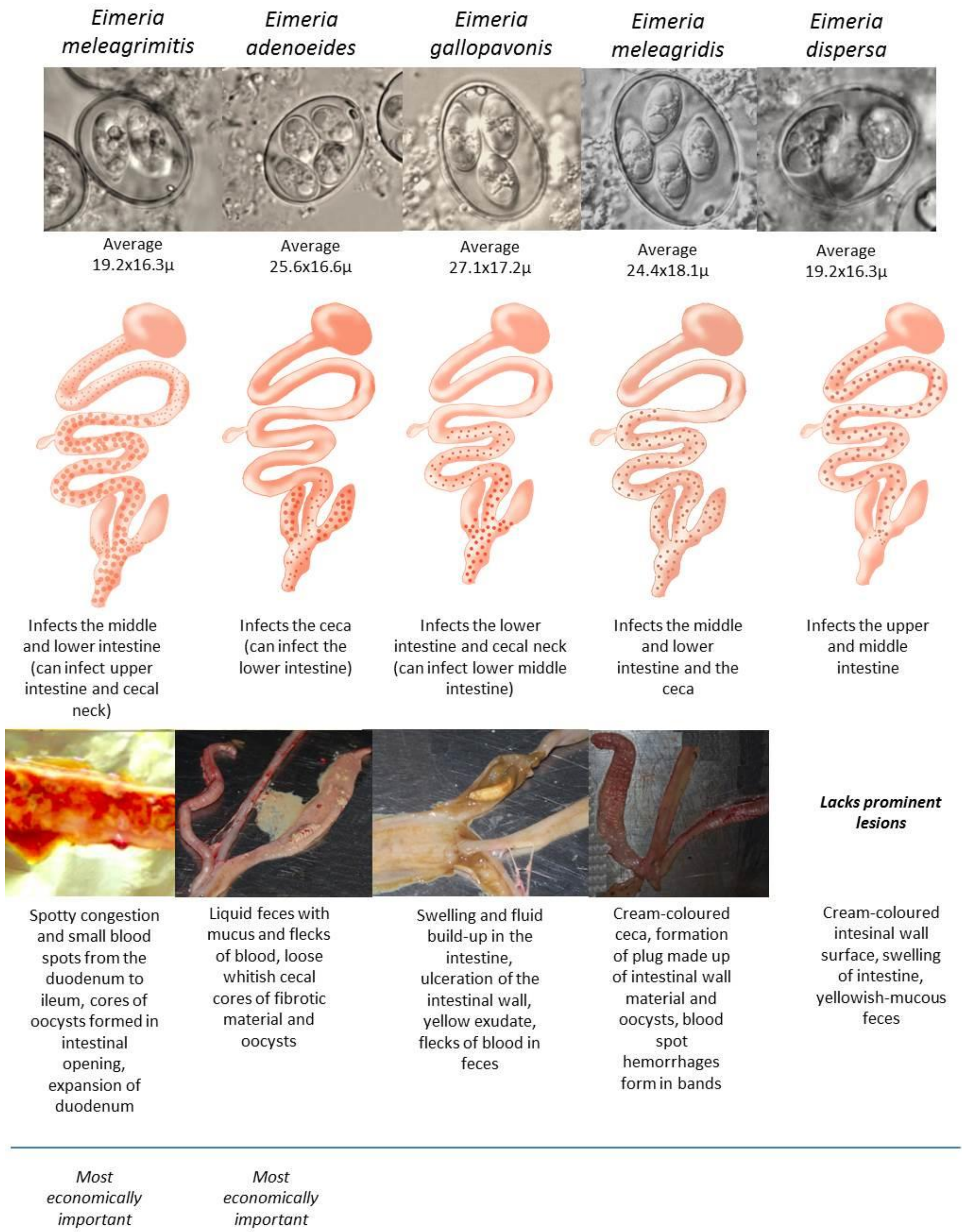

Figure 7. Five turkey *Eimeria* species commonly associated with disease. *Eimeria* oocysts, location of infection along the intestine and lesions per species are shown (5, 7, 8).

Game Bird *Eimeria* Species

The *Eimeria* species of game birds (e.g. pheasant, chukars or bobwhite quail) have not been researched in detail like chicken or turkey *Eimeria* species.

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1. Fayer, R. Epidemiology of protozoan infections: the coccidia. Veterinary Parasitology 6:75-103. 1980.

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5. Thank you to Dr. Jean-Michel Reperant for chicken *Eimeria* oocyst photos and *E. meleagrimitis* lesion photo

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8. Thank you to Ms. Shiem El-Sherry for the turkey *Eimeria* oocyst photos and *E. adenoeides, E. gallopavonis* and *E. meleagridis* photos

Interaction of *Eimeria* with other poultry diseases: Necrotic Enteritis

In the field, necrotic enteritis and coccidiosis infections usually go hand in hand. Necrotic enteritis is a bacterial infection of poultry caused by *Clostridium perfringens* and lesions usually localize around the small intestine (1). *Clostridium perfringens* is a bacterium that can readily be found anywhere, including among the naturally present intestinal flora of chickens (2). Development of necrotic enteritis requires favourable intestinal conditions such as a weakened intestinal barrier produced by predisposing factors such as diet composition and intestinal cell damage (e.g. caused by coccidiosis) (3).

This website will focus on the relationship between coccidiosis and necrotic enteritis. For information on the other potential predisposing factors for development of necrotic enteritis refer to:

Van Immerseel, F., J. De Buck, F. Pasmans, G. Huyghbaert, F. Haesebrouck and R. Ducatelle, 2004. Clostridium perfringens in poultry: An emerging threat for animal and public health. Avian Pathol., 33: 537-549.

Clostridium perfringens lacks about 13 essential amino acids that can be acquired from the host (2). Bacteria can access these required amino acids from the host in many ways such as leakage of proteins (made up of many amino acids) into the intestine after intestinal cell damage or from mucous (made up of mostly glycoproteins and water) lining the intestinal tract (3). Consequently, *Eimeria* species that damage cells of the small intestine as well as cause an increase in mucous production during infection, specifically *E. maxima, E. acervulina, E. necatrix* or *E. brunetti*, can predispose birds to subsequent necrotic enteritis (3). Other *Eimeria* species induce excess mucous production in the small intestine (*E. praecox* and *E. mitis*) but they induce minimal intestinal lesions and therefore may be less associated with development of necrotic enteritis.

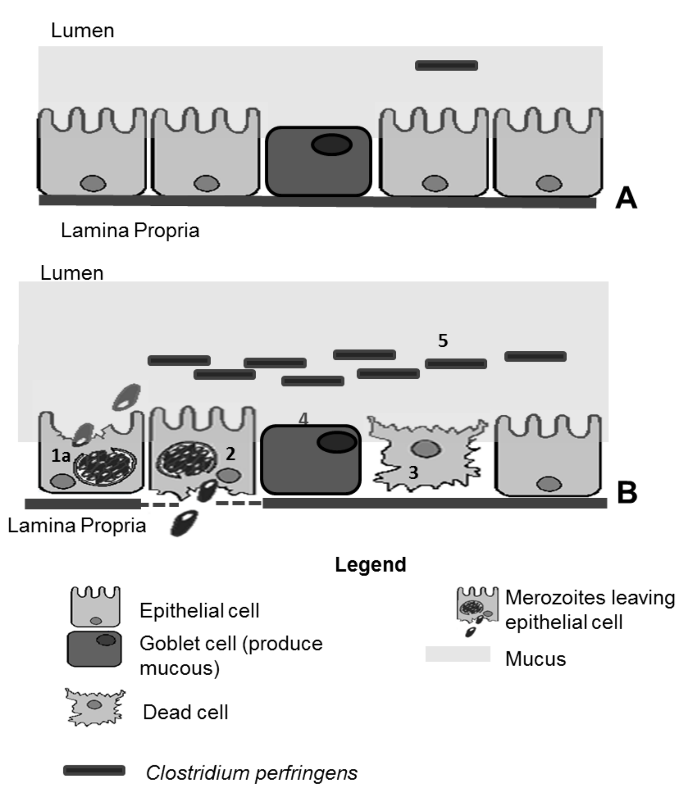

Figure 8. Simplified illustration of possible ways *Clostridium perfringens* can access required amino acids from a chicken intestinal tract with coccidiosis. The healthy gastrointestinal tract consists of a mucus and epithelial layer as well as a basal lamina to act as a barrier between the indigenous microbiota, lumen, and lamina propria, respectively (A). Coccidiosis can predispose chickens to necrotic enteritis outbreaks (B). During coccidiosis lesions are caused during the asexual cycle usually when the motile asexual stage exits the cell, breaks the intestinal cell membrane [1, 2] and kills the intestinal cell [3]. *Clostridium perfringens* usually occurs in the small intestine and requires access to amino acids. *Eimeria* species that damage cells of the small intestine [1-3], causing leakage of proteins, and cause and increase in mucous production [4] permits *Clostridium perfringens* replication [5].

Coccidial lesions may have formed and partially or completely resolved by the time clinical necrotic enteritis arises. Thus, a lack of coccidial lesions concurrent with necrotic enteritis does not mean that a coccidial infection did not occur (3). However, necrotic enteritis is unlikely to predispose a bird to coccidiosis because clostridial lesions produce an environment that is unsuitable for asexual development of *Eimeria* species (3).

Necrotic enteritis is considered an illness mainly of broiler birds between two and six weeks of age (3) but has also been noted in commercial layer replacement pullets at 16 weeks of age or later (4). While managing coccidiosis prior to these ages may not eliminate the potential for a necrotic enteritis outbreak, it can help to limit one of the predisposing factors.

For further reading on the relationship between coccidiosis and necrotic enteritis please refer to:

Williams, R.B., 2005. Intercurrent coccidiosis and necrotic enteritis of chickens: rational, integrated disease management by maintenance of gut integrity. Avian Pathol., 34: 159-180.

References

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Management through the Environment

Please refer to the Life Cycle page for better understanding of this section.

To become infectious and survive, oocysts need proper temperature, relative humidity and oxygen. Best sporulation occurs at temperatures around 29°C, relative humidity (RH) of 30-70% and with adequate access to oxygen (1-9).

Producers may reduce sporulation if any of these requirements is not met. However, because of the close relation between *Eimeria* and their host, changing the environment dramatically may also impact bird health.

WARNING: The type of coccidiosis prevention program used on your farm (e.g. preventative drugs or live vaccines) can impact how you manage *Eimeria* through the environment. See the "Methods of Control" section for further details.

There are three main atmospheric components that can impact oocyst sporulation (1-9):

1. **Temperature**
    a. Oocysts become infectious under temperatures ranging between 4 and 37°C, with an optimal temperature of about 29°C. Extreme temperatures outside of this range can kill the oocyst.
    b. As from placement (day old chicks) to two weeks of age the temperature in a typical chicken barn is maintained between 28 and 36°C, it is an ideal environment for oocysts to become infective.

2. **Relative humidity**
   Because barns require ventilation, the outside temperature and humidity can impact the environment of the barn. Especially if the equipment does not control the RH of the air feeding the barn. There is not a designated optimal relative humidity percentage set-out for sporulation but an RH of 35-70% is considered adequate.

    a. Different *Eimeria* species may respond differently to various moisture levels, such that onset of sporulation, percentage of sporulation and viability/survivability of the sporulated oocysts could be impacted. However, faster sporulation and longer survival in the environment will increase the likelihood that an oocyst will become infective and available for ingestion to contribute to parasite transmission.

3. **Oxygen access**
    a. If the oocyst does not have adequate oxygen access during sporulation, it may not become infective. For example, the accumulation and compaction of litter can decrease oxygen access which can act to kill the oocyst. In addition, high ammonia levels resulting from accumulated litter can also kill oocysts.

Example of the minimum outside temperature needed paired with the temperature gradient needed in a generic chicken barn over the first 6 weeks of rearing to achieve an RH of 35% inside the barn (if air handling equipment does not control the RH of the air feeding the barn).

	Day 1-2	Day 3-4	Day 5-7	Week 2	Week 3	Week 4	Week 5-6
Relative humidity (%) inside the barn	35	35	35	35	35	35	35
Temperature (°C) inside the barn	36	34	32	29	27	24	20
Dew Point (°C) outside the barn	18	16	15	12	10	8	4

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Managing Cocci in My Flock

Chickens

Pullets (Layers/Broiler Breeders)

Click Here if you have Broilers

This is NOT a housing management guide. These sections were created to help explain the relationship between housing and oocyst ingestion. Please consult your veterinarian and bird management guide from the breeding company for housing management information.

I use:

Name of Rearing System	Picture of Rearing System
Conventional Cage Rearing – Click here for live vaccine or anticoccidial drug prevention methods A coccidiosis and/or a necrotic enteritis outbreak may be seen around 2-4 and 19-26 weeks of age.	
Litter Rearing – Click here for live vaccine or anticoccidial drug prevention methods A coccidiosis and/or a necrotic enteritis outbreak may be seen around 2-4 and 19-26 weeks of age. *Picture courtesy of Kobus Van-Heerden*	

Alternate System: Aviary Rearing – Click here for live vaccine or anticoccidial drug prevention methods A coccidiosis and/or a necrotic enteritis outbreak may be seen around 2-4 and 19-26 weeks of age.	
Alternate System: Enriched Cage Rearing – Click here for live vaccine or anticoccidial drug prevention methods A coccidiosis and/or a necrotic enteritis outbreak may be seen around 2-4 and 19-26 weeks of age.	

Pullets Reared in Conventional Cages

Pullets Reared in Conventional Cages - Live Vaccines

Brooding

The brooding and immediate post-brooding periods are important to vaccine success because this is the time where offspring vaccine oocysts can cycle in the barn at low levels. Essentially, the cycling during this phase is acting as an immunity booster to the original vaccine dose; without this cycling, the vaccine will not work as effectively.

General Good Barn Practice – Provide chicks with clean, biosecure housing. Ensure that feed and water are readily available to the chicks when they are placed (1). Additionally, proper heat, ventilation and lighting as well as feed and water quality are required for good rearing management (1).

Physical Cage Environment During Brooding: Oocyst Cycling – A mesh floor assists in reducing the number of oocysts accessible to the pullet but these mesh floors will not eliminate oocysts from the cage environment. When a live vaccine is used with cage reared pullets, the limited oocyst cycling provided by the mesh floor alone is usually not enough to generate adequate and complete protection against coccidiosis challenge (2). A management method that has been tested is placement of a degradable material (e.g. thick chick paper, fibre trays made of egg carton material) over a portion (40%) of the cage floor that lasts approximately 5 weeks (2,3). A typical *Eimeria* species will start to shed from the bird between 5 and 7 days post initial ingestion of an infective oocyst (i.e. live vaccine administration). The oocyst takes between 24-48 hours to become infective once shed. The long-lasting coverage may provide sufficient duration for low level cycling and thus sufficient exposure to infective oocysts.

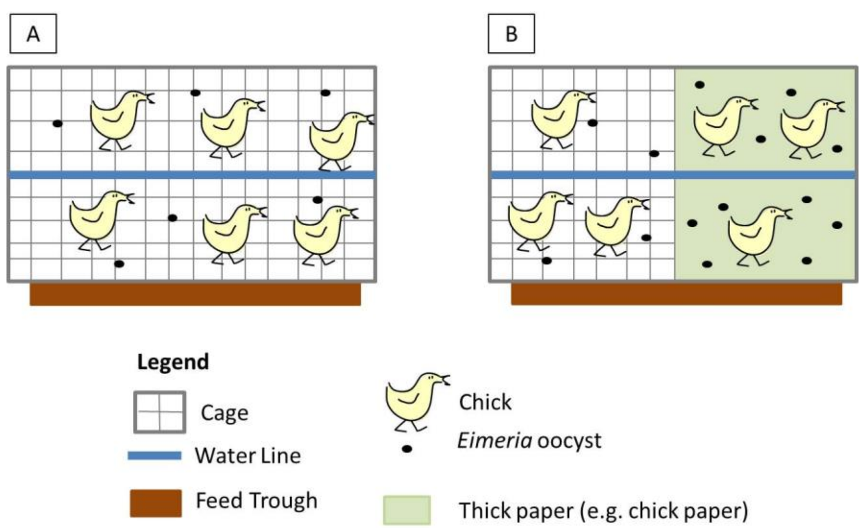

Figure 9. Simple diagram illustrating *Eimeria* oocyst build-up in a conventional caging system. A mesh floor (A) will assist in reducing the number of oocysts accessible to the pullet but these mesh floors will not eliminate oocysts. A tested management method that may provide sufficient duration and exposure to oocysts for low level cycling is the placement of a degradable material (e.g. thick chick paper, fibre

trays made of egg carton material) over a portion (40%) of the cage floor that lasts approximately 5 weeks (B).

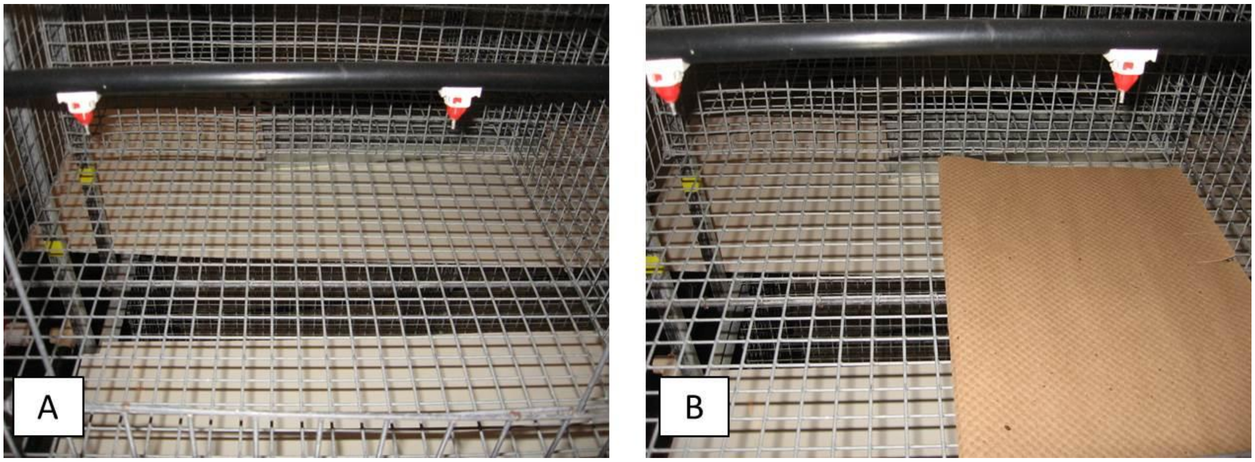

Figure 10. An example of the mesh floor without (A) and with (B) 40% cage floor coverage of the conventional cage mesh floor.

Physical Cage Environment During Brooding: Nipple Drinker Cups – If nipple cups are attached to the drinkers this is a potential reservoir for oocysts.

Figure 11. Example of a dirty nipple drinker cup for pullets reared in conventional cages. Be cautious as this dirty cup can be a potential reservoir for oocysts.

General Good Practice for Coccidiosis Management During Rearing

Atmospheric Barn Environment: Get to Know Relative Humidity (RH) - Because barns require ventilation, the outside temperature and humidity can impact the environment of the barn; especially if the equipment does not measure and account for RH of the air feeding the barn.

Example of the minimum outside temperature needed paired with the temperature gradient needed in a generic chicken barn over the first 6 weeks of rearing to achieve an RH of 35% inside the barn (if air handling equipment does not control the RH of the air feeding the barn).

	Day 1-2	Day 3-4	Day 5-7	Week 2	Week 3	Week 4	Week 5-6
RH (%) inside the barn	35	35	35	35	35	35	35
Temperature (°C) inside the barn	36	34	32	29	27	24	20
Dew Point (°C) outside the barn	18	16	15	12	10	8	4

Click here to calculate Relative Humidity.

There is not a designated optimal relative humidity percentage set-out for oocyst sporulation but an RH of 35-70% is considered adequate (bird management guides recommend between 60-70%). Interestingly, good monitoring of RH may also help the welfare of the bird (4).

Atmospheric barn environment: Oxygen Access - If the oocyst does not have adequate oxygen access during sporulation, it may not become infective. High ammonia levels resulting from accumulated manure can also kill oocysts.

Physical Cage Environment: Manure Belts - When a manure belt is in use it will rotate and go through a scraping area where manure is scraped off the belt into a manure disposal area. While most of the manure is removed during this process, the scraper cannot remove all of the manure and it is not equipped to remove microscopic organisms, such as *Eimeria*. In multitier conventional cage system, the manure belts act as a roof for the tier level below. When the bird is tall enough they are able to peck at the manure belt roof and potentially at oocysts that remain on the belt (5,6). This issue can act as a potential disease source OR a method to allow for low level of oocyst cycling depending on the number of oocysts being shed and becoming infectious in the environment.

Figure 12. Example of a manure belt in use during pullet rearing. The scraper removes most, but not all the manure (A) and is not equipped to remove microscopic organisms, such as *Eimeria*. In a multi-tier conventional cage system, the manure belt acts as a roof for the tier below (B). Pullets in lower tiers may have access to *Eimeria* from the manure belt, especially when they are tall enough to peck at the belt. (Picture Credits: Guy Kostrey, Sceneskape Productions)

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Pullets Reared in Conventional Cages – Anticoccidial Drugs

Brooding

General Good Barn Practice – Provide chicks with clean, biosecure housing. Ensure that feed and water are readily available to the chicks when they are placed (1). Additionally, proper heat, ventilation and lighting as well as feed and water quality are required for good rearing management (1).

Physical Cage Environment During Brooding: Nipple Drinker Cups – If nipple cups are attached to the drinkers this is a potential reservoir for oocysts.

Figure 13. Example of a dirty nipple drinker cup for pullets reared in conventional cages. Be cautious as this dirty cup can be a potential reservoir for oocysts.

General Good Practice for Coccidiosis Management During Rearing

Physical Cage Environment: Manure Belts - When a manure belt is in use it will rotate and go through a scraping area where manure is scraped off the belt into a manure disposal area. While most of the manure is removed during this process, the scraper cannot remove all of the manure and it is not equipped to remove microscopic organisms, such as *Eimeria*. In multitier conventional cage system, the manure belts act as a roof for the tier level below. When the bird is tall enough they are able to peck at the manure belt roof and potentially at oocysts that remain on the belt (5,6). This issue can act as a potential disease source OR a method to allow for low level of oocyst cycling depending on the number of oocysts being shed and becoming infectious in the environment.

Figure 14. Example of a manure belt in use during pullet rearing. The scraper removes most, but not all the manure (A) and is not equipped to remove microscopic organisms, such as *Eimeria*. In a multi-tier conventional cage system, the manure belt acts as a roof for the tier below (B). Pullets in lower tiers may have access to *Eimeria* from the manure belt, especially when they are tall enough to peck at the belt. (Picture Credits: Guy Kostrey, Sceneskape Productions)

References

1. Anonymous. Layer management guide: Lohmann LSL Classic. In. Lohmann Tierzucht GmBh. 2005.

2. Price, K.R. Use of live vaccines for coccidiosis control in replacement layer pullets. The Journal of Applied Poultry Research 21:679-692. 2012.

3. Dr. Mike Petrik, personal communication.

Pullets Reared on Litter

Pullets Reared on Litter - Live Vaccines

Brooding

The brooding and immediate post-brooding periods are important to vaccine success because this is the time where offspring vaccine oocysts can cycle in the barn at low levels. Essentially, the cycling during this phase is acting as an immunity booster to the original vaccine dose; without this cycling, the vaccine will not work as effectively.

General Good Barn Practice – Provide chicks with clean, biosecure housing. Ensure that feed and water are readily available to the chicks when they are placed (1,2). Additionally, proper heat, ventilation and lighting as well as feed and water quality are required for good rearing management (1,2).

Half House Brooding - This management method is a modification of whole house brooding. The birds are confined to half of the house with a set of drinker and feeder lines. The house is heated with forced air heaters and the aim is to achieve uniform temperature in the air space. In this management method, bird density is increased for the period they are in half of the house. A typical *Eimeria* species will start to shed from the bird between 5 and 7 days post initial ingestion of an infective oocyst (i.e. live vaccine administration). The oocyst takes between 24-48 hours to become infective once shed. If birds are kept in the half house for at least 10 days (and if relative humidity, temperature and oxygen access are maintained), this brooding method may provide sufficient duration for low level cycling and thus sufficient exposure to infective oocysts.

Note: If birds are moved to the whole barn earlier than 10 days there will have been oocyst shedding, oocyst sporulation but not enough time to allow for the ingestion of these shed oocysts as is needed for the live vaccine to work effectively.

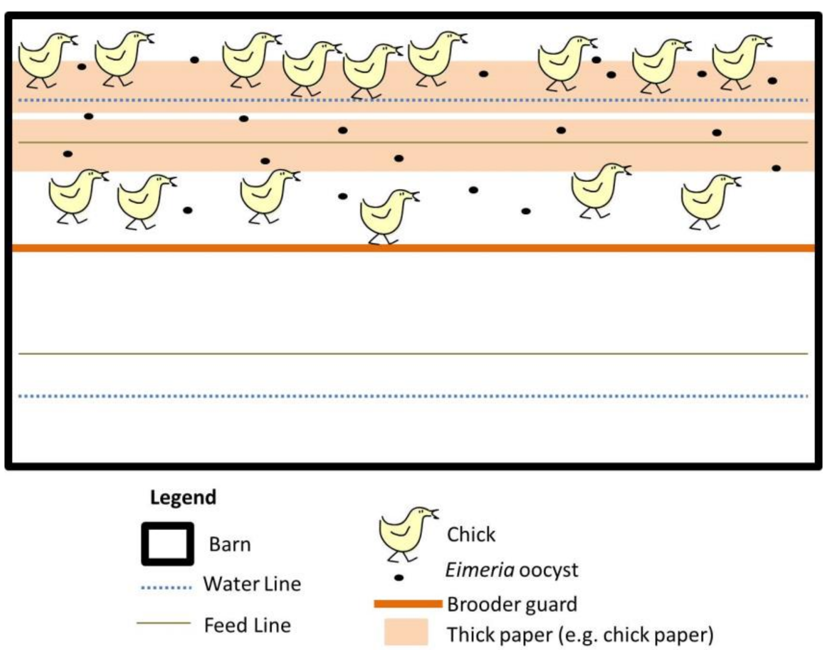

Figure 15. Simple diagram illustrating *Eimeria* oocyst build-up in a half house brooding system. In this brooding method bird density is increased for the period the broilers are in half of the house. As offspring vaccine oocysts are shed into the environment they can accumulate in the occupied area of the house. If the birds are kept in half of the house until the offspring oocysts sporulate and become infective, this brooding method may provide the sufficient duration and exposure to oocysts for low-level cycling.

Figure 16. An example of half house brooding (Picture Credit: Guy Kostrey, Sceneskape Productions).

Physical Environment During Brooding - Similar to broiler birds (1) providing 60% paper coverage below the feeder and water lines during the brood phase would provide the extra feed and water spillage needed to stimulate bird activity and appetite as early as possible. Interestingly, this method may provide the needed coverage to allow progeny vaccine oocysts to remain at the litter surface for ingestion by the bird (low-level oocyst cycling). Without this coverage, oocysts may fall between the litter material used thus preventing birds from ingesting them. If the removal of the paper is a normal practice, it has to be removed before 5 days after vaccination, or only after 10 days after vaccination. Warning: If you remove the paper between 5 and 10 days after vaccination during the peak vaccine oocyst shed time you will remove the shed oocysts from the barn. Removing these oocysts from the barn may impact vaccine success.

Physical Environment During Brooding - Chicks during the brood stage are small enough that they may be able to fit in the open feeders. Be aware that these chicks will defecate into the feeders and should the feces contain oocysts, this will allow for cycling. Additionally, nipple cups attached to the drinkers are also potential reservoirs for oocysts.

Figure 17. An image of a chick resting in an open feeder. Note the fecal droppings inside the feeder (Picture Credit: Dr. Lloyd Weber).

General Good Practice for Coccidiosis Management During Rearing

Atmospheric Barn Environment: Get to Know Relative Humidity (RH) - Because barns require ventilation, the outside temperature and humidity can impact the environment of the barn; especially if the equipment does not measure and account for RH of the air feeding the barn.

Example of the minimum outside temperature needed paired with the temperature gradient needed in a generic chicken barn over the first 6 weeks of rearing (2) to achieve an RH of 35% inside the barn (if air handling equipment does not control the RH of the air feeding the barn).

	Day 1-2	Day 3-4	Day 5-7	Week 2	Week 3	Week 4	Week 5-6
Relative humidity (%) inside the barn	35	35	35	35	35	35	35
Temperature (°C) inside the barn	36	34	32	29	27	24	20
Dew Point (°C) outside the barn	18	16	15	12	10	8	4

Click here to calculate Relative Humidity.

There is not a designated optimal relative humidity percentage set-out for oocyst sporulation but an RH of 35-70% is considered adequate (bird management guides recommend between 60-70%). Interestingly, good monitoring of RH may also help the welfare of the bird (3).

Atmospheric barn environment: Oxygen Access and Litter - If the oocyst does not have adequate oxygen access during sporulation, it may not become infective. Accumulation and compaction of litter can decrease oxygen access which can act to stop sporulation. In addition, high ammonia levels resulting from accumulated litter can also kill oocysts.

Physical Barn Environment: Leaky Drinkers - A nipple drinker in a broiler barn can have at least 1 million hits during an entire growing cycling. This wear and tear on the drinker over time can cause the drinkers to leak. Leaky drinkers cause localized areas of high moisture which can be a good spot for above average oocyst sporulation. Be cautious of these areas as there may be infective oocyst build-up.

Figure 18. Examples of leaky drinkers and dirty drinker cups (A-C) for birds reared on litter. Be cautious of localized areas of high moisture due to leaky drinkers (B, C) and dirty drinker cups (A) that can be potential reservoirs for oocysts (Picture Credits: Dr. Lloyd Weber).

References

1. Anonymous. Ross Broiler Management Manual. In. Aviagen. 2009. Access HERE.

2. Anonymous. Layer management guide: Lohmann LSL Classic. In. Lohmann Tierzucht GmBh. 2005.

3. Stamp Dawkins, M., C.A. Donnelly, and T.A. Jones. Chicken welfare is influence more by housing conditions than by stocking density. Nature 427:342-344. 2004.

Pullets Reared on Litter – Anticoccidial Drugs

Brooding

General Good Barn Practice – Provide chicks with clean, biosecure housing. Ensure that feed and water are readily available to the chicks when they are placed (1,2). Additionally, proper heat, ventilation and lighting as well as feed and water quality are required for good rearing management (1,2).

Full House Brooding - This brooding method heats the whole house using forced air heaters and the aim is to achieve uniform temperature in the house (1). In this style of brooding (should temperature be adequate), birds should be spread throughout the entire house. Similar to broilers (1) providing 60% paper coverage below the feeder and water lines during the brood phase would provide the extra feed and water spillage needed to stimulate bird activity and appetite as early as possible. If oocysts are in the environment, the spread of birds could reduce the potential for a bird to ingest an infective oocyst.

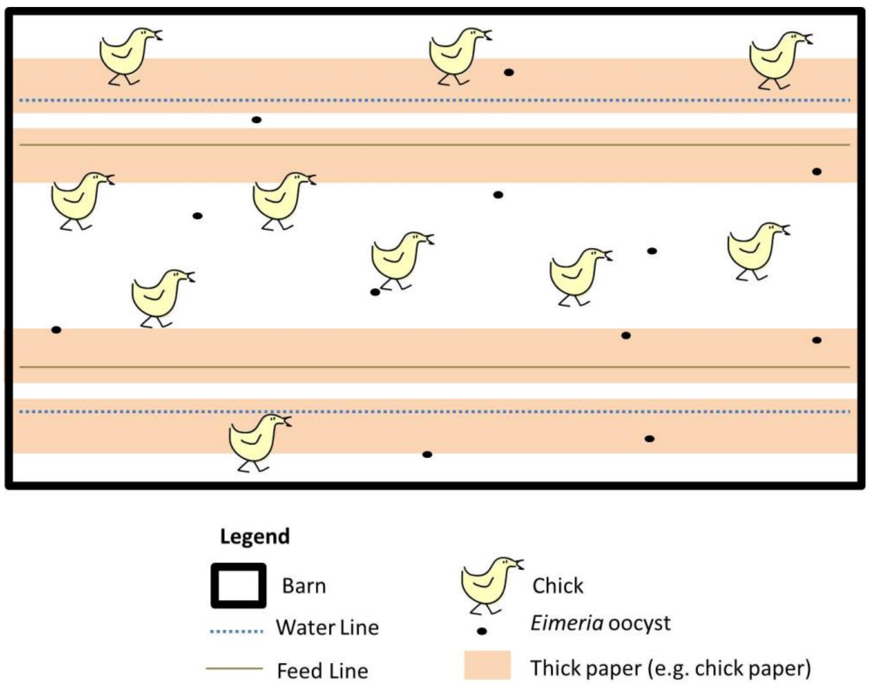

Figure 19. Simple diagram illustrating *Eimeria* oocyst build-up in a full house brooding system. In full house brooding if oocysts are in the environment, the spread of birds could reduce the potential for a bird to ingest an infective oocyst.

Figure 20. An example of full house brooding using paper coverage over the litter around the feeder and water lines (Picture Credit: Dr. Lloyd Weber).

Physical Environment During Brooding - Chicks during the brood stage are small enough that they may be able to fit in the open feeders. Be aware that these chicks are able to defecate into the feeders and this is another spot where birds can ingest infectious oocysts if present in the feces. Additionally, nipple cups attached to drinkers are also potential reservoirs for oocysts.

Figure 21. An image of a chick resting in an open feeder. Note the fecal droppings inside the feeder (Picture Credit: Dr. Lloyd Weber).

General Good Practice for Coccidiosis Management During Rearing

Litter Management: Keeping the Litter Dry - Make sure the floor is warm and dry prior to spread shavings or straw and placing birds in the barn. Be sure the bedding (shavings or straw) starts off dry. Be aware of leaky drinkers and flushing birds. If necessary, remove “cakey” litter (areas of localized high moisture).

Leaky Drinkers - A nipple drinker in a broiler barn can have at least 1 million hits during an entire growing cycling. This wear and tear on the drinker over time can cause the drinkers to leak. Leaky drinkers cause localized areas of high moisture which can be a good spot for above average oocyst sporulation. Be cautious of these areas as there may be infective oocyst build-up.

Figure 22. Examples of leaky drinkers and dirty drinker cups (A-C) for birds reared on litter. Be cautious of localized areas of high moisture due to leaky drinkers (B, C) and dirty drinker cups (A) that can be potential reservoirs for oocysts (Picture Credits: Dr. Lloyd Weber).

References

1. Anonymous. Ross Broiler Management Manual. In. Aviagen. 2009. Access HERE.

2. Anonymous. Layer management guide: Lohmann LSL Classic. In. Lohmann Tierzucht GmBh. 2005.

Pullets Reared in Aviary Systems

Pullets Reared in Aviary Systems - Live Vaccines

Brooding

The brooding and immediate post-brooding periods are important to vaccine success because this is the time where offspring vaccine oocysts can cycle in the barn at low levels. Essentially, the cycling during this phase is acting as an immunity booster to the original vaccine dose; without this cycling, the vaccine will not work as effectively.

Note: Oocyst transmission has yet to be studied in aviary systems. Methods used with litter or cage rearing may be tried but are NOT guaranteed to work.

General Good Barn Practice – Provide chicks with clean, biosecure housing. Ensure that feed and water are readily available to the chicks when they are placed (1). Additionally, proper heat, ventilation and lighting as well as feed and water quality are required for good rearing management (1).

Physical Enriched Cage Environment During Brooding: Nipple Drinker Cups – If nipple cups are attached to the drinkers this is a potential reservoir for oocysts.

General Good Practice for Coccidiosis Management During Rearing

Atmospheric Barn Environment: Get to Know Relative Humidity (RH) - Because barns require ventilation, the outside temperature and humidity can impact the environment of the barn; especially if the equipment does not measure and account for RH of the air feeding the barn.

Example of the minimum outside temperature needed paired with the temperature gradient needed in a generic chicken barn over the first 6 weeks of rearing (1) to achieve an RH of 35% inside the barn (if air handling equipment does not control the RH of the air feeding the barn).

	Day 1-2	Day 3-4	Day 5-7	Week 2	Week 3	Week 4	Week 5-6
Relative humidity (%) inside the barn	35	35	35	35	35	35	35
Temperature (°C) inside the barn	36	34	32	29	27	24	20
Dew Point (°C) outside the barn	18	16	15	12	10	8	4

Click here to calculate Relative Humidity.

There is not a designated optimal relative humidity percentage set-out for oocyst sporulation but an RH of 35-70% is considered adequate (bird management guides recommend between 60-70%). Interestingly, good monitoring of RH may also help the welfare of the bird (2).

Atmospheric Barn environment: Oxygen Access - If the oocyst does not have adequate oxygen access during sporulation, it may not become infective. High ammonia levels resulting from accumulated manure can also kill oocysts.

Physical Aviary System Environment: Perches, Platforms and Dust Bath Areas - As the pullets grow to use the perches, platforms and dust bath areas fecal build-up may occur on or below these additions. Consequently, it is important to note these areas as potential reservoirs for oocysts. Additionally, this elevation may allow the birds to defecate on each other which could be another way in which birds could ingest oocysts (3).

Figure 23. An example of a platform in an aviary pullet rearing system during use. Fecal build-up can occur on this platform during rearing and if the feces are contaminated with infective oocysts this platform is another area where pullets can ingest oocysts. (Picture Credit: Guy Kostrey, Sceneskape Productions)

References

1. Anonymous. Layer management guide: Lohmann LSL Classic. In. Lohmann Tierzucht GmBh. 2005.

2. Stamp Dawkins, M., C.A. Donnelly, and T.A. Jones. Chicken welfare is influence more by housing conditions than by stocking density. Nature 427:342-344. 2004.

3. Appleby, M.C. The Edinburgh modified cage: effects of group size and space allowance on brown laying hens. Journal of Applied Poultry Research 7:152-161. 1998.

Pullets Reared in Aviary Systems – Anticoccidial Drugs

Brooding

General Good Barn Practice – Provide chicks with clean, biosecure housing. Ensure that feed and water are readily available to the chicks when they are placed (1). Additionally, proper heat, ventilation and lighting as well as feed and water quality are required for good rearing management (1).

Physical Enriched Cage Environment During Brooding: Nipple Drinker Cups – If nipple cups are attached to the drinkers this is a potential reservoir for oocysts.

General Good Practice for Coccidiosis Management During Rearing

Physical Enriched Cage Environment: Perches, Platforms and Dust Bath Areas - As the pullets grow to use the perches, platforms and dust bath areas fecal build-up may occur on or below these additions. Consequently, it is important to note these areas as potential reservoirs for oocysts. Additionally, this elevation may allow the birds to defecate on each other which could be another way in which birds could ingest oocysts (2).

Figure 24. An example of a platform in an aviary pullet rearing system during use. Fecal build-up can occur on this platform during rearing and if the feces are contaminated with infective oocysts this platform is another area where pullets can ingest oocysts. (Picture Credit: Guy Kostrey, Sceneskape Productions)

References

1. Anonymous. Layer management guide: Lohmann LSL Classic. In. Lohmann Tierzucht GmBh. 2005.

2. Appleby, M.C. The Edinburgh modified cage: effects of group size and space allowance on brown laying hens. Journal of Applied Poultry Research 7:152-161. 1998.

Pullets Reared in Enriched Cages

Pullets Reared in Enriched Cages - Live Vaccines

Brooding

The brooding and immediate post-brooding periods are important to vaccine success because this is the time where offspring vaccine oocysts can cycle in the barn at low levels. Essentially, the cycling during this phase is acting as an immunity booster to the original vaccine dose; without this cycling, the vaccine will not work as effectively.

Note: Oocyst transmission has yet to be studied in enriched cages. Methods used with litter or cage rearing may be tried but are NOT guaranteed to work.

General Good Barn Practice – Provide chicks with clean, biosecure housing. Ensure that feed and water are readily available to the chicks when they are placed (1). Additionally, proper heat, ventilation and lighting as well as feed and water quality are required for good rearing management (1).

Physical Enriched Cage Environment During Brooding: Nipple Drinker Cups – If nipple cups are attached to the drinkers this is a potential reservoir for oocysts.

Figure 25. Example of a dirty nipple drinker cup for pullets reared in conventional cages. Be cautious as this dirty cup can be a potential reservoir for oocysts.

General Good Practice for Coccidiosis Management During Rearing

Atmospheric Barn Environment: Get to Know Relative Humidity (RH) - Because barns require ventilation, the outside temperature and humidity can impact the environment of the barn; especially if the equipment does not measure and account for RH of the air feeding the barn.

Example of the minimum outside temperature needed paired with the temperature gradient needed in a generic chicken barn over the first 6 weeks of rearing (1) to achieve an RH of 35% inside the barn (if air handling equipment does not control the RH of the air feeding the barn).

	Day 1-2	Day 3-4	Day 5-7	Week 2	Week 3	Week 4	Week 5-6
Relative humidity (%) inside the barn	35	35	35	35	35	35	35
Temperature (°C) inside the barn	36	34	32	29	27	24	20
Dew Point (°C) outside the barn	18	16	15	12	10	8	4

Click here to calculate Relative Humidity.

There is not a designated optimal relative humidity percentage set-out for oocyst sporulation but an RH of 35-70% is considered adequate (bird management guides recommend between 60-70%). Interestingly, good monitoring of RH may also help the welfare of the bird (2).

Atmospheric Barn environment: Oxygen Access - If the oocyst does not have adequate oxygen access during sporulation, it may not become infective. High ammonia levels resulting from accumulated manure can also kill oocysts.

Physical Enriched Cage Environment: Manure Belts - When a manure belt is in use it will rotate and go through a scraping area where manure is scraped off the belt into a manure disposal area. While most of the manure is removed during this process, the scraper cannot remove all of the manure and it is not equipped to remove microscopic organisms, such as *Eimeria*. In multitier conventional cage system, the manure belts act as roofs for the tier level below. When the bird is tall enough they are able to peck at the manure belt roof and potentially at oocysts that remain on the belt (3,4). This issue can act as a potential disease source OR a method to allow for low level of oocyst cycling depending on the number of oocysts being shed and becoming infectious in the environment.

Physical Enriched Cage Environment: Perches, Platforms and Dust Bath Areas - As the pullets grow to use the perches, platforms and dust bath areas fecal build-up may occur on or below these additions. Consequently, it is important to note these areas as potential reservoirs for oocysts. Additionally, this elevation may allow the birds to defecate on each other which could be another way in which birds could ingest oocysts (5).

References

1. Anonymous. Layer management guide: Lohmann LSL Classic. In. Lohmann Tierzucht GmBh. 2005.

2. Stamp Dawkins, M., C.A. Donnelly, and T.A. Jones. Chicken welfare is influence more by housing conditions than by stocking density. Nature 427:342-344. 2004.

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4. Dr. Mike Petrik, personal communication.

5. Appleby, M.C. The Edinburgh modified cage: effects of group size and space allowance on brown laying hens. Journal of Applied Poultry Research 7:152-161. 1998.

Pullets Reared in Enriched Cages – Anticoccidial Drugs

Brooding

General Good Barn Practice – Provide chicks with clean, biosecure housing. Ensure that feed and water are readily available to the chicks when they are placed (1). Additionally, proper heat, ventilation and lighting as well as feed and water quality are required for good rearing management (1).

Physical Enriched Cage Environment During Brooding: Nipple Drinker Cups – If nipple cups are attached to the drinkers this is a potential reservoir for oocysts.

Figure 26. Example of a dirty nipple drinker cup for pullets reared in conventional cages. Be cautious as this dirty cup can be a potential reservoir for oocysts.

General Good Practice for Coccidiosis Management During Rearing

Physical Enriched Cage Environment: Manure Belts - When a manure belt is in use it will rotate and go through a scraping area where manure is scraped off the belt into a manure disposal area. While most of the manure is removed during this process, the scraper cannot remove all of the manure and it is not equipped to remove microscopic organisms, such *as Eimeria*. In multi-tier conventional cage system, the manure belts act as roofs for the tier level below. When the bird is tall enough they are able to peck at the manure belt roof and potentially at oocysts that remain on the belt (2,3). This issue can act as a potential disease source OR a method to allow for low level of oocyst cycling depending on the number of oocysts being shed and becoming infectious in the environment.

Physical Enriched Cage Environment: Perches, Platforms and Dust Bath Areas - As the pullets grow to use the perches, platforms and dust bath areas fecal build-up may occur on or below these additions. Consequently, it is important to note these areas as potential reservoirs for oocysts. Additionally, this elevation may allow the birds to defecate on each other which could be another way in which birds could ingest oocysts (4).

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3. Dr. Mike Petrik, personal communication.

4. Appleby, M.C. The Edinburgh modified cage: effects of group size and space allowance on brown laying hens. Journal of Applied Poultry Research 7:152-161. 1998.

Broilers

This is NOT a housing management guide. These sections were created to help explain the relationship between housing and oocyst ingestion. Please consult your veterinarian and bird management guide from the breeding company for housing management information.

A coccidiosis and/or a necrotic enteritis outbreak may be seen around 2 weeks to market.

Broilers Reared on Litter – Live Vaccines

Brooding

The brooding and immediate post-brooding periods are important to vaccine success because this is the time where offspring vaccine oocysts can cycle in the barn at low levels. Essentially, the cycling during this phase is acting as an immunity booster to the original vaccine dose; without this cycling, the vaccine will not work as effectively.

General Good Barn Practice – Provide chicks with clean, biosecure housing. Ensure that feed and water are readily available to the chicks when they are placed (1). Additionally, proper heat, ventilation and lighting as well as feed and water quality are required for good rearing management (1).

Half House Brooding - This management method is a modification of whole house brooding. The birds are confined to half of the house with a set of drinker and feeder lines. The house is heated with forced air heaters and the aim is to achieve uniform temperature in the air space. In this management method, bird density is increased for the period they are in half of the house. A typical *Eimeria* species will start to shed from the bird between 5 and 7 days post initial ingestion of an infective oocyst (i.e. live vaccine administration). The oocyst takes between 24-48 hours to become infective once shed. If birds are kept in the half house for at least 10 days (and if relative humidity, temperature and oxygen access are maintained), this brooding method may provide sufficient duration for low level cycling and thus sufficient exposure to infective oocysts.

Note: If birds are moved to the whole barn earlier than 10 days there will have been oocyst shedding, oocyst sporulation but not enough time to allow for the ingestion of these shed oocysts as is needed for the live vaccine to work effectively.

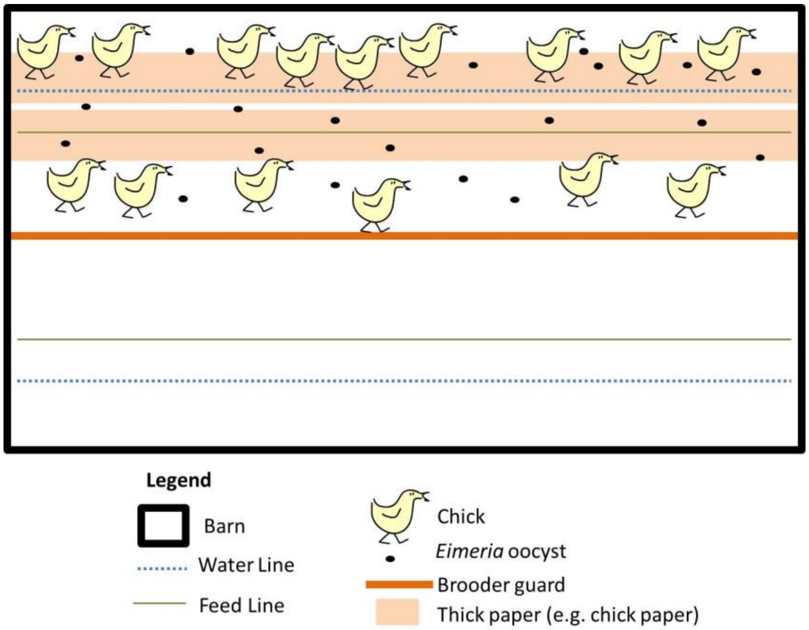

Figure 27. Simple diagram illustrating *Eimeria* oocyst build-up in a half house brooding system. In this brooding method bird density is increased for the period the broilers are in half of the house. As offspring vaccine oocysts are shed into the environment they can accumulate in the occupied area of the house. If the birds are kept in half of the house until the offspring oocysts sporulate and become infective, this brooding method may provide the sufficient duration and exposure to oocysts for low-level cycling.

Figure 28. An example of half house brooding (Picture Credit: Guy Kostrey, Sceneskape Productions).

Physical Environment During Brooding - According to management guidelines (1) providing 60% paper coverage below the feeder and water lines during the brood phase would provide the extra feed and water spillage needed to stimulate bird activity and appetite as early as possible. Interestingly, this method may provide the needed coverage to allow progeny vaccine oocysts to remain at the litter surface for ingestion by the bird (low-level oocyst cycling). Without this coverage, oocysts may fall between the litter material used thus preventing birds from ingesting them. If the removal of the paper is a normal practice, it has to be removed before 5 days after vaccination, or only after 10 days after vaccination. Warning: If you remove the paper between 5 and 10 days after vaccination during the peak vaccine oocyst shed time you will remove the shed oocysts from the barn. Removing these oocysts from the barn may impact vaccine success.

Physical Environment During Brooding - Chicks during the brood stage are small enough that they may be able to fit in the open feeders. Be aware that these chicks are able to defecate into the feeders and this is another spot where birds can ingest infectious oocysts if present in the feces. Additionally, nipple cups attached to drinkers are also potential reservoirs for oocysts.

Figure 29. An image of a chick resting in an open feeder. Note the fecal droppings inside the feeder (Picture Credit: Dr. Lloyd Weber).

General Good Practice for Coccidiosis Management During Rearing

Atmospheric Barn Environment: Get to Know Relative Humidity (RH) - Because barns require ventilation, the outside temperature and humidity can impact the environment of the barn; especially if the equipment does not measure and account for RH of the air feeding the barn.

Example of the minimum outside temperature needed paired with the temperature gradient needed in a generic chicken barn over the first 3 weeks of rearing (whole house brooding – [1]) to achieve an RH of 35% inside the barn (if air handling equipment does not control the RH of the air feeding the barn).

	Day 1-2	Day 3-4	Day 5-7	Week 2	Week 3	Week 4	Week 5-6
Relative humidity (%) inside the barn	35	35	35	35	35	35	35
Temperature (°C) inside the barn	36	34	32	29	27	24	20
Dew Point (°C) outside the barn	18	16	15	12	10	8	4

Click here to calculate Relative Humidity.

There is not a designated optimal relative humidity percentage set-out for oocyst sporulation but an RH of 35-70% is considered adequate (bird management guides recommend between 60-70%). Interestingly, good monitoring of RH may also help the welfare of the bird (2).

Atmospheric barn environment: Oxygen Access and Litter - If the oocyst does not have adequate oxygen access during sporulation, it may not become infective. Accumulation and compaction of litter can decrease oxygen access which can act to stop sporulation. In addition, high ammonia levels resulting from accumulated litter can also kill oocysts.

Physical Barn Environment: Leaky Drinkers - A nipple drinker in a broiler barn can have at least 1 million hits during an entire growing cycling. This wear and tear on the drinker over time can cause the drinkers to leak. Leaky drinkers cause localized areas of high moisture which can be a good spot for above average oocyst sporulation. Be cautious of these areas as there may be infective oocyst build-up.

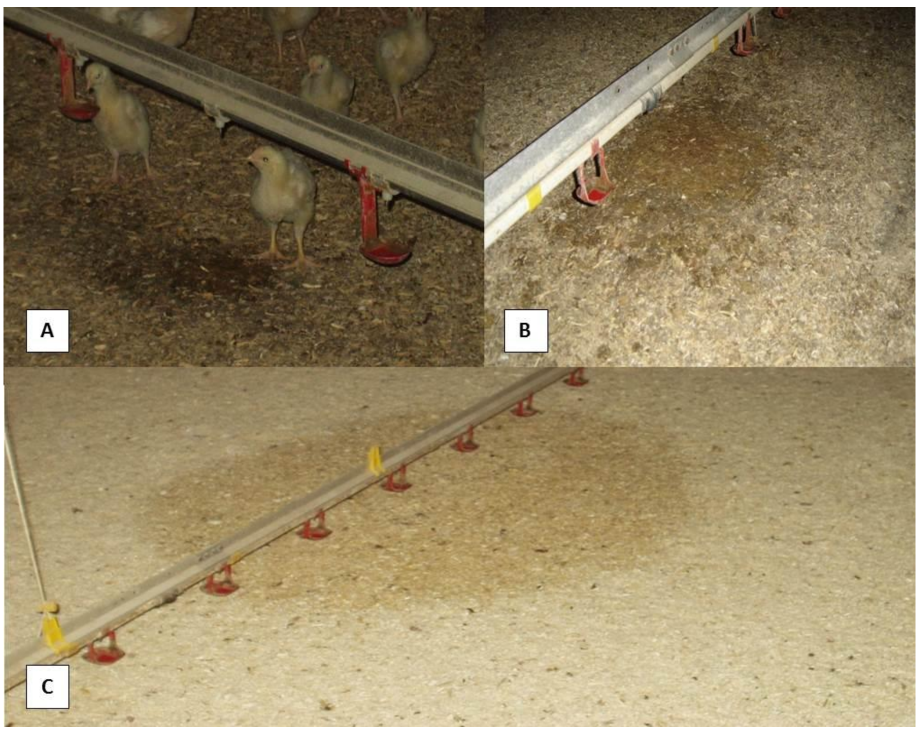

Figure 30. Examples of leaky drinkers and dirty drinker cups (A-C) for birds reared on litter. Be cautious of localized areas of high moisture due to leaky drinkers (B, C) and dirty drinker cups (A) that can be potential reservoirs for oocysts (Picture Credits: Dr. Lloyd Weber).

References

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Broilers Reared on Litter – Anticoccidial Drugs

Brooding

General Good Barn Practice - Provide chicks with clean, biosecure housing. Ensure that feed and water are readily available to the chicks when they are placed (1). Additionally, proper heat, ventilation and lighting as well as feed and water quality are required for good rearing management (1).

Full House Brooding - This brooding method heats the whole house using forced air heaters and the aim is to achieve uniform temperature in the house (1). In this style of brooding (should temperature be adequate), birds should be spread throughout the entire house. According to management guidelines (1) providing 60% paper coverage below the feeder and water lines during the brood phase would provide the extra feed and water spillage needed to stimulate bird activity and appetite as early as possible. If oocysts are in the environment, the spread of birds could reduce the potential for a bird to ingest an infective oocyst.

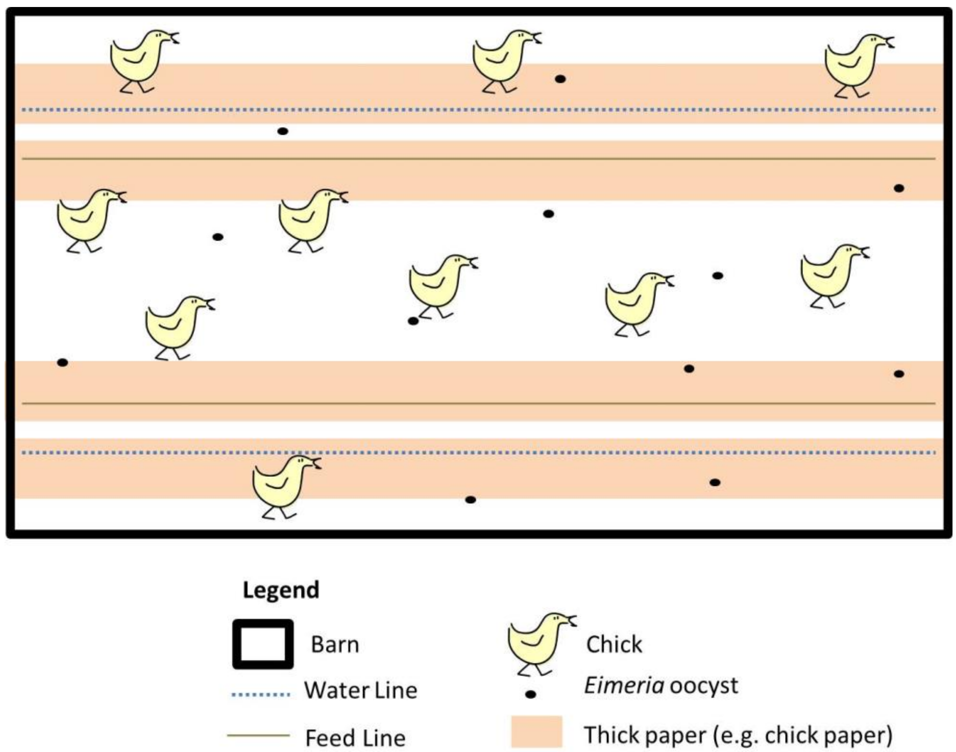


Figure 31. Simple diagram illustrating *Eimeria* oocyst build-up in a full house brooding system. In full house brooding if oocysts are in the environment, the spread of birds could reduce the potential for a bird to ingest an infective oocyst.

Figure 32. An example of full house brooding using paper coverage over the litter around the feeder and water lines (Picture Credit: Dr. Lloyd Weber).

Physical Environment During Brooding - Chicks during the brood stage are small enough that they may be able to fit in the open feeders. Be aware that these chicks are able to defecate into the feeders and this is another spot where birds can ingest infectious oocysts if present in the feces. Additionally, nipple cups attached to drinkers are also potential reservoirs for oocysts.

Figure 33. An image of a chick resting in an open feeder. Note the fecal droppings inside the feeder (Picture Credit: Dr. Lloyd Weber).

General Good Practice for Coccidiosis Management During Rearing

Litter Management: Keeping the Litter Dry - Make sure the floor is warm and dry prior to spread shavings or straw and placing birds in the barn. Be sure the bedding (shavings or straw) starts off dry. Be aware of leaky drinkers and flushing birds. If necessary, remove "cakey" litter (areas of localized high moisture).

Leaky Drinkers - A nipple drinker in a broiler barn can have at least 1 million hits during an entire growing cycling. This wear and tear on the drinker over time can cause the drinkers to leak. Leaky drinkers cause localized areas of high moisture which can be a good spot for above average oocyst sporulation. Be cautious of these areas as there may be infective oocyst build-up.

Figure 34. Examples of leaky drinkers and dirty drinker cups (A-C) for birds reared on litter. Be cautious of localized areas of high moisture due to leaky drinkers (B, C) and dirty drinker cups (A) that can be potential reservoirs for oocysts (Picture Credits: Dr. Lloyd Weber).

References

1. Anonymous. Ross Broiler Management Manual. In. Aviagen. 2009. Access HERE.

Turkeys

This is NOT a housing management guide. These sections were created to help explain the relationship between housing and oocyst ingestion. Please consult your veterinarian and bird management guide from the breeding company for housing management information.

A coccidiosis and/or a necrotic enteritis outbreak may be seen around 4-8 weeks of age to market.

(Thank you Peter Gadzinsky for the turkey photo).

Turkeys Reared on Litter – Live Vaccines

Brooding

The brooding and immediate post-brooding periods are important to vaccine success because this is the time where offspring vaccine oocysts can cycle in the barn at low levels. Essentially, the cycling during this phase is acting as an immunity booster to the original vaccine dose; without this cycling, the vaccine will not work as effectively.

Brooding with Brooder Rings (1) - In this management method, bird density is increased for the period they are in the brooder rings. A typical *Eimeria* species will start to shed from the bird between 5 and 7 days post initial ingestion of an infective oocyst (i.e. live vaccine administration). The oocyst takes between 24-48 hours to become infective once shed. If birds are kept in the brooder ring for period of time to allow the poults to ingest offspring vaccine oocysts (and if relative humidity, temperature and oxygen access are maintained), this brooding method may provide sufficient duration for low level cycling and thus sufficient exposure to infective oocysts.

Note: If birds are moved to the whole barn earlier in the brooding period there will have been oocyst shedding, oocyst sporulation but not enough time to allow for the ingestion of these shed oocysts as is needed for the live vaccine to work effectively.

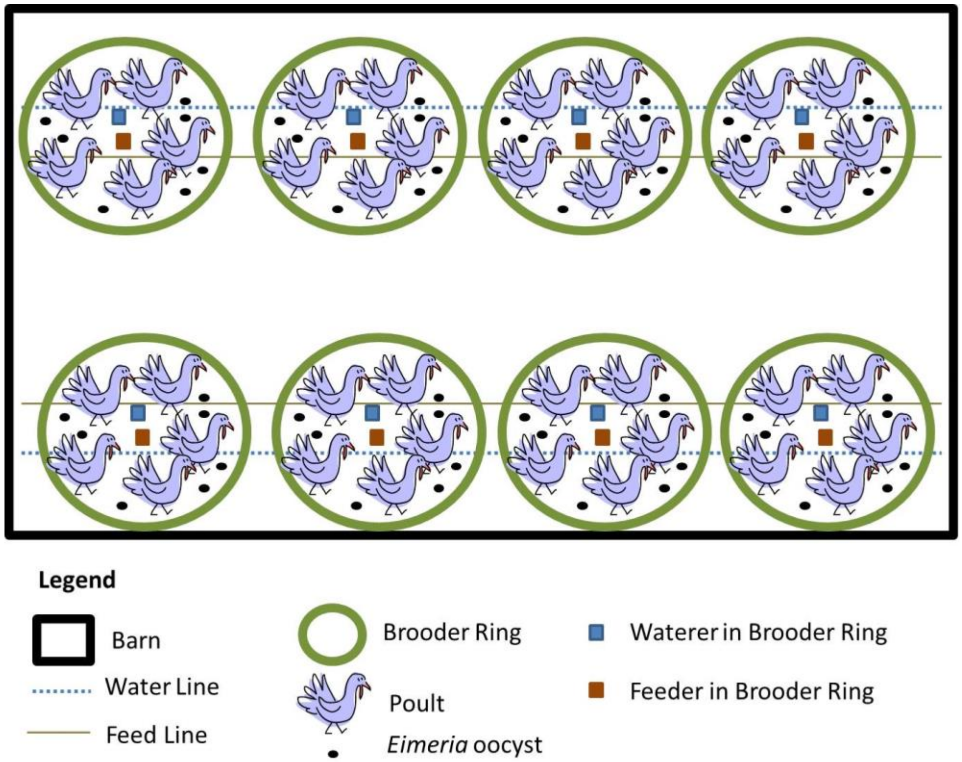


Figure 35. Simple diagram illustrating *Eimeria* oocyst build-up in a brooder ring brooding system. In this brooding method bird density is increased for the period the poults are in the brooder ring. As offspring vaccine oocysts are shed into the environment they can accumulate in the occupied rings. If the poults are kept in the brooder ring until the offspring oocysts sporulate and become infective, this brooding method may provide the sufficient duration and exposure to oocysts for low-level cycling.

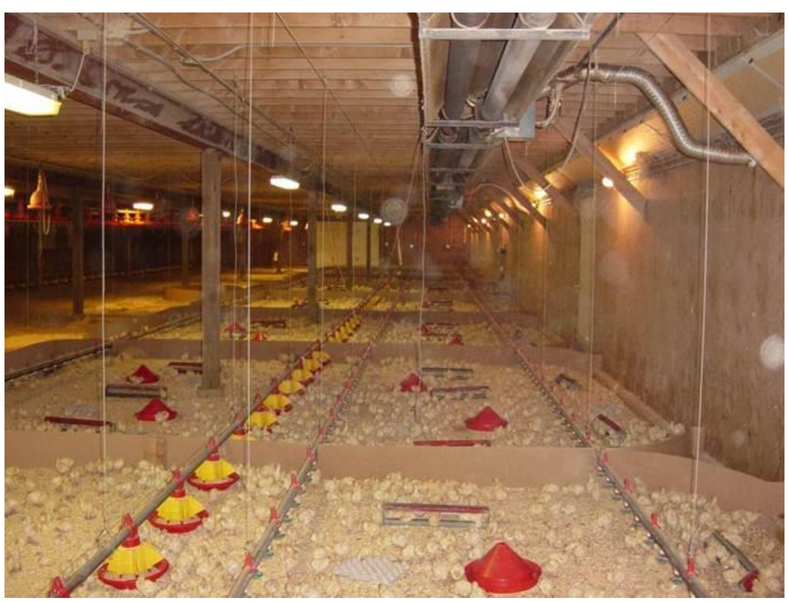


Figure 36. An example of brooder rings for brooding poults (Picture Credit: Dr. Lloyd Weber).

Large Ring/Whole Room Brooding (1) - This brooding method does not confine birds near to the point heat source and with good heating the birds should spread out in barn/large ring. There would be no increased bird density so the transmission rate of infective oocyst ingestion would be reduced (but not eliminated).

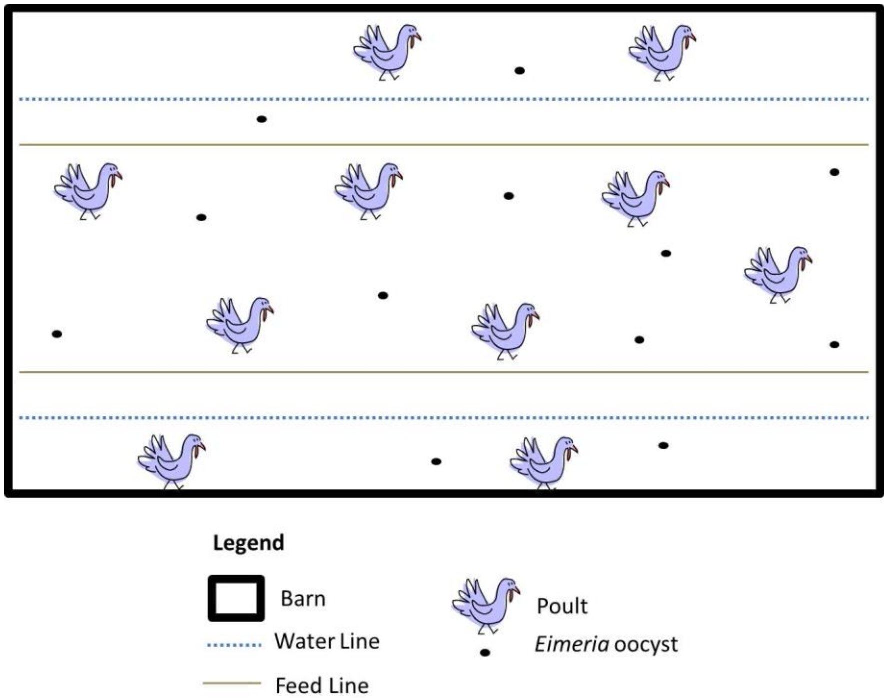


Figure 37. Simple diagram illustrating *Eimeria* oocyst build-up in a large ring/whole room house brooding system. In this brooding system, if oocysts are in the environment the spread of birds could reduce the potential for a bird to ingest an infective oocyst.

Physical Environment During Brooding: Litter -Some oocysts may fall between the litter used and if birds do not peck or scratch at the area in which the oocyst fell it may be lost to the bird.

Physical Environment During Brooding: Feeders and Bell Drinkers - Poults during the brood stage are small enough that they may be able to fit in the open feeders. Be aware that these poults will defecate into the feeders and should the feces contain oocysts, this will allow for cycling. Additionally, bell drinkers are also potential reservoirs for oocysts.

General Good Practice for Coccidiosis Management During Rearing

Atmospheric Barn Environment: **Get to know Relative Humidity (RH)**- Because barns require ventilation, the outside temperature and humidity can impact the environment of the barn; especially if the equipment does not control the RH of the air feeding the barn.

Example of the minimum outside temperature needed paired with the temperature gradient needed in a generic conventionally brooded turkey barn over the first 7 weeks of rearing (1) to achieve an RH of 35% inside the barn (if air handling equipment does not control the RH of the air feeding the barn).

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Relative humidity (%) inside the barn	35	35	35	35	35	35	35
Temperature (°C) inside the barn	28.9	27.8	26.6	25.5	22.8	21.1	20
Dew Point (°C) outside the barn	12	11	10	8	7	5	4

Click here to calculate Relative Humidity.

There is not a designated optimal relative humidity percentage set-out for oocyst sporulation but an RH of 35-70% is considered adequate (bird management guides recommend between 60-70%). Interestingly, good monitoring of RH may also help the welfare of the bird (2).

Atmospheric barn environment: Oxygen Access and Litter - If the oocyst does not have adequate oxygen access during sporulation, it may not become infective. Accumulation and compaction of litter can decrease oxygen access which can act to stop sporulation. In addition, high ammonia levels resulting from accumulated litter can also kill oocysts.

Physical barn environment: Leaky Drinkers - Leaky drinkers cause localized areas of high moisture which can be a good spot for above average oocyst sporulation. Be cautious of these areas as there may be infective oocyst build-up.

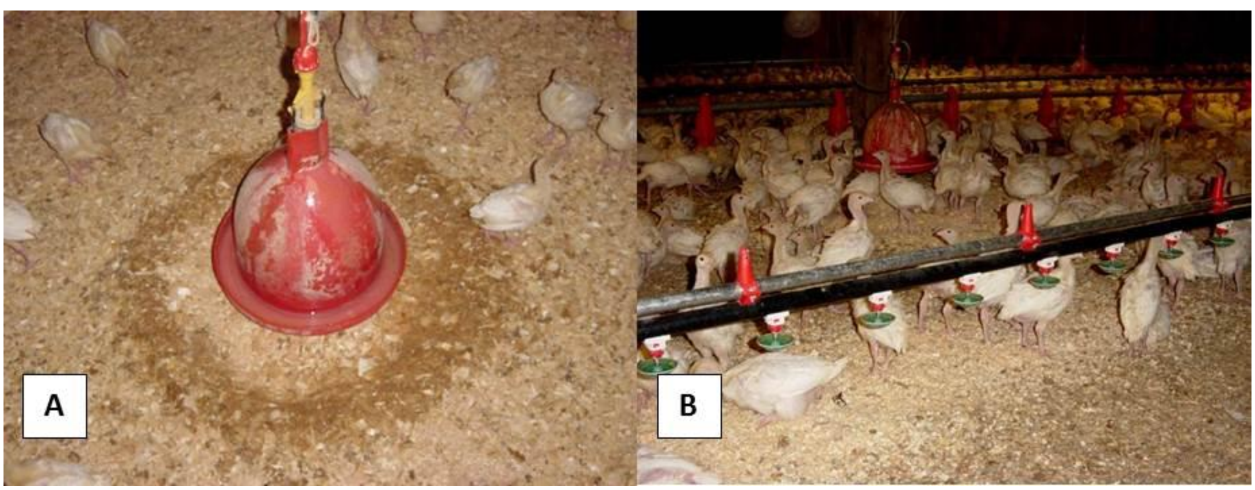


Figure 38. Examples of leaky drinkers (A) and dirty bell cups (B) for turkeys reared on litter. Be cautious of localized areas of high moisture due to leaky drinkers (A). Dirty bell drinkers (B) can be potential reservoirs for oocysts (Picture Credits: Dr. Lloyd Weber).

Physical barn environment: Wet Phase of Turkey Production - The wet phase of turkey production can occur between 6 and 9 weeks of age, in part due to a vegetable diet (e.g. more soybeans or canola and no meat meal). This flushing can increase litter moisture to a point where oocyst sporulation may be fast and overwhelming. Be cautious of this time and, if necessary, remove "cakey" litter (areas of localized high moisture).

References

1. Anonymous. Commercial Management Guide. In. Hybrid: A Hendrix Genetics Company. 2013. Access HERE.

2. Stamp Dawkins, M., C.A. Donnelly, and T.A. Jones. Chicken welfare is influence more by housing conditions than by stocking density. Nature 427:342-344. 2004.

Turkeys Reared on Litter – Anticoccidial Drugs

Brooding

Large Ring/Whole Room Brooding (1) – This brooding method does not confine birds near to the point heat source and with good heating the birds should spread out in barn/large ring. There would be no increased bird density so the transmission rate of infective oocyst ingestion would be reduced (but not eliminated). With preventative anticoccidial drug use this brooding method may help to keep the litter dry and the oocyst insult lower.

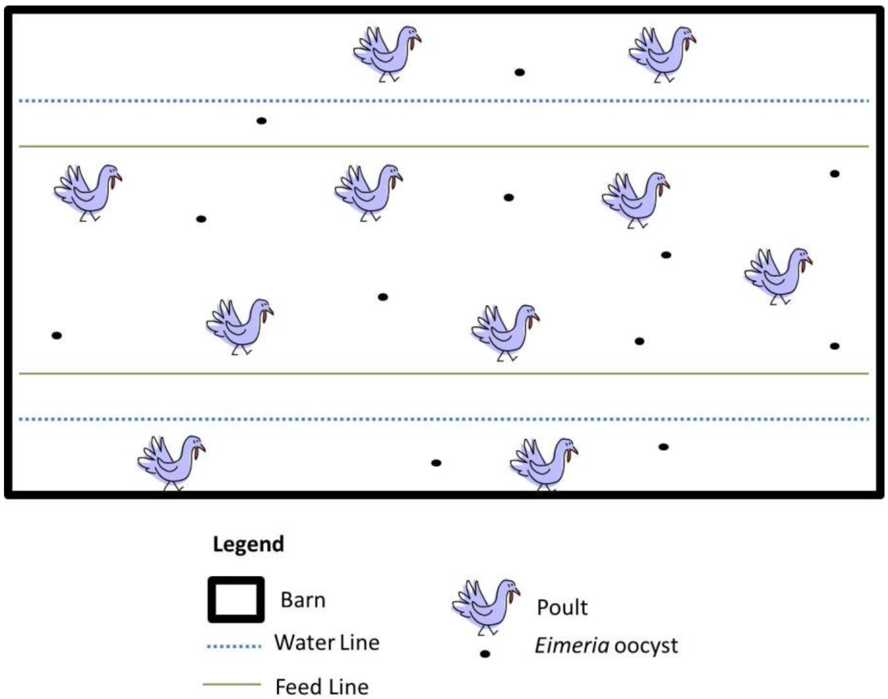


Figure 39. Simple diagram illustrating *Eimeria* oocyst build-up in a large ring/whole room house brooding system. In this brooding system, if oocysts are in the environment the spread of birds could reduce the potential for a bird to ingest an infective oocyst.

Physical Environment During Brooding: Litter – Note that some oocysts may fall between the litter used and if birds do not peck or scratch at the area in which the oocyst fell it may be lost to the bird.

Physical Environment During Brooding: Feeders and Bell Drinkers – Poults during the brood stage are small enough that they may be able to fit in the open feeders. Be aware that these poults are able to defecate into the feeders. Should the feces contain oocysts this is another spot where birds can ingest infectious oocysts. Additionally, bell drinkers are another potential reservoir for oocysts.

General Good Practice for Coccidiosis Management

Litter Management: Keeping the Litter Dry - Make sure the floor is warm and dry prior to spread shavings or straw and placing birds in the barn. Be sure the bedding (shavings or straw) starts off dry. Be aware of leaky drinkers and flushing birds. If necessary, remove "cakey" litter (areas of localized high moisture).

Leaky Drinkers - Leaky drinkers cause localized areas of high moisture which can be a good spot for above average oocyst sporulation. Be cautious of these areas as there may be infective oocyst build-up.

Physical barn environment: Wet Phase of Turkey Production - The wet phase of turkey production can occur between 6 and 9 weeks of age, in part due to a vegetable diet (e.g. more soybeans or canola and no meat meal). This flushing can increase litter moisture to a point where oocyst sporulation may be fast and overwhelming. Be cautious of this time and, if necessary, remove "cakey" litter (areas of localized high moisture).

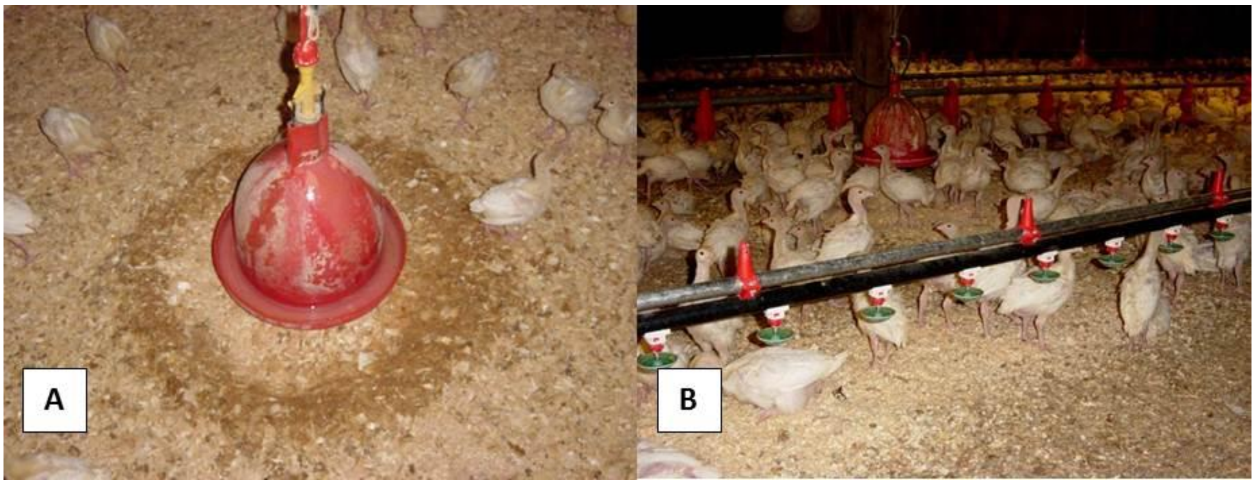


Figure 40. Examples of leaky drinkers (A) and dirty bell cups (B) for turkeys reared on litter. Be cautious of localized areas of high moisture due to leaky drinkers (A). Dirty bell drinkers (B) can be potential reservoirs for oocysts (Picture Credits: Dr. Lloyd Weber).

References

1. Anonymous. Commercial Management Guide. In. Hybrid: A Hendrix Genetics Company. 2013. Access HERE.

Game Birds

This is NOT a housing management guide. These sections were created to help explain the relationship between housing and oocyst ingestion. Please consult your veterinarian and bird management guide from the breeding company for housing management information.

Ideally, it is best to house birds of the same age and species together at any given time. Older birds can shed large numbers of oocysts and have partial immunity due to some exposure to the parasite (without showing obvious signs of being sick). If these older birds are housed with younger birds the young birds could ingest large numbers of infectious oocysts and become sick.

If a variety of ages must be housed on the same property, it is always good practice with cleaning/feeding/etc. to start with the youngest birds first and finish with the oldest birds. Keep feeders, drinkers or other equipment separate between the younger and older birds. If equipment must move from older to younger birds a thorough cleaning should be completed prior to the move.

Be aware that wild birds of the same species are susceptible to the same species of *Eimeria*. As a result, keeping wild birds and fecal matter of wild birds away from your birds is essential.

Currently, there are no registered live coccidiosis vaccines for game birds in Ontario, Canada. There are also no registered anticoccidial drugs that have LABEL claim for game birds in Ontario, Canada. For questions regarding anticoccidial drug off-label use PLEASE CONSULT YOUR VETERINARIAN.

General Good Practice for Coccidiosis Management

Atmospheric barn environment: Get to Know Relative Humidity - Because barns require ventilation, the outside temperature and humidity can impact the environment of the barn; especially if the equipment does not control the RH of the air feeding the barn.

There is not a designated optimal relative humidity percentage set-out for sporulation but an RH of 35-70% is considered adequate for oocyst sporulation (bird management guides for chickens and turkeys recommend between 60-70%). Interestingly, practicing good relative humidity monitoring may also help the welfare of the bird (1).

Atmospheric Barn Environment: Oxygen Access - If the oocyst does not have adequate oxygen access during sporulation, it may not become infective. High ammonia levels resulting from accumulated manure can also kill oocysts.

Physical Barn Environment: Nipple Drinker Cups – If nipple cups are attached to the drinkers this is a potential reservoir for oocysts.

Cage Reared Game Birds

Physical Barn Environment: Oocyst Cycling in the Cage – A mesh floor assists in reducing the number of oocysts accessible to the bird but these mesh floors will not eliminate oocysts from the cage environment. A mesh floor alone usually does not provide enough potential for oocyst transmission to generate adequate oocyst low-level oocyst cycling for complete protection against coccidiosis challenge (2). A typical *Eimeria* species will start to shed from the bird between 5 and 7 days post initial ingestion of an infective oocyst. The oocyst takes between 24-48 hours to become infective once shed.

Physical Barn Environment: Manure Belts in a Cage System - When a manure belt is in use it will rotate and go through a scraping area where manure is scraped off the belt into a manure disposal area. While most of the manure is removed during this process, the scraper cannot remove all of the manure and it is not equipped to remove microscopic organisms, such as Eimeria. In multi-tier conventional cage system the manure belts act as roofs for the tier level below. When the bird is tall enough they are able to peck at the manure belt roof and potentially at oocysts that remain on the belt (3, 4). This issue can act as a potential disease source OR a method to allow for low level of oocyst cycling depending on the number of oocysts being shed and becoming infectious in the environment.

Litter Reared Game Birds

Litter Management: Keeping the Litter Dry - Make sure the floor is warm and dry prior to spread shavings or straw and placing birds in the barn. Be sure the bedding (shavings or straw) starts off dry. Be aware of leaky drinkers and flushing birds. If necessary, remove "cakey" litter (areas of localized high moisture).

Leaky Drinkers - Wear and tear on the nipple drinker over time can cause the drinkers to leak. Leaky drinkers cause localized areas of high moisture which can be a good spot for above average oocyst sporulation. Be cautious of these areas as there may be infective oocyst build-up.

Outside Access - If the flock has access to outside, how the outdoor run is designed and managed may influence *Eimeria* transmission (5). If an outdoor run is used, the run should be rotated each flock to reduce the potential for oocyst transmission between flocks. If the land used for a run is limited, a suggestion to help reduce oocyst transmission is removing approximately the top 20cm of soil from the run and planting a new fast-growing crop (6).

Good Practice When Showing Birds

1. Make sure the bird's feet are cleaned prior to having the bird re-enter the housing facility. This will help remove feces from other birds and potential contaminants.

2. Wash your hands with soap and water prior to and proceeding the event. This will help remove feces from other birds and potential contaminants.

3. The shoes and clothes worn to a bird show event should be different and separate than the shoes and clothes worn into your birds' housing facility.

References

1. Stamp Dawkins, M., C.A. Donnelly, and T.A. Jones. Chicken welfare is influence more by housing conditions than by stocking density. Nature 427:342-344. 2004.

2. Price, K.R., M.T. Guerin, L. Newman, B.M. Hargis, and J.R. Barta. Examination of a novel practical poultry management method to enhance the effect of live *Eimeria* vaccination for conventionally housed replacement layer pullets. International Journal of Poultry Science 12:175-184. 2013.

3. Price, K.R. Use of live vaccines for coccidiosis control in replacement layer pullets. The Journal of Applied Poultry Research 21:679-692. 2012.

4. Dr. Mike Petrik, personal communication.

5. Sossidou, E.N., A. Dal Bosco, H.A. Elson, and C.M.G.A. Fontes. Pasture-based systems for poultry production: implications and perspectives. World's Poultry Science Journal 67:47-58. 2011.

6. Flegal, C.J. Managing Game Birds. Extension Bulletin E-692 Michigan State University. 1994. Access HERE.

Small Flock

This is NOT a housing management guide. These sections were created to help explain the relationship between housing and oocyst ingestion. Please consult your veterinarian and bird management guide from the breeding company for housing management information.

The timing of coccidiosis outbreaks may vary depending on the immune status of your flock and how your birds are reared. Commonly, coccidiosis is a disease of young birds between 2-4 weeks of age.

Ideally, it is best to house birds of the same age and species together at any given time. Older birds can shed large numbers of oocysts and have partial immunity due to some exposure to the parasite (without showing obvious signs of being sick). If these older birds are housed with younger birds the young birds could ingest large numbers of infectious oocysts and become sick.

If a variety of ages must be housed on the same property, it is always good practice with cleaning/feeding/etc. to start with the youngest birds first and finish with the oldest birds. Keep feeders, drinkers or other equipment separate between the younger and older birds. If equipment must move from older to younger birds a thorough cleaning should be completed prior to the move.

Be aware that wild birds of the same species are susceptible to the same species of *Eimeria*. As a result, keeping wild birds and fecal matter of wild birds away from your birds is essential.

Outside Access - If the flock has access to outside, how the outdoor run is designed and managed may influence *Eimeria* transmission (1). If an outdoor run is used, the run should be rotated each flock to reduce the potential for oocyst transmission between flocks. If the land used for a run is limited, a suggestion to help reduce oocyst transmission is removing approximately the top 20cm of soil from the run and planting a new fast-growing crop (2).

Meat Birds

For a detailed description of brooding and housing birds on litter with respect to coccidiosis management please see the Broiler birds reared on litter section.

Egg Birds

For a detailed description of brooding and housing birds on litter with respect to coccidiosis management please see the Pullets reared on litter section.

Good Practice When Showing Birds

1. Make sure the bird's feet are cleaned prior to having the bird re-enter the housing facility. This will help remove feces from other birds and potential contaminants.

2. Wash your hands with soap and water prior to and proceeding the event. This will help remove feces from other birds and potential contaminants.

3. The shoes and clothes worn to a bird show event should be different and separate than the shoes and clothes worn into your birds' housing facility.

References

1. Sossidou, E.N., A. Dal Bosco, H.A. Elson, and C.M.G.A. Fontes. Pasture-based systems for poultry production: implications and perspectives. World's Poultry Science Journal 67:47-58. 2011.

2. Flegal, C.J. Managing Game Birds. Extension Bulletin E-692 Michigan State University. 1994. Access HERE.

Methods of Control

Biosecurity

General Biosecurity Methods Against *Eimeria*

Most disinfectants used commonly against other pathogens cannot penetrate through the [oocyst](#) wall to kill the infective sporozoites. Under laboratory conditions, when an oocyst is held at 4°C, they may last as long as 2 years. In soil, infective oocysts have also been shown to last as long as 602 days (1).

While the oocyst wall is not sticky, it can be carried around by the action of personnel, rodents, flies, dust and even forced air movements. Additionally, should the barn environment contain crevices or porous surfaces (e.g. cement), oocysts may remain in these areas and when the barn is cleaned, the cleaner must take extra precautions with these areas.

References

1. Reid, M.W. History of avian medicine in the United States. X. Control of coccidiosis. Avian Diseases 34:509-525. 1990.

Disinfectants (or lack thereof)

In contrast to widely available disinfectants effective against many bacteria and viruses, very few substances and situations can either kill or decrease the viability of *Eimeria* species or can effectively kill coccidial oocysts in a reasonable amount of time (i.e. minutes rather than hours/days) and are not highly corrosive and/or toxic. Unfortunately, these agents are extremely harsh and can be detrimental to the bird.

Examples of substances or situations that can impact *Eimeria* species are (1-5):

Substances or Situation	Effect on *Eimeria*	Effect on bird
Fumigation – Ammonia, paraformaldehyde	One of the few substances able to penetrate the oocyst wall and stop sporulation and/or kill the oocyst.	Ammonia fumes can burn the eyes and the inside of the throat of the bird. Formaldehyde will fix the lungs and kill the bird.
Oxygen access	Sporulation will not occur without oxygen.	Birds cannot survive without oxygen.
Ultraviolet radiation (sun exposure for an extended period of time)	Can stop the ability of the oocyst to sporulate or stop the ability of a sporulated oocyst to infect a host.	Unfeathered parts can burn which can cause pain for the bird.
Freeze/thaw	A hard freeze can kill the oocyst.	Unfeathered parts can freeze which can injure the bird. If the frozen section thaws this causes pain for the bird.
Desiccation (drying)	The oocyst wall will shrink due to water loss and sporulation cannot be completed properly.	A dry environment can have a negative impact on chicken welfare (e.g. mortality, physiology, behaviour).

High temperature (over 37°C)	Sporulation is unable to be completed and/or the oocyst will be killed.	Increased heat can cause heat stress which can lead to death if left untreated.
Bacteria	Bacterial breakdown of litter can produce a local litter environment lacking oxygen which can stop sporulation.	Depending on the species of bacteria present and whether or not the birds are susceptible to infection, presence of bacteria can induce bacterial infections.

If the flock has access to outside (e.g. a grass run) and the birds remain near the housing building or within the barn, there may be potential for a heightened disease risk due to higher transmission associated with local increased bird density (6). Nevertheless, how the outdoor run is designed and managed may influence *Eimeria* transmission.

References

1. Reyna, P.S., L.R. McDougald, and G.F. Mathis. Survival of coccidia in poultry litter and reservoirs of infection. Avian Diseases 27:464-473. 1983.

2. Daugschies, A., B. Bangoura, and M. Lendner. Inactivation of exogenous endoparasite stages by chemical disinfectants: current state and perspectives. Parasitology Research 112:917-932. 2013.

3. Marquardt, W.C., C.M. Senger, and L. Seghetti. The effect of physical and chemical agents on the oocyst of *Eimeria zurnii* (Protozoa, Coccidia). Journal of Protozoology 7:186-189. 1960.

4. Peckham, M.C. Vices and Miscellaneous Diseases and Conditions. In: Diseases of Poultry. M.S. Hofstad, H.J. Barnes, M.W. Reid and H.W. Yoder Jr., eds. Iowa State University Press, Ames, Iowa, USA. pp 741-782. 1984.

5. Reid, M.W., P.L. Long, and L.R. McDougald. Coccidiosis. In: Diseases of Poultry, 8 ed. M.S. Hofstad, B.W. Calnek, M.W. Reid and H.W. Yoder Jr., eds. Iowa State University Press, Ames, Iowa, USA. pp 692-717. 1984.

6. Fanatico, A.C. Organic Poultry Production in the United States. In: ATTRA publication. NCAT, Fayetteville, AR. 2008.

Live Vaccines

Live non-attenuated vaccination exploits the limited parasite reproduction of a live organism and the host's ability to naturally reduce clinical signs of *Eimeria* infection. In other terms, live vaccines stimulate the immune response of the host with no clinical or subclinical pathogenic effects with limited parasite reproduction and minimal oocyst output. To induce protective immunity for a mixed *Eimeria* species infection, birds have to be given at least two or more exposures to the specific parasite (1). With vaccination, the first exposure comes from the oocysts in the vaccine dose and the second exposure comes from cycled oocysts via fecal-oral transmission. Once this protective immunity is developed for a certain *Eimeria* species the bird is immune against further infection with this particular parasite (1). The number of oocysts in the initial vaccine dose determines the number of oocysts that will be cycled. With all live coccidiosis vaccines, there is a fine balance between giving sufficient parasites with cycling to reduce clinical signs versus having so many cycling parasites that intestinal lesions are formed.

There are two main factors needed for a live vaccine to reach its full protective potential (2):

1. **Vaccine administration - synchronous, uniform vaccine oocyst ingestion**
   Commonly spray vaccination is used in the hatchery at day of hatch. The spray cabinet will spray a coarse, high volume, coloured spray either made up of water or gel droplets over a batch of chicks.

2. **Environment control in the barn - adequate controlled low-level oocyst cycling**
   Environmental control in the barn can be separated into two sections:

   a. **Physical environment –** including where the birds are housed (e.g. litter, conventional cage, alternative system).
   b. **Atmospheric barn environment –** including temperature, relative humidity and oxygen access (see Management through the environment).

Intimately knowing your housing system and each barn's atmospheric environment can help you manipulate oocyst cycling and, proactively managing these factors is likely to improve live vaccine success.

Please consult your veterinarian and vaccine company representative for information specific to the vaccine and vaccine management system being used on your farm.

References

1. Chapman, H.D. Practical use of vaccines for the control of coccidiosis in the chicken. World's Poultry Science Journal 56:7-20. 2000.

2. Price, K.R. Use of live vaccines for coccidiosis control in replacement layer pullets. Journal of Applied Poultry Research 21:679-692. 2012.

Anticoccidial Drugs

"Anticoccidials are most effective when combined with healthy chicks and good management (adequate space, good ventilation and litter management, ready access to feed and clean water)"

-- Janet Schell (Wallenstein Feed & Supply)

Anticoccidial drugs are medications that are usually added to the feed to prevent coccidial infections. These drugs can also be added to the water to treat or limit infections. When used for prevention, these drugs are used in small quantities starting at day of age and used until the specific withdrawal period. In Ontario (CAN) there are fewer anticoccidials available for use in turkeys than chickens and no anticoccidial drugs with approved application for game birds:

> Anticoccidial medications, like all medicated feed ingredients have to be approved for use by Health Canada before they can be sold and used in feed. Many anticoccidial medications are registered through the CFIA (Canadian Food Inspection Agency) to be used in the feed without a veterinary prescription. The medication supplier has to show supportive data for both the efficacy and the safety of the medication and clearances are typically given with a specified claim, dosage, species and withdrawal if applicable. If an anticoccidial medication does not have this CFIA Medicated Ingredients Brochure clearance or is used in combination with another medication that is not registered to be used together, then a veterinary prescription is required.

-- Janet Schell (Wallenstein Feed & Supply)

Anticoccidial drugs can have a coccidiostatic effect ("in-the-gut" development of Eimeria is halted but able to resume after drug withdrawal), coccidiocidal effect (*Eimeria* are killed during "in-the-gut" development) or both (1).

Several types of anticoccidial drugs are used or have been used in the poultry industry including, but not limited to (1, 2, 3):

1. **Ionophore** – produced through fermentation (of various bacteria such as *Streptomyces* and *Actinomadura* species) and act as a coccidiocide and coccidiostat by affecting parasite membrane function (e.g. monensin, salinomycin sodium, lasalocid sodium, maduramicin ammonium, narasin)
2. **Chemical** – synthetic compounds produced by chemical means
    a. *Quinolones* – have an effect on energy metabolism of the parasite and act as a coccidiocide and coccidiostat (e.g. buquinolate, decoquinate)
    b. *Coccidiostatic thiamine analogs* – effect on co-factor synthesis for the parasite (e.g. amprolium)
    c. *Guanidine derivatives* – active against the first-generation schizonts of *E. tenella* by preventing asexual replication (e.g. robenidine hydrochloride)
    d. *Pyridinols* – mostly insoluble in water and active against the sporozoite stage allowing sporozoite penetration of intestinal host cells but not parasite development (e.g. clopidol)
    e. *Benzeneacetonitrile* - mode of action unknown (e.g. diclazuril)

f. *Nicarbasin* – mode of action not defined but thought to impact the parasite's ability to generate energy
g. *Nitrobenzamides* – thought to stop asexual replication (e.g. zoalene)

Health Canada decides if withdrawals are required and this would be determined based on each drug's metabolism and clearance from tissues (3).

Click HERE for a flowchart summary of different types of anticoccidial drugs and their effect and mechanism of action towards certain chicken Eimeria species.

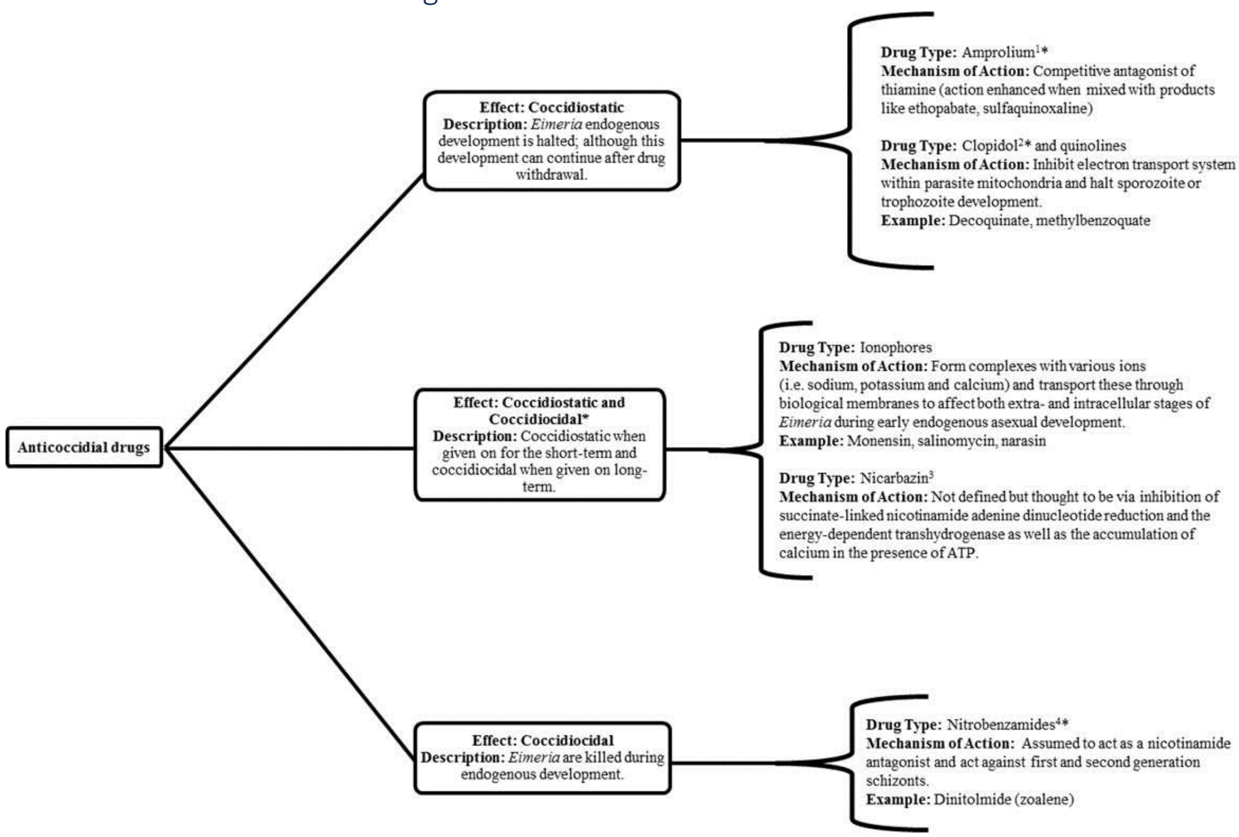
Please consult your veterinarian and feed company representative for information specific to the drug being used on your farm.

A limitation of preventative anticoccidial drug use is the rise of drug-resistant *Eimeria* strains after prolonged use in the field (4). Several strategies have been created to prevent resistance (see examples in the table below). In general, ionophorous drugs trigger less resistance than chemical drugs.

Summary of commonly employed strategies used to combat the development of drug resistance (5-8).

Strategy	Definition and Rationale for Use
Rotation Program	**Definition:** Use of a single anticoccidial drug for several successive flocks before changing to an alternative drug for an equal time period. **Rationale:** Drugs with different modes of action are used so if resistance to one drug's mode of action is developed the parasite would be susceptible to the second drug's mode of action.
Shuttle Program	**Definition:** Alternate the combination of anticoccidial use between different feed periods during the life of the flock (i.e. different drug(s) within the starter feed, the grower feed and, sometimes, the finisher feed as well). **Rationale:** Drugs with different modes of action are used so if resistance to one drug's mode of action is developed the parasite would be susceptible to the second drug's mode of action. **Note:** A shuttle program can be part of a rotation program.
Step-Down Shuttle Program (for replacement layer pullets)	One drug is used at a predetermined level for the starter period, a second drug may be used at an alternate dose for the grower period and either a third drug or the first drug may be used at a reduced level for a further developing period.
Alternating between live vaccination and anticoccidial programs (Do not use an anticoccidial drug at the SAME TIME with a vaccinated flock)	Live coccidiosis vaccines are rotated into a single anticoccidial or shuttle program for one or two flocks to 'rest' the anticoccidial program. Most, if not all, vaccine strains of coccidian are drug-sensitive and therefore the poultry house will be seeded with drug-sensitive parasites that will interbreed with any existing coccidia that may have begun to develop reduced drug sensitivity. This approach can greatly extend the useful life of anticoccidials (particularly ionophores) in the field.

Flowchart of Anticoccidial Drugs



*Depending on the species of Eimeria some anticoccidials work as both coccidiostats and coccidiocides.
1. Coccidiostatic for *E. acervulina* and *E. mivati*. Coccidiostatic and coccidiacidal for *E. necatrix*, *E. brunetti* and *E. tenella*.
2. Cocciostatic for *E. necatrix*, *E. brunetti*, *E. mivati* and *E. tenella*. Coccidiostatic and coccidiocidal for *E. acervulina*.
3. Coccidiocidal for *E. mivati*.
4. Coccidiocidal for *E. acervulina* and *E. mivati*. Coccidiostatic and coccidiocidal for *E. tenella*, *E. necatrix* and *E. brunetti*.

Figure 41. A summary of different types of anticoccidial drugs and their effect and mechanism of action towards certain chicken *Eimeria* species. Anticoccidial drugs can be categorized as a coccidiostat or a coccidiocide based on their effect on *Eimeria*. Some drug types can act as both a coccidiostat and a coccidiocide depending on the species of *Eimeria* being acted against. The mechanisms of action for some drug types are known, although the process for selective effects against certain *Eimeria* species is poorly understood (5-8).

References

1. Chapman, H.D. Anticoccidial drugs and their effects upon the development of immunity to *Eimeria* infections in poultry. Avian pathology 28:521-535. 1999.

2. Chapman, H.D., T.K. Jeffers, and R.B. Williams. Forty years of monensin for the control of coccidiosis in poultry. Poultry Science 89:1788-1801. 2010.

3. Compendium of Veterinary Products

4. Abbas, R.Z., Z. Iqbal, D. Blake, M.N. Khan, and M.K. Saleemi. Anticoccidial drug resistance in fowl coccidia: the state of play revisited. World's Poultry Science Journal 67:337-350. 2011.

5. Williams, R.B. A compartmentalised model for the estimation of the cost of coccidiosis in the world's chicken production industry. International Journal of Parasitology 29:1209-1229. 1999.

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7. Chapman, H.D., T.E. Cherry, H.D. Danforth, G. Richards, M.W. Shirley, and R.B. Williams. Sustainable coccidiosis control in poultry production: the role of live vaccines.International Journal of Parasitology 32. 2002.

8. Reid, W.M., E.M. Taylor, and J. Johnson. A technique for demonstration of coccidiostatic activity of anticoccidial agents. Transactions of the American Microscopical Society 88:148-159. 1969.

Monitoring for Success

Monitoring your flock by assessing average daily gain, feed conversion, water intake and the number of flocks with coccidiosis diagnosed is a good first step to measure overall flock health.

There are two specific coccidiosis monitoring methods: **lesion scoring** and **oocyst counting**. Usually, lesion scoring is used when the prevention method is anticoccidial drugs while oocyst counting is used when the prevention method is live vaccine. However, these two monitoring methods can also be used at the same time with a flock given any coccidiosis prevention method (**please consult your veterinarian**).

The monitoring methods can be suggested by the veterinarian, feed or vaccine technical representative. Regardless, post-mortem analysis by a veterinarian should always be performed whenever a flock experiences higher signs of disease or mortality.

The presence of lesions always comes before oocyst shed in the environment. Lesions are formed due to the asexual and sexual cycle of the parasite, whereas oocyst formation and shed occurs after these stages. See the Parasite Biology: Life Cycle section for more information.

Lesion Scoring

Based on severity, the lesion scoring process allows the veterinarian to assess whether a prevention program is working and whether the disease is prevalent in the flock.

Random flock health checks can be completed to assess gut health and performance of the coccidiosis prevention method.

A veterinarian will complete a post-mortem analysis on a random selection of birds. To complete an intestinal lesion score the veterinarian will remove the intestines of the bird and assess the intestinal lesions based on a pre-defined guideline. The veterinarian will assess upper, middle, lower, ceca and rectal sections of the intestine. If needed, the veterinarian can also take microscope slide scrapings of that section of the intestine to confirm the presence of *Eimeria* life cycle stages.

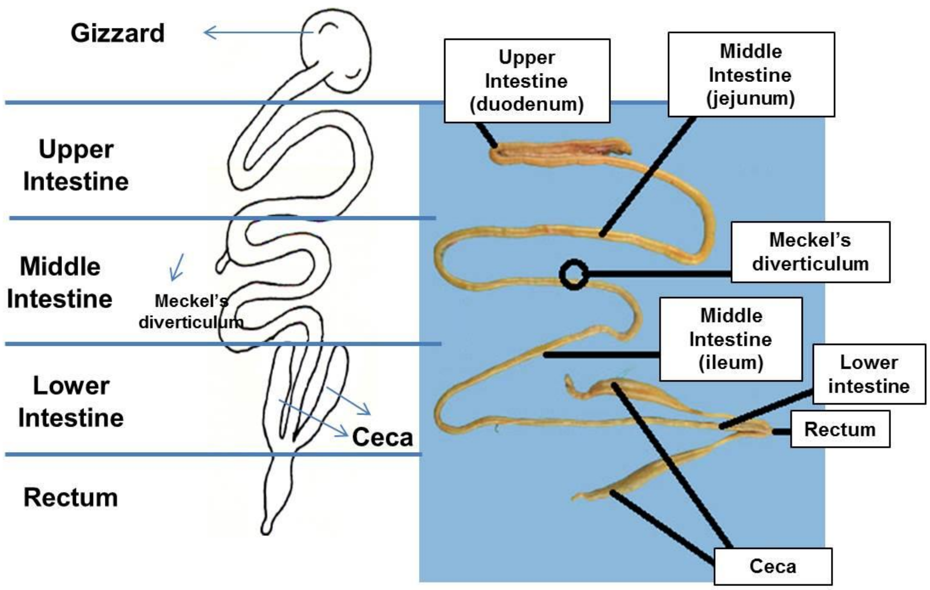

Figure 42. Normal poultry intestine with important sections and markers labelled that are used when a veterinarian is assessing coccidial intestinal lesions (1, 2).

The guideline for chickens:

Reid, W.M., and P.L. Long. A diagnostic chart for nine species of fowl coccidia. College of Agriculture Experiment Stations, University of Geogia. 1979.

AND

[Johnson, J., and W. Reid. Anticoccidial drugs: Lesion scoring techniques in battery and floor-pen experiments with chickens. Experimental Parasitology 28:30-36. 1970.]

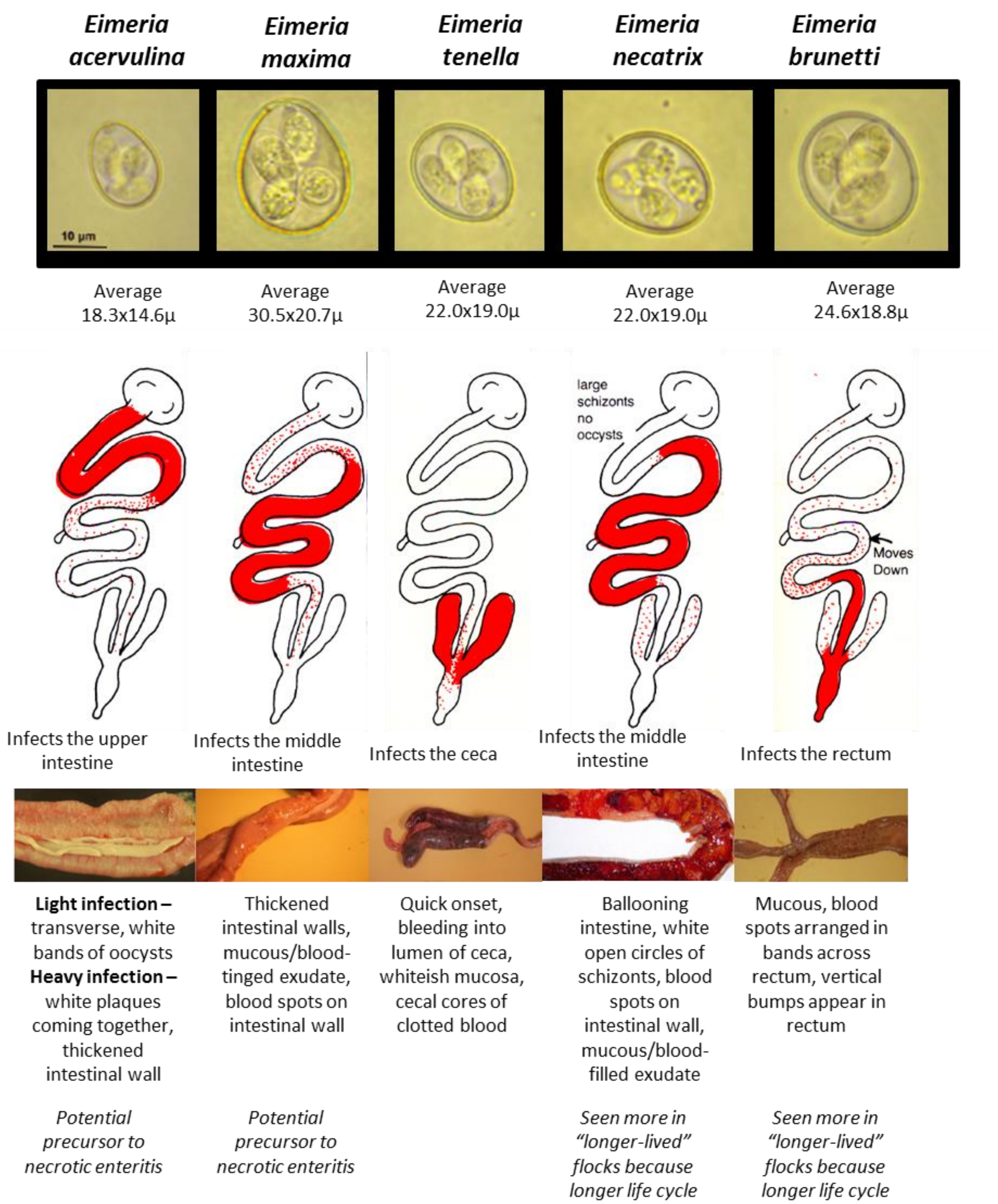

Figure 43. Five chicken *Eimeria* species commonly associated with disease. *Eimeria* oocysts, location of infection along the intestine and lesions per species are shown (1, 3).

Lesion scores can be completed for turkeys, however a standardized system has yet to be established (4). General information on coccidiosis lesions of turkeys:

Reid, M.W., P.L. Long, and L.R. McDougald. Coccidiosis. In: Diseases of Poultry, 8 ed. M.S. Hofstad, B.W. Calnek, M.W. Reid and H.W. Yoder Jr., eds. Iowa State University Press, Ames, Iowa, USA. pp 692-717. 1984.

AND

Chapman, H.D. Coccidiosis in the turkey. Avian pathology 37:205-223. 2008.

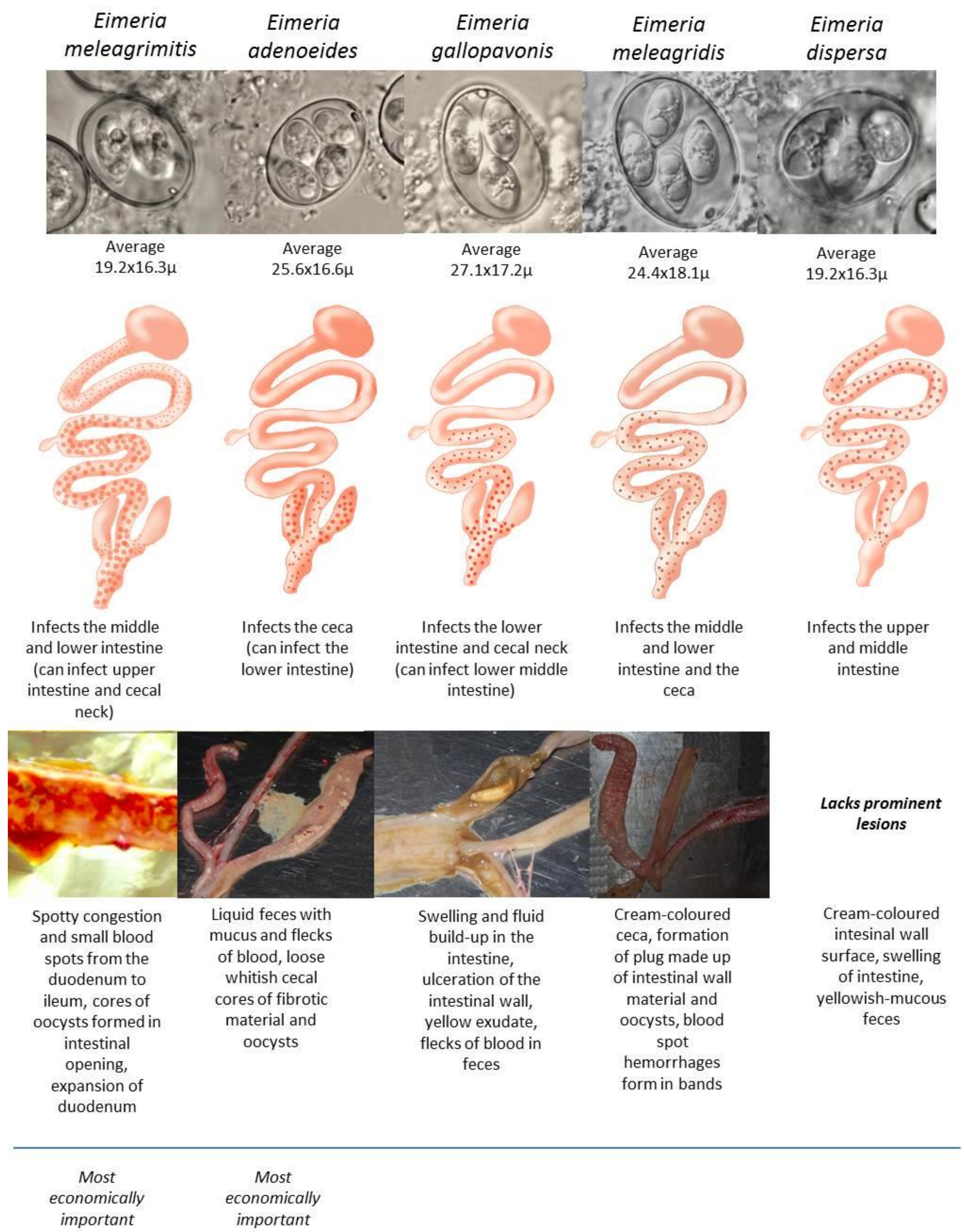

Figure 44. Five turkey *Eimeria* species commonly associated with disease. *Eimeria* oocysts, location of infection along the intestine and lesions per species are shown (3,5,6).

References

1. Reid, W.M., and P.L. Long. A diagnostic chart for nine species of fowl coccidia. College of Agriculture Experiment Stations, University of Geogia. 1979.

2. http://www.animalhealth.bayer.com/4959.0.html

3. Thank you to Dr. Jean-Michel Reperant for chicken Eimeria oocyst photos and E. meleagrimitis lesion photo

4. Holdsworth, P.A., D.P. Conway, M.E. McKenzie, A.D. Dayton, H.D. Chapman, G.F. Mathis, J.T. Skinner, H.C. Mundt, and R.B. Williams. World Association for the Advancement of Veterinary Parasitology (WAAVP) guidelines for evaluating the efficacy of anticoccidial drugs in chickens and turkeys. Veterinary Parasitology 121:189-212. 2004.

5. Reid, M.W., P.L. Long, and L.R. McDougald. Coccidiosis. In: Diseases of Poultry, 8 ed. M.S. Hofstad, B.W. Calnek, M.W. Reid and H.W. Yoder Jr., eds. Iowa State University Press, Ames, Iowa, USA. pp 692-717. 1984.

6. Thank you to Ms. Shiem El-Sherry for the turkey *Eimeria* oocyst photos and *E. adenoeides*, *E. gallopavonis* and *E. meleagridis* photos

Oocyst Counting

This process monitors the number of oocysts present in the environment and can provide an estimation of how well the prevention program is working, or if an outbreak is occurring.

Oocyst counting in the field is based on the oocyst per gram of feces measurement. This process requires communication between the farmer and the technician providing the service to properly collect samples and ensure these samples are being analyzed with the right tools.

Oocyst counting with live vaccine prevention programs - This process is helpful in indirectly determining successful ingestion of vaccine oocysts via assessing the numbers of oocysts being shed at approximately 7 days of age. The parasite life cycle is between 5-7 days from ingestion of an infective oocyst to the start of oocyst shed. Additionally, this process is helpful in indirectly measuring low level oocyst cycling in the barn by assessing oocyst shed on approximately 14, 21, 28, etc. in the farm.

Oocyst counting with anticoccidial prevention programs - This process is helpful in determining overall oocyst numbers in the barn which would be indicative of a potential coccidiosis challenge.

Good Practices When Collecting Fecal Samples from the Barn for Oocyst Counting

When collecting fecal samples in the barn, it is important to obtain a sample that is representative of the full barn environment. A small sample obtained from the first few steps or cages into the barn will not provide a good representation of what is happening.

1. Fecal samples should come from fresh feces not mixed with litter or grass or dried fecal matter found on a manure belt. If material other than fecal matter is picked-up it could skew the oocyst count result. If possible, fecal samples should contain both intestinal and cecal droppings.

2. Fecal samples should be collected randomly from all over the barn and should not be from one specific area.
3. Amount of fecal sample collected should be between 60 to 100grams (about 3-5cm or 1-2inches from the bottom of a ziplock bag). Because larger birds produce heavier droppings, be sure to collect samples from all around the house and not from one location only.
4. Clearly label the sample bags with the information requested from the service technician.

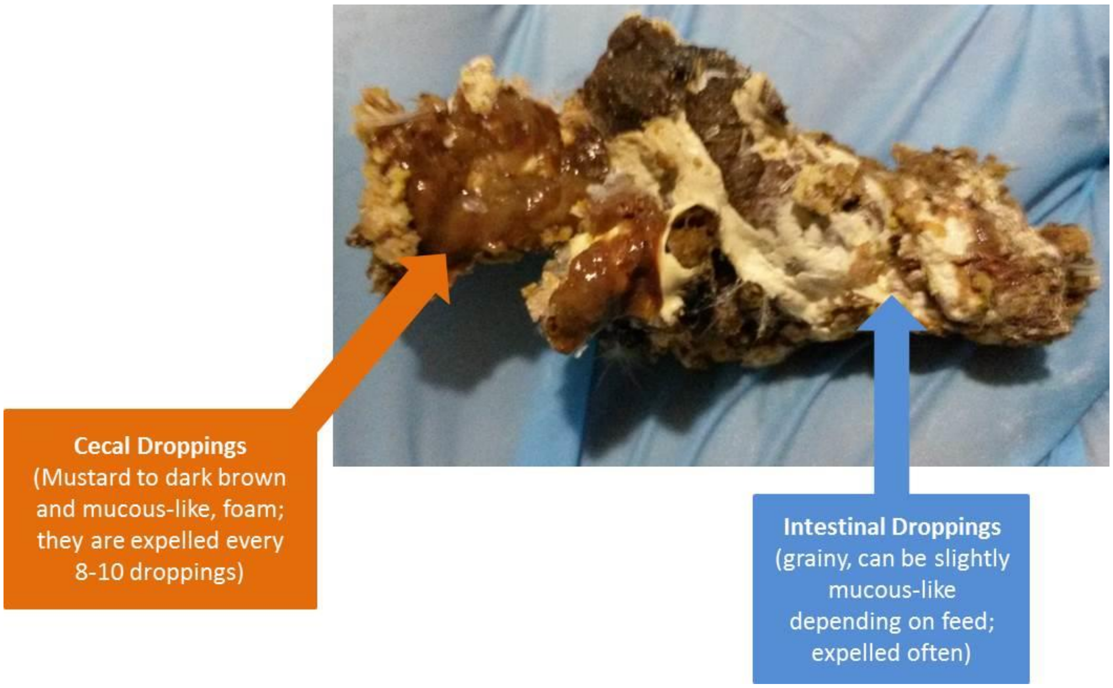

Figure 45. A normal poultry fecal sample demonstrating cecal and intestinal droppings with white urate.

What Happens to that Sample?

The fecal sample is brought to a laboratory and the oocysts are counted using some variation of the McMaster counting chamber technique. Here, oocysts are measured in oocysts per gram of feces.

A description of the McMaster counting chamber technique can be found here:

Conway, D.P., and E. McKenzie. Poultry coccidiosis: diagnostic and testing procedures. Blackwell Publishing Professional, Ames, IA. 2007.

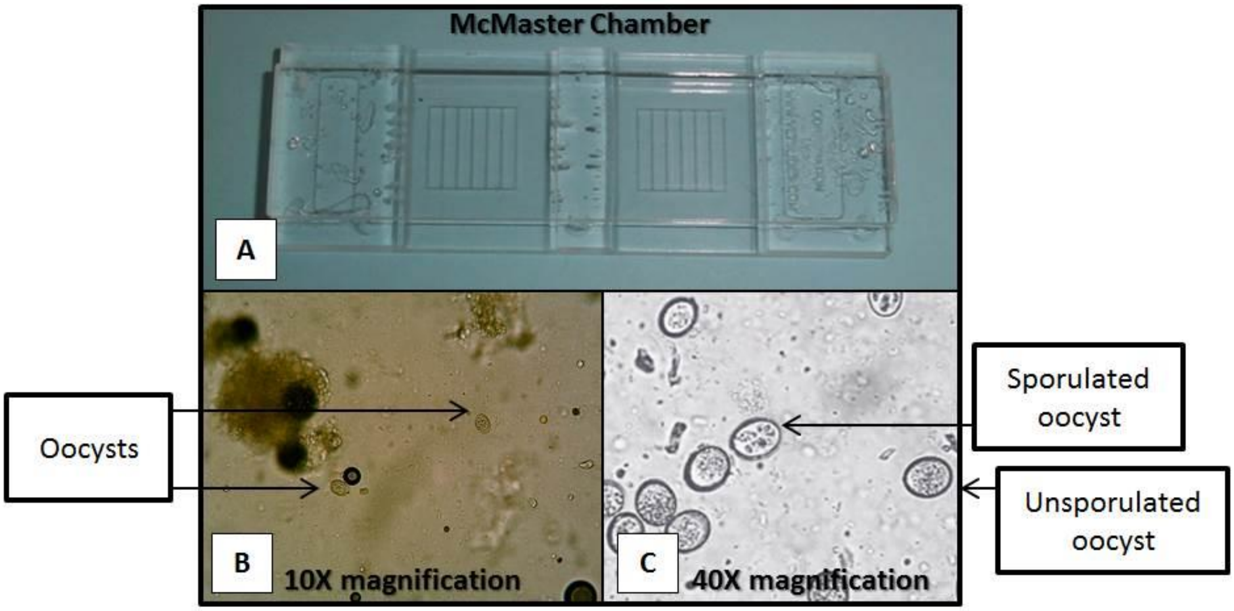

Figure 46. An example of a McMaster chamber (A) that can be used for counting oocysts. Oocysts in a fecal sample can be viewed at low (B) and high (C) power magnification with background plant material and air bubbles. At a higher magnification (C) it is easier to view sporulated versus unsporulated oocysts. Photo credits: A, B - Thank you to Mr. Kobus Van-Heerden; C - Sloss, M.W., Kemp, R.L. and A. M. Zajac. Veterinary Clinical Parasitology. 6th ed. 1994.)

Glossary

Parasite - an organism that lives in or on another organism (its host) and benefits by deriving nutrients at the host's expense

Oocyst - a thick-walled protective case in which *Eimeria* become infectious. This structure serves to transfer the parasites to new hosts

Sporocyst - a thin protective case within an oocyst that allows sporozoites to develop

Sporozoite - a motile stage of that is the infective agent

Excyst - the action of a sporozoite exiting a sporocyst inside the intestine

Sporulation - the oocyst becoming infective

Pre-patent period - the time between ingestion of an infective oocyst and initiation of oocyst shedding following parasite replication "in-the-gut"

Patent period - time of oocyst shedding

Inoculation - when birds have been given oocysts or have ingested oocysts

Relative humidity (RH) - the amount of water vapor present in air expressed as a percentage of the amount needed for saturation at the same temperature

Dew point - atmospheric temperature (varying according to pressure and humidity) below which water droplets begin to condense and dew can form (i.e. the temperature at which air becomes saturated).

Related Links

Digital Education on Coccidiosis – Canadian Poultry Magazine article introducing this project

Poultry Health Research Network (University of Guelph) – A network of experts, consisting of poultry researchers and poultry health specialists, who address problems ranging from very basic biological processes, to environmental concerns and industrially relevant issues

Poultry Industry Council – A non-profit corporation with a mandate to manage research and education on behalf of the Poultry Industry in Ontario, Canada.

Animal Health Laboratory (University of Guelph) – A full-service, fully computerized veterinary diagnostic laboratory

The College of Veterinarians of Ontario – A public register of all active veterinarians in Ontario, Canada. Use the advanced search engine to find active poultry veterinarians in Ontario, Canada.