

CORNELL POULTRY POINTERS

Cornell Cooperative Extension

Vol. 50 No. 3 July 2000

Barb Smagner, Managing Editor

THIS ISSUE IS DEDICATED TO TWO OUTSTANDING GENTLEMEN AND SCHOLARS: DR. RANDALL K. COLE AND DR. MILTON L. SCOTT

We are pleased to dedicate this issue to Drs. Cole and Scott. Both have made exceptional contributions to poultry science and the poultry industries through their research, teaching, and extension (outreach) programs. Even though they have long since retired from Cornell, they continue to share their ideas and are a source of inspiration for the rest of us. On behalf of everyone reading Cornell Poultry Pointers, we hope you will join with us in congratulating both Drs. Cole and Scott on their achievements.

CONTENTS

- 1) This Issue Is Dedicated to Two Outstanding Gentlemen and Scholars: Dr. Randall K. Cole and Dr. Milton L. Scott
- 2) 2000 Friend of the Department Award
- 2) Intro to talks
- 2) Lighting: Programs for Pullets and Layers
- 5) An Update on Concentrated Animal Feeding Operations
- 7) Shell Quality and Bone Mineralization: An Overview of Research at Cornell University
- 11) The Role of Biotechnology in the Poultry Industry
- 12) The Impact of Biotechnology on Poultry Genetics and Breeding
- 14) Seasonal Variations in *Carcinops pulilio* Dispersal and Potential for Suppression of Dispersal Behaviour
- 18) Strategies to Improve the Value of Cage Layer Manure
- 26) New York State Disease Report 1999-2000

2000 FRIEND OF THE DEPARTMENT AWARD

Mr. John Gingerich, the Production Manager of Wegman's Egg Farm in Wolcott, NY, was the recipient of this year's Friend of the Department award presented at the 2000 Cornell Poultry Conference on June 21 at the Ramada Inn, Ithaca, NY.

John managed Gingerich Egg Farms (a small layer operation near Castorland, NY) from its inception for seven years. Then, he owned the farm for the next ten years at which point he closed the farm to join Wegman's Egg Farm. John has been with Wegman's for 15 years; the first ten years as poultry specialist, and the last five years as Production Manager. In this capacity, John is responsible for pullets, layers, crops, feed mill, and compost operations.

John has helped the Department in various ways during the years. He has been a speaker at the Cornell Poultry Conference several times, and helped for many years in selecting the topics for the conference. He has been extremely helpful for many years in receiving our domestic and foreign visitors and showing them Wegman's Egg Farm and talking to them about the issues that are facing American egg producers. Additionally, he always has welcomed our students and with patience and love taught them about various aspects of poultry production and management. For these and many other contributions of John, we have been delighted to recognize him as the Friend of Department for the year 2000.

We wish John and his family good health and prosperity for years to come.

K. Keshavarz
Department of Animal Science
Cornell University

The following information is from the Cornell Poultry Conference, held June 21, 2000, at the Ithaca Ramada Inn. If you would like information on any of the topics listed, please contact the speaker directly.

LIGHTING PROGRAMS FOR PULLETS AND LAYERS

Lighting chickens has become a little more complex in the last 10 years than just screwing in the bulb and flicking on the switch. Now there are a wide variety of lighting devices available to poultry producers, each with its own characteristics and applicability to rearing chickens. However, before we get to the details, I have found that most people are slightly confused about what light is and what aspects of it are important to rearing poultry. I would therefore like to elaborate on this just a little.

WHAT IS LIGHT?

Visible light is just a tiny portion of the total electromagnetic spectrum, which includes radio waves, microwaves, x-rays and gamma rays. The light environment can be classified in three ways, **wavelength, intensity and duration**. Each of these aspects will be discussed relative to rearing poultry.

WAVELENGTH OR COLOR OF LIGHT

Research has shown that the color of light can have many different

effects on growth and reproduction in poultry. It has been reported that **blue-green light stimulates growth** in chickens while **orange-red stimulates reproduction**. Birds have pigmented oil droplets on their cone cells that correspond to peak sensitivities of 415 nm, violet; 460 nm, blue; 510 nm, green; and 560 nm, yellow for young birds with a peak at 580 nm, orange for adults. This is important to remember when selecting a light source for illuminating poultry. The lighting industry uses four methods to describe light color but only one really applies to selecting lighting for poultry, Chromaticity.

Chromaticity is the measure of a light source's warmth (warm light) or coolness (cool light) expressed in degrees Kelvin. The scale runs from 2000 to 7000K. Chromaticity values of 4000K and higher are considered cool (a lot of blue light), those around 3500K or 3600K are called "balanced" or "neutral" and those of about 3000K or lower are considered warm (more red light). A color temperature designation is truly accurate only for an incandescent lamp because it produces a continuous spectrum. Fluorescent and HID (high-intensity discharge; high pressure (HP) Sodium, Low pressure sodium and Metal Halide lamps) lamps are said to have a "correlated" (apparent) color temperature and are thus always described using the term *correlated color temperature* (CCT).

WHAT KIND OF LAMPS ARE AVAILABLE TO POULTRY PRODUCERS?

Incandescent, Fluorescent, Metal Halide and High- and Low-Pressure Sodium lamps are currently being used in poultry production facilities for laying hens, breeder flocks and growing meat birds. The **incandescent** bulb is the current standard by which others are compared, relative to poultry production.

Incandescent bulbs produce light

by passing an electric current through a tungsten filament, heating it to incandescence. These lamps provide light energy over the entire visible spectrum, however much of the electrical energy is converted to heat energy as infrared. They have a light efficiency of about 8-24 lumens per watt and a rated life of about 750-2000 hours. A tungsten-halogen incandescent lamp will last about 3000 hours with an efficiency of about 20 lumens per watt.

Fluorescent lamps produce light by the passage of an electric current through a low-pressure vapor or gas contained within a glass tube. The ultraviolet radiation given off by the mercury-vapor arc stream produced along the length of the tube is absorbed by the phosphor material coating the inside of the glass tube, causing it to fluoresce at wavelengths that are seen as visible light. The wavelengths emitted depend upon the phosphors used in coating the tube. The new CF lamps all use a special tri-phosphor coating, resulting in light emitted in discrete wavelengths from each of the primary colors, red-orange, green and blue, giving an appearance of balanced white light. There are two styles of the CF lamps, "twin" and "quad" tube. They come in 5, 7, 9, 13, 16, 22, and 28 watt sizes with efficiencies of 50 to 69 lumens per watt and rated lifetimes of greater than 10,000 hours. Recent research has demonstrated that some may last more than 20,000 hours under poultry house conditions. However, these lamps will decrease their light output by about 20% - 30% over their lifetime, and this must be considered upon initial installation. All fluorescent lamps require a ballast. The CF lamps have been used successfully in all types of poultry operations, including caged layers, breeder flocks, growing broilers, growing pullets and turkeys. Recent research has indicated a preference for CF lamps over incandescent lamps by Leghorn layers.

High Pressure Sodium (HPS) lamps discharge an electric arc through a concentrated sodium vapor producing energy across the entire visible spectrum, but with the highest intensity in the yellow, orange and red regions. These are considered warm lights at about 2100K color temperature. They run at about 51-132 lumens per watt and come in wattages ranging from 35 to 1000. They have the longest rated life of all the lamps discussed, at about 24,000 hours. All HPS lamps require a ballast. These lamps require a warm up time to full illumination of between 5 and 15 minutes, which means that after a power outage, backup lighting may be necessary until full illumination has been achieved again. These lamps have been used successfully in poultry facilities, mostly in breeder houses and turkey facilities, with peaked roofs so that light distribution is more easily controlled.

Metal Halide (MH) lamps have ratings from 32 to 1500 watts and come in three different outer bulb finishes, clear, phosphor coated and diffuse. The MH lamps emit light across the entire visible spectrum, but are considered a cool light, having a lot of blue. They have efficiencies of about 80 to 100 lumens per watt and are rated at about 10,000 to 20,000 hours of life. MH lamps require a ballast also. Because these lamps must be mounted in a specific orientation (vertical or horizontal) they are not used much in the chicken house, but have been used in warehouse areas and egg handling rooms, where ceilings are high and efficient, bright lighting is required. These lamps also have a warm up period of between 5 and 15 minutes to achieve full illumination.

COSTS AND EFFICIENCY OF LAMPS

When choosing a light source, one should consider not only spectral quality and efficiency (operating costs), but also the initial cost, including the cost of auxiliary equipment, such as ballasts, reflectors, lamp housings and supports required to operate the lamp. Additionally, one must consider the type of house and age and type of bird, and overall light requirements of workers as well as birds.

The following table lists lamp types and some cost factors.

Table 1. Lighting Source Comparison

	Inc.	CF	MH	HPS
Initial Cost	Low	Moderate	High	High
Operating Cost	High	Moderate	Low	Low
Efficiency*	8-24	50-69	80-100	51-132
Rated Life (hrs)	500-200	10,000+	15,000+	24,000+
Color Temp (K)	2500K	2700K	3700- 4000K	2100K

* Efficiency is measured as the rated lumens per watt.

FIGURING YOUR OWN EFFICIENCY

Energy savings can be calculated by using the following simple equations. All you need to supply is the present cost of electricity on a kilowatt hour basis, the wattage of your present incandescent or other lamps, the ballast plus lamp wattage of the replacement fixture and the number of hours the lamps are on each day. (Just fill in the blanks)

$$\text{_____ watts/bulb} \div 1,000 \text{ watts} \times \text{_____ hours on per day} = \text{kwh/bulb/day.}$$

$$\text{_____ kwh/bulb/day} \times \text{_____ bulbs/house} = \text{kwh/house/day.}$$

$$\text{_____ kwh/house/day} \times 365 \text{ days/year} \times \text{_____ ¢ per kwh} = \text{cost/house/year.}$$

HOW BRIGHT AND HOW LONG?

Now that the physical aspects of the lamps have been discussed, it is time to turn our attention to *intensity* and *duration* as related to chickens.

Intensity: With blackout housing pullets can be exposed to 1 to 2 fc from day one to day three and then placed on .5 to 1 fc to 18 or 20 weeks, or when recommended body weights and shank lengths are achieved. After 19 - 20 weeks, and the birds can be exposed to .5 to 1.5 fc during the entire production period. In natural light housing (window or curtain houses) then the natural light is supplemented with 1.5 - 5.0 fc for the period when supplemental lighting is used. It has been found that birds exposed to very dim lights, say 3 hrs at .02 - .03 fc) prior to exposure to bright lights, say 8 hrs at .5 fc or more, might perceive this as sunrise and daylight and shift their biological clock as if exposed to 11 hours of normal light. However, the reverse, dim following bright, does not shift their perception. It appears that the threshold intensity for photostimulation is about .15 fc. However maximal egg production has been achieved at intensities between .5 and 1 fc.

The next important aspect is **duration** of light stimulation. Two rules exist for this:

1). **Never Increase** the duration or intensity of light during the **growing period**.

2). **Never Decrease** the duration or intensity of light during the **production period**.

Duration depends upon the age of the chicken and type of housing you use. Chicks can be exposed to 21-23 hrs of continuous light at one and two days of age and then reduced to 15 or 16 hrs of light until the birds are three weeks of age. (Chicks have a very low fear response during their first three days of life and can be exposed to many

environmental stimuli, such as new housing, light and dark, etc. without much adverse effects.) At three weeks of age, reduce the hours of light to 10-12 hours or as dictated by natural daylength in open or brownout housing. In summer for open and brownout housing use decreasing hours of light up to six weeks of age and then hold constant to avoid delays in maturity. When target body weights are achieved start your stimulatory lighting program. Jump to 13 hours and then add 15-30 min per week until 16 hrs of light is reached. Light stimulation should continue until peak production is achieved.

To be most effective, lighting programs for growing birds must be correlated with the lighting programs for production birds. Most breeding companies have specified lighting programs that work well with their birds and these programs should be followed.

WHERE SHOULD THE LAMPS BE PLACED IN MY BUILDING?

The distribution of light within your poultry facility will depend upon placement of the lamps. The lamps should be placed so that the maximum illumination value is spread over the largest area. This all depends upon the physical dimensions and equipment in your building.

In cage layer facilities, it is best to place the lamps such that the darkest areas have at least .5 - .75 fc of light. The number of feet between lamps will depend upon the size of the lamp and the physical surroundings of the cages, ceiling, etc. Just remember, your goal is to achieve **even** lighting throughout your building, at the desired brightness level for your birds. Lamps should be placed so that the minimum lighting desired is found at the darkest point (usually midway between lamps on the floor.) The bright spots must not exceed the maximum illumination required.

One last point, all the lamps described above, except the incandescent, will lose up to 20% of their original light output during their rated life, and must be considered in lamp placement. For example, if you desire no less than .5 fc at the darkest point and you use a CF lamp, at the end of the lamp life, or when dirty you may only have .4 fc or less. (If a lamp is rated at 100 lumens, it will have only 80 lumens toward the end of the lamp life.) Incandescent lamps will lose some but less of their original illumination value.

Dirty lamps will also decrease light output, by as much as 15 to 20%, therefore it is important to clean the lamps off at least once per week.

*[Speaker: Michael J. Darre,
Department of Animal Science,
College of Agriculture and Natural
Resources, University of
Connecticut.]*

AN UPDATE ON CONCENTRATED ANIMAL FEEDING OPERATIONS

EPA continues to turn its attention toward agriculture and non-point pollution. Using their figures one fourth of the water pollution in the country is from animal waste. *E. coli* and *pfisteria* concerns are making headlines. EPA is actively working to get states to prevent this pollution. NY has identified agriculture 20% as the largest contributor adversely

impacting lakes on the priority watershed list. The next highest pollution source identified was Point sources at 13% followed by on-site systems at 12%. All farms will have to live with continuing and intensifying scrutiny of their environmental impact.

DEC in New York has CAFO permits available as a general permit. To be included under this permit in NY a farm needs to have sent in a Notice of Intent before January 1 2000, although they are still accepting them as of 6/1/00. The farm then must complete a certified plan within 18 months if the farm has more than 1,000 animal units, or within 24 months for farms that have between 300 and 1,000 animal units. The farm must implement the plan by January 1, 2005.

Over 500 farms in NY have sent in their notice of intent as of 6/1/00. This includes 128 farms with more than 1,000 animal units and 406 farms with between 1,000 and 300 animal units. Approximately 70 planners have been qualified to write the plans. However only one has been certified, that is completed three plans that were successfully reviewed by a team of CCE, SWCD, and NRCS experts. More planners are expected to complete their three plan review soon.

EPA expects all livestock farms to have a Comprehensive Nutrient Management Plan (CNMP) by 2009. They recently completed a series of inspector training courses throughout the US to prepare inspectors to look evaluate farms. DEC in NY does not have in their work plan any inspection plans.

EPA will make changes to the poultry and swine CAFO regulations in 2001. They will likely drop any references to liquid systems and waterer overflows that now confuse the issue on poultry. They may make some changes to their animal unit calculation. They will likely make specific requirements for documentation on where and how

the manure is spread.

Total Maximum Daily Load (TMDL) ratings for nonpoint nutrients and bacteria are supposed to come out in 2003. If the existing loads in some watersheds exceed the limits states may be forced to accelerate enforcement of nonpoint programs on agriculture to lower the loads.

Soon the Coastal Zone Management Reauthorization Act (CZMRA) has to be reviewed for compliance. States may think they've got it covered. NY hopes voluntary implementation of AEM will meet it. EPA may not think progress is good enough and insist on an acceleration.

After evaluating the specific watershed situation and the potential pollution concerns they have, farms should have decided whether to get a permit or not. Farms that have more than 300 animal units and the potential to discharge should get the permit. Those farms with fewer animal units should start to take steps now to eliminate pollution. Smart farmers will begin to plan for these requirements.

One of the main issues facing poultry producers is ensuring that the land the manure is spread on will meet the requirements of a nutrient management plan. The phosphorous loading from manure is of particular concern. Soils that have been fertilized in the past with manure spread at a rate to provide nitrogen are often high in phosphorous already.

There are three ways to determine the rate of manure to be spread to meet phosphorous limits. First is following the agronomic recommendation for economic return from phosphorous additions. This will limit manure to the amount needed to supply the phosphorous needed for optimum economic growth of the crop. On fields high in phosphorous this may be none.

The second way is to limit phosphorous to environmental

thresholds where phosphorous levels in the field are set at their saturation point. That is where additional phosphorous cannot be adsorbed by the soil and will be mobile. These levels are higher than the agronomic levels.

Finally a phosphorous index can be developed that identifies fields that have high phosphorous and then also identifies fields that have a high probability of loss. By determining whether phosphorous is likely to be transported off the field to a watershed some fields that are high in phosphorous but don't contribute much to the downstream water could continue to receive some phosphorous.

Farms should use a nutrient management plan and a professional planner to make decisions on where manure is to be spread. Manure exported off your farm will likely need to have a nutrient management plan as well. Preparing plans for the fields on other farms that use the manure will help prevent surprises in the future from limitations on the amount of manure they can take.

Environmental issues with increased public concern and an increase in regulations are here and will continue to evolve. We need to be prepared to manage our operations to include these concerns and regulations.

[Speaker: Peter Wright, Department of Agricultural and Biological Engineering, Cornell University.]

SHELL QUALITY AND BONE MINERALIZATION: AN OVERVIEW OF RESEARCH AT CORNELL UNIVERSITY

It is estimated that about 6-8% of the eggs produced annually are lost from the point of production up to the point of delivery to retail stores with a value of about 480 million dollars. If, in fact, this loss will be realistic, then considering the number of hens that currently exist in the U.S., the estimate of loss can be close to \$1.5/hen/year or about \$100,000 annually for a family farm of 60,000 hens. This calculation may not be realistic, but signifies the extent of the problem. If the true extent of loss will be only 1/4 of this estimate, still the extent of loss can be about \$25,000 for a family farm of 60,000 hens annually.

Due to the economic significance of shell quality to producers, one area of our research during the past two decades have been dealt with shell quality and bone mineralization. The results of an extensive field studies on commercial farms revealed two situations which were causes of concerns; first, it was realized that some producers were using Ca quite generously in layers diets. We observed Ca levels as high as 5-5.5% in the diet, that based on a daily feed intake of 110 g/hen/day during winter months (when the feed samples were collected), the Ca intake per hen per day was about 6 g or greater. Additionally, we observed that extensive Ca separation is taking place in different

phases of the feed handling systems; this included the bulk bins and feeding lines. The pattern of Ca separation along the feeding lines was not similar in different farms and it was varied depending on the type of feeding systems and the speed of movement of feed along the feeding lines. Our additional studies indicated that both feeding systems and preferential selection for feeding particles contribute to Ca separation along the feed lines.

In the first series of experiments, we were interested to find out what is the maximum level of Ca that laying hens can tolerate safely and to determine whether increasing the Ca above the recommended level could have a beneficial effect on shell quality. Calcium levels up to 6.5% did not produce an adverse effect on performance when dietary available P (aP) was adequate (0.5%) during an experiment that lasted from 20 to 66 wk of age. However, production performance significantly was reduced and mortality was significantly increased when the diet contained 6.5% Ca and a marginal level of aP (0.2%). A diet with a Ca level of 6.5% and an aP of 0.2% provides a Ca:aP ratio of 32.5:1. This Ca:aP ratio caused inferior performance and high mortality. Due to Ca separation, a similar Ca:aP was observed on commercial farms. Consequently, the Ca separation to the extent that is taking place on commercial farms, has the potential to produce adverse effect on performance and egg shell quality.

The effect of dietary Ca on shell quality in this and two additional experiments were inconsistent and varied from one to another experiment. Consequently, another experiment was conducted in more detail to reevaluate the Ca requirement of laying hens for optimum performance and egg shell quality. The results indicated that a dietary Ca level of up to 5.5% with a constant aP level of 0.4% from 20 to 66 wk of age did not produce an

adverse effect on performance or a beneficial effect on shell quality as compared to the control group which was fed a diet with 3.5% Ca and 0.4% aP levels. Other dietary regimens including a step-up Ca level with aging with a constant level of aP, a step-down aP level with aging with a constant level of Ca, or a combination of step-up Ca with step-down aP with aging were without a beneficial effect on shell quality. The only treatment that resulted in a significant improvement in shell quality for the entire experiment was the one in which 50% of the pulverized Ca was replaced with oyster shell particles. The birds on this dietary treatments were receiving a sequence of 3.5, 4.5, and 5.5% Ca for the periods of 20 to 36, 36 to 54, and 54 to 66 wk of age. The results indicated that even when the Ca level is plentiful in the diet, the presence of Ca sources in particle forms are expected to produce beneficial effects on shell quality. The results also indicated that a step-down aP regimen of 0.4-0.3-0.2% with aging (20 to 36, 36 to 54, and 54 to 66 wk of age, respectively) with a constant level of Ca (3.5%), resulted in comparable performance to the control group. However, we did not observe a beneficial effect on shell quality due to reducing the dietary aP level with aging in this experiment. Also, we were not able to show a beneficial effect on shell quality when the vitamin D3 was increased from 2,200 ICU/kg feed in phase 1 to 4,400 ICU/kg feed in phase 2, and further to 8,800 ICU/kg in phase 3 of the experiment. The results of digestibility studies indicated that absolute daily Ca retention was not reduced with aging. Consequently, as has been reported by others as well, reduced shell quality with aging appears to be due to an increase in egg size without a concomitant ability of hens to increase the Ca retention proportionally with aging to maintain shell quality. The results

of this experiment generally indicated that the tolerance of laying hens for Ca is relatively high particularly when an adequate level of aP is present in the diet. In several other experiments and both under high temperatures of summer months or cold to moderate temperatures of winter and spring months, we observed a beneficial effect from oyster shell on shell quality when it was used at 50% of the supplemental source of Ca in the diet. An industry concern was whether particles of oyster shell or Ca chips are reaching to the end of the lines when the particle sources are used at the 50% inclusion level. We collected feed samples containing either oyster shell or Ca chips along the feeding line in a commercial poultry house with 60,000 hens. The result of particle counts indicated that both particle sources were reached evenly to the end of the feeding line, although under the conditions of that field study, the speed of movement of feed in the feeding lines was only 40 feet/min.

Because Ca separation in various phases of the feed handling system was a serious problem on commercial egg farms, a series of experiments were conducted to determine the impact of variation of Ca intake on production performance and shell quality. In one experiment, the control group was fed a constant Ca level of 3.5% in the period of the experiment (60 days; 10 cycles of 6 days), while the alternative group was fed a 1.5% Ca in the first 3 days and a 5.5% Ca diet in second 3 days of each 6-day cycle and for a total of ten cycles. Regardless of the methods used for measurement of shell quality, it was significantly reduced within 24 hours of feeding the low-Ca (1.5%) diet and returned to normal within 24 hours of feeding the high-Ca (5.5%) diet. These results indicated that Ca separation in the extent that is taking place on commercial farms has the

potential to contribute significantly to formation of eggs with inferior egg shell quality. In fact, the results of additional studies indicated that consumption of a low-Ca diet only during the afternoon hours has the potential to reduce the egg shell quality significantly. In this experiment, the control group was fed a diet with 3.5% Ca both during the a.m. and the p.m. hours. The other groups were fed 2.5% Ca in the a.m. hours (5 a.m. to 1 p.m.), and 4.5% Ca during the p.m. hours (1 p.m. to 9 p.m.) or vice versa, or 1.5% Ca in the a.m. and 5.5% Ca during the p.m. hours or vice versa. Although the daily Ca intake of birds receiving 4.5% Ca in the a.m. and 2.5% Ca in the p.m. was not different than the birds of the control group, their shell quality was significantly reduced as compared to the control group. A more extreme situation was the birds receiving 5.5% Ca during the morning, and 1.5% Ca during the afternoon. The shell quality and production performance of this group was reduced even further. The results of this experiment refined our previous findings and indicated that when hens on a daily basis receives diets with low and high Ca (due to Ca separation on the field) their shell quality will be affected when the period of inadequate Ca intake would be in the p.m. hours. The results are not surprising, because adequate Ca intake during the afternoon hours is quite critical for shell formation. Additionally, the results indicate that for the current-day strains that are laying at such a high rate, there is no room for nutrient separation even for one day.

In a study related to pattern of daily feed intake, we observed that hens are consuming only 40% of their daily feed intake during the morning hours (5 a.m. to 1 p.m.), and the next 60% during the afternoon hours (1 p.m. to 9 p.m.). Additionally, we noted that most of the afternoon feed is consumed mainly just during the

3-4 hours prior to when lights go off. On the other hand, we observed that over 97% of eggs with young hens, and over 90% of eggs with old hens, are laid during the morning hours (5 a.m. to 1 p.m.). This emphasizes that every effort should be made that sufficient feed will be in the feeders a few hours prior to light goes off so that sufficient Ca will be available in the digestive system for shell formation during the dark hours.

One other factor that received a considerable degree of interest in recent years and has thought to be important in the formation of sound shells deals with the solubility of supplemental sources of Ca that are used in the diet. It is a fact that Ca sources should be solubilized in the digestive system and the Ca ion should be released before it can be absorbed and used for shell or bone formation. So one can speculate that the higher the solubility of Ca sources, the better their potential for use for bone and shell formation. However, it should be mentioned that the relationship between the in vitro solubility of Ca sources with their in vivo solubilization and their potential for use for bone and shell formation is not as yet well understood. We conducted an experiment to determine the relationship of in vitro solubility of Ca sources with their in vivo utilization for bone and shell formation. Two pulverized Ca sources [(pulverized oyster shell (POS) and pulverized limestone (PL)] were used in this experiment. The results of the sieves analysis showed that 97% of both pulverized sources of Ca passed through sieve #16 (i.e., were less than 1.18 mm in diameter), indicating that for all practical purposes they had almost identical particle size. However, the in vitro solubility was 77.8% for POS, while it was 46.6% for PL. An experiment was conducted with three levels of Ca (3, 3.5, and 4%) in combination with four sources of Ca (all PL, all POS, 2/3 PL + 1/3 OS, and

2/3 POS + 1/3 OS) in a 3 x 4 factorial arrangement of the treatments. The period of experiment was from 22 to 62 wk of age.

Specific gravity was significantly greater for hens fed 3.5 and 4% Ca than those fed 3% Ca diet during 22 to 38 wk, 38 to 62 wk and for the entire experiment (22-62 wk of age). Specific gravity was not different for hens fed 3.5 and 4% Ca for these periods. The average daily Ca intake for the entire experiment was 3.29 and 3.77 g/hen/day for hens fed 3 and 3.5% Ca, respectively. These results substantiated our previous finding and indicates that the NRC (1984) estimated Ca requirement of 3.5% (3.85 g/hen/day) for laying hens more realistically represents the calcium requirement of laying hens throughout the production cycle, than the NRC (1994) recommended value of 3.25 g/hen/day. Specific gravity was not different for hens fed all the supplemental Ca in the form of PL as compared to POS in any part of the experiment, although these two sources of Ca varied considerably in their in vitro solubilities. Specific gravity was significantly greater for hens fed the supplemental Ca in form of 2/3 PL plus 1/3 OS or 2/3 POS plus 1/3 OS than hens fed all the supplemental Ca as PL during 38 to 62 wk of age. For the entire experiment, specific gravity was significantly greater only for hens fed the supplemental Ca in the form of 2/3 POS plus 1/3 OS than for hens fed all the supplemental Ca as PL. However, specific gravity practically was not different for hens fed 2/3 PL plus 1/3 OS and those fed 2/3 POS plus 1/3 OS for the entire experiment. These results indicated that most parts of the beneficial effect of Ca sources on shell quality was attributed to OS particles. The results of this experiment indicated that a diet with 3% Ca (3.3 g intake/hen/day) is not adequate for optimum shell formation. Our data suggests that Ca intake should be about 3.75-4 g/hen/day. This substantiates the

NRC (1984) recommend Ca level of 3.85 g/hen/day. The beneficial effect of OS particles in this experiment was consistent with the results of a previous experiment, although the response from OS was less pronounced. This indicates that for getting the best response from OS, it should make up 1/2 of the supplemental source of Ca. Furthermore, the data indicated that solubility of Ca sources in the range used in this experiment did not have an effect on bone mineralization or shell quality. While we do not rule out the importance of solubility of Ca sources for optimum bone and shell formation, probably a Ca source with solubility of less than 44% should have been used to detect the importance of solubility of Ca sources on shell quality and bone formation. However, it appears that neither too much solubility nor too little solubility are proper for shell formation. Probably a Ca source with a solubility of about 50% should give satisfactory results with regard to solubility.

Another series of experiments dealt with the impact of dietary vitamin C and 25-OH-D₃ (Hy.D) on shell quality and bone mineralization. The effect of vitamin C on shell quality and bone mineralization has been a subject of debate amongst scientists during the past 6 decades. It is generally accepted that various classes of poultry have inherent capability to synthesis vitamin C and under normal conditions they do not have a need for this vitamin in their diets. However, under certain stressful conditions such as environmental, nutritional or pathological stress, the metabolic need for this vitamin may exceed the inherent synthetic ability either due to diminishing the biosynthesis of the vitamin by the body and/or due to increasing the requirement under these stressful conditions. Under such conditions, supplementing the poultry diet with vitamin C may have a beneficial

effect on shell quality, bone formation and other production traits.

Due to the economic significance of shell quality and bone mineralization to the poultry industry, and because of the controversial reports pertaining to the beneficial effect of supplemental vitamin C on shell quality and bone mineralization, we conducted a series of experiments to further examine the effect of vitamin C on shell quality and bone mineralization of laying hens. Because inferior shell quality is a major problem during high environmental temperatures of summer months, and also with older hens, the experiments were conducted under these conditions to increase the sensitivity of responses to dietary treatments.

Also, in recent years, 25-OH-D₃ (Hy.D) with reasonable price has become available to the poultry industry. Because vitamin D₃ should be converted first to 25-OH-D₃ in the liver, and then to 1,25(OH)₂-D₃ in the kidney to convert to its active form (1,25(OH)₂D₃), we felt it is probable that Hy.D might be more active than vitamin D₃ in enhancing shell and bone formation. The results of these experiments generally indicated: 1) a level of 250 ICU vitamin D₃/kg diet is marginal for optimum shell formation. A level of 500 ICU/kg diet appears to be more compatible with the requirement for this vitamin. However, industry should use a higher level of vitamin D₃ to prevent the possibility of losses of potency due to storage, and the individual variation on vitamin D₃ requirement for Ca utilization, 2) no benefits on performance and shell quality were obtained when 25-OH-D₃ was used in place of vitamin D₃ at 500 ICU in the diet, 3) vitamin C levels up to 1,000 ppm did not have a beneficial effect to improve shell quality or bone formation, 4) vitamin C was not more effective in improving performance and shell quality in the presence of 25-OH-D₃.

than vitamin D₃ in the diet.

Another area with regard to bone and shell quality that deserved receiving particular consideration was related to the importance of proper time of changing the growing Ca level to layer Ca level. It is important to realize that during the early stages of egg production cycle, laying hens are in a negative Ca balance, i.e., the Ca outgo through egg shell and excreta is more than the Ca intake. Laying hens are utilizing the Ca from medullary bones to compensate for this extra Ca need. When pullets are moved from the growing house to laying house at proper time, then the medullary bones have enough Ca to take care of this extra need. However, when pullets that are already producing eggs remain in the growing house on a low-Ca growing diet, then most of the stored Ca of medullary bones are utilized for eggs formation during the late stage of the growing period. When pullets are moved to laying houses, because still they need to borrow Ca from the medullary bones, then the bones become extremely depleted of Ca and this contributes to the incidence of cage layer fatigue (osteoporosis) in the flock during the early stages of the egg production cycle.

We conducted an experiment to determine the effect of feeding a high-Ca diet (3.5%) for various durations during the latter part of the growing period on bone ash and bone Ca and shell quality during the early stages of the production cycle. The control group received a normal growing diet with 0.8% Ca from 14 to 20 wk of age. Other groups received a high-Ca diet of 3.5% from 14, 15, 16, 17 or 18 wk up to 20 wk of age (i.e., the experimental groups were kept on a high-Ca diet for 2, 3, 4, 5, and 6 wk, respectively, prior to housing). Increasing the Ca level did not produce an adverse effect on body weight and feed consumption during the growing period. Also, the left, right, or total weight of

kidney and plasma level of uric acid which is an indication of normal functioning of the kidney was not different for birds fed the high Ca diet for various durations as compared to the control group. However, bone ash was increased significantly when pullets were fed the high-Ca diet for 2 wk prior to housing, and both bone ash and bone Ca were increased significantly when pullets were fed a high-Ca diet for 3-wk prior to housing. Shell quality during the early part of the egg production cycle was not influenced by the dietary treatments under the condition of this experiment, although others reported beneficial effect on shell quality as well.

Based on the information obtained from our research at Cornell University, in part, and briefly, which has been presented in the previous paragraphs, the following recommendations can be made:

1.) Change the growing Ca level to 3.5% when the secondary signs of sexual maturity (growth of comb and wattle) can be seen clearly in the flock. Use these physiological changes as criteria for changing the Ca level from growing to laying levels rather than the chronological age.

2.) A Ca intake of about 4 g/hen/day is adequate to satisfy the Ca requirement of laying hens for optimum shell formation throughout the production cycle. Although the tolerance of the laying hens for Ca is relatively high, particularly when the dietary level of P is adequate, increasing the dietary Ca to provide more than 4 g Ca/hen/day, does not seem to provide a beneficial effect on shell quality.

3.) "Resident time" of Ca sources in the digestive system is important and has a direct effect on egg shell quality. About 50% of the supplemental Ca in the diet of laying hens should be provided in particle form with proper solubility (50% or higher).

4.) A step-down P regimen can be used satisfactorily in the laying period with aging. Such an approach has the advantage of reducing the feed cost and diminishing environmental pollution attributed to P excretion and may be effective in improving egg shell quality.

5.) Every effort should be made to reduce Ca separation in different phases of the feed handling systems. Calcium separation to the extent that normally may take place in commercial farms is an important factor for problems associated with poor egg production performance and inferior shell quality.

6.) Because the pattern of calcium separation could vary with different feeding systems and the speed of movement of feed in the feeders, every producer should evaluate his/her situation independently and appropriate measures should be taken to overcome the problems.

The following are a few tips for reducing Ca separation in different phases of the feed handling systems:

a. Auger systems for feed delivery from truck to feed storage bins result in less ingredients and Ca separation than air system of feed delivery.

b. Bulk bins should be equipped with a feed distribution system at the top and a redistributing device at the bottom to re-mix any ingredients that may become separated.

c. Running the feeding systems at the maximum speed reduces the potential of preferential selection of ingredients by hens which contribute to Ca and other nutrient separations.

d. Augers in good working condition have less vibration and may cause less separation.

e. Allow birds to clean up the feed in the trough once a day. This prevents accumulation of fines in the trough which may result in excessive intake of Ca or other fine particles by the birds.

*[Speaker: Kavous Keshavarz,
Department of Animal Science,
Cornell University.]*

THE ROLE OF BIOTECHNOLOGY IN THE POULTRY INDUSTRY

Like many industries, the feed industry is facing numerous challenges. One primary challenge is that we are now very much a part of the food chain, where total traceability will become the norm, rather than the exception. The European Commissioner for Food, David Byrne, has stated clearly that food safety is the number one ingredient in food, and his approach has now been embraced by food importers around the world. This means that producers and food exporters in the United States must take note if we are to consider ourselves an exporting nation. Necessity, however, is the mother of invention, and in this respect, biotechnology has not and will not let us down. Science will help us find our way forward.

A brief reflection on the advances that have changed the face of agriculture over the last few years affirms the role of science in response to these challenges.

ENVIRONMENTAL POLLUTION CHALLENGE OF PHOSPHATES

The use of the enzyme phytase has changed the way we look at the inclusion of ingredients such as dicalcium phosphate in poultry diets. Furthermore, the advent of phytase preparations from non-genetically modified organisms has given a reasonable cost of structure to an enzyme preparation that not only contains phytase, but also contains beneficial levels of amylase, protease, and cellulase. This has resulted in exciting new strategies that improve animal performance, as well as reduce environmental

phosphorus pollution.

THE CHALLENGE TO GROWTH PROMOTERS

While there are a number of alternative solutions to antimicrobial growth promoters, many have failed detailed scientific scrutiny. The exception is the use of supplemental mannan oligosaccharide, which has proven itself to be as effective as antimicrobial growth promoters in 92% of the production trials that have been completed.

THE CHALLENGE OF MYCOTOXINS

Mycotoxins can play an enormous role in depriving animals of their ability to fulfill their genetic potential. The combination of chemistry on one hand and microbiology on the other have given us a unique way of tackling this problem. By altering the stereo specificity of the naturally occurring glucans present in yeast, we can now physically titrate mycotoxins out of contaminated feeds.

CHALLENGE: THE PERCEPTIONS ON SELENITE

While much maligned as a possible carcinogen and yet recognized as an essential mineral, selenium has had a checkered past. The suggestion that selenium be allowed in feeds at levels of no more than 0.1 parts per million has led to reinvestigation of its central role in metabolism and to the possibility of using selenium in a more natural form. The net result has been the emergence of selenomethionine as a feed supplement, not just as an alternative to inorganic selenium sources, but as a preferred source of selenium. Whether it acts through sparing effect on vitamin E or through its ability to reduce broiler breeder mortality and improve broiler efficiency, it is clear that selenomethionine will be the preferred source of selenium in the future.

CHALLENGE OF RISING COSTS

As nutritionists understand more and more the role of enzymes in the diet, biotechnology has been able to perfect a number of the novel enzyme systems that can be used in animal production systems. The use of alpha-galactosidase and proteases result in as much as a 7% improvement in amino acids retention, a 7% improvement in energy utilization, and a cost reduction of as much as \$7.00 per ton of feed. Work with these systems suggests that production challenges will always be met with responses if we allow biotechnology to take its rightful place in poultry production.

CHALLENGES OF THE FUTURE

Future challenges will need to focus on improving the efficiency of animal production and the safety of food products. Perhaps we will want to get the chicken to our market in 35, rather than 42 days, to improve eggshell quality or to improve the digestibility of feather meal.

All of these targets are achievable. We have now become aware of bioactive nucleotides, which have been demonstrated to improve growth rate and repair tissue particularly in rapidly growing birds. Furthermore, by activating some of the enzymes involved in calcium deposition, eggshell quality can be improved. Finally, we now know that some enzymes are capable of breaking the disulfate bond in feathers. These enzymes are commercially used to improve the digestibility of feather meals, such that its overall value to the poultry industry is increased by \$30-40 per ton.

Challenges will always be the lifeblood of our industry and any successful company in our industry. The future will be in the hands of those who respond fastest to these challenges. This millennium is about speed. It is about response time. It is about knowing our industry. Our industry can no longer be considered

as just a feed industry, but more as part of the food industry and the human food chain.

[Speaker: T. Pearse Lyons, Alltech, Inc., Nicholasville, KY.]

THE IMPACT OF BIOTECHNOLOGY ON POULTRY GENETICS AND BREEDING

GENETIC IMPROVEMENT IN POULTRY

A major objective of the primary breeding sector of the poultry industry is to genetically improve the efficiency of production, the quality of eggs and meat and the health and welfare of poultry. Efforts are focused on economic traits required by the consumer and producer as well as traits related to environmental issues in poultry production. The impact of biotechnology on poultry genetics and breeding will therefore apply to the layer and meat (broiler, turkey, duck etc.) segments of the industry.

We are all aware of the tremendous genetic improvements that have been achieved in many economic traits in egg and meat strains including egg production, growth rate, livability, disease resistance, feed efficiency and egg and meat quality in the last 2-3 decades. Today, it is feasible for many commercial layers to achieve 314 eggs per HH, 19.20 Kg egg mass,

2.00 FCR and 94% livability from 17-72 wk of age. In broilers, live weight, FCR, eviscerated yield, de-boned breast meat to 42 and 49 days of 2300 & 2770 g, 1.82 & 1.96, 67.9 & 68.8%, and 16.0 & 16.5%, respectively are typical. Similar high performance levels are observed in turkeys. These genetic improvements have been accomplished using what is usually referred to as "traditional" or "conventional" breeding techniques. Further progress in genetic improvement of poultry through the current improved traditional breeding methods is expected to continue in the future.

In the May 2000 issue of the Monthly Newsletter of the International Egg Commission, the United Egg Producers issued the following statement regarding genetically modified (GM) foods and eggs. "Eggs are not a genetically modified food. This includes shell eggs and eggs used for processed egg products. Only traditional breeding techniques are used to produce laying hens in the U.S.; neither chickens nor eggs are modified by genetic engineering. Even when a laying hen eats genetically engineered feed, any product unique to genetic engineering are destroyed by the digestive process of the hen. Scientific research has confirmed that none of the genetically engineered materials are passed into the egg."

Thus, the discussion of the impact of Biotechnology on Poultry Genetics and Breeding at this year's Cornell Poultry Conference falls into the debate on GM foods.

It is well established scientifically that genetic improvement of any trait in an animal requires a modification in the genetic constitution of the animal with respect to the genes that influence the trait. In poultry, some of the traits that require continued genetic improvement include stress resistance, disease resistance, immune competence (immune balance), behavior, nutrient

utilization efficiency and reproductive performance. In addition, layers must have high rate and persistency of egg production, better feed efficiency, egg size, egg quality (internal and external) and livability. In meat birds growth rate, muscle mass, carcass quality, feed efficiency and livability are important. As these traits are improved genetically, the birds under selection are thus genetically modified. It is therefore important to examine what traditional or conventional breeding methods are and what biotechnology entails with respect to genetic improvement of performance in poultry.

TRADITIONAL (CONVENTIONAL) POULTRY BREEDING

Traditional poultry breeding practices incorporate quantitative and qualitative genetics, reproductive physiology, statistics, computer science and poultry husbandry in a highly interactive fashion to maximize the genetic improvement. The initial ingredient in this process is the accurate measurement of the **trait (phenotype)**. For example, egg number, feed consumption, egg weight, shell quality & mortality for layers; juvenile body weight, amount of fat, breast meat yield etc. for meat birds. The geneticist then analyses these traits for genetic variability at the genome level on the basis of quantitative genetics theory using the "infinitesimal model". The infinitesimal model assumes that each trait is influenced by many genes, each with a small effect on the trait. Advanced statistical techniques, e.g. Restricted Maximum Likelihood (REML) and Best Linear Unbiased Predictor (BLUP) are used respectively to analyze for genetic variation and estimate the breeding value of the individual chicken or turkey. Selection is based on complex indexes that incorporate, optimally individual and family information

for a range of traits with the aim of maximizing overall economic response in the commercial product. It must be noted that quantitative genetic theory is based on the assumption of the organization of the genome, the size and distribution of genetic effects and the linearity of the genetic effects. Essentially, these are just estimates and a complete knowledge of the actual genes involved and all their functions is not yet available. A better understanding of the biological and molecular aspects of growth, development and reproduction will enhance the efficiency of the traditional selection process.

BIOTECHNOLOGY AND ITS MEANINGS

In many agricultural industries including Poultry, the “new” science of Biotechnology is considered by many people to be the pathway to bring improved changes in the efficiency of production to feed an expanding human population. The question is: what can biotechnology achieve that traditional breeding techniques cannot? Alternatively one may ask: What can biotechnology add to conventional breeding methods to accelerate poultry genetic improvement?

The word biotechnology is a composite of 2 Greek words: “BIOS” - meaning “life”, “living being” or “organic nature” and “Technologia” - translated as “systematic treatment”. According to the Convention on Biological Diversity, biotechnology means: “any technological application that uses biological systems, living organisms or derivatives, to make or modify products or processes for specific use.” In this broad sense, biotechnology has been part of poultry research and improvement as well as production systems for many years, although the term is rarely used in conjunction with traditional poultry breeding. For example, strain-cross breeding to

exploit heterosis (hybrid vigor), artificial insemination, vaccination, chick sexing, diagnosis to identify carriers of egg transmitted diseases may all be termed traditional biotechnologies. In recent years the word “biotechnology” has been used in a narrow sense to describe a myriad of new technologies that enable us to study, change or manipulate living cells or their components. Terms used to describe some of these novel technologies which are components of biotechnology include “**molecular biology**”, “**molecular genetics**”, “**genetic engineering**”, “**gene cloning**”, “**recombinant DNA**”, “**gene transfer**”, “**genomics**”, “**proteomics**” “**transcriptomics**” and “**bio-informatics**”. The common denominator of these technologies is that they allow us to manipulate both the reproductive process and the genome (genetic material). These technologies have demonstrated possibilities of introducing within living organisms dramatic rapid morphological and physiological changes that were until recently, only described by science fiction. Our understanding of the molecular structure and function of the DNA and our ability to manipulate it has expanded greatly through recent advances in molecular biology and related novel technologies. We now understand how the genetic information is stored in a cell, how the information is duplicated, and how it is passed from cell to cell, and from generation to generation. Poultry genetic improvement is based on the understanding of the inheritance of economic traits of interest.

With biotechnology, the **initial ingredient** required for an effective selection is the **Gene(s)** affecting the trait. The application of biotechnology in poultry breeding will be a move from measuring the **Phenotype** to measuring the **Gene(s)**. The use of biotechnology should, therefore, be viewed as the

logical extension to traditional poultry breeding. The novel aspect of biotechnology is the ability to directly manipulate or change some of the genes that influence traits of interest.

However, to be able to apply the tools of biotechnology or add them to current traditional methods, the breeder must identify the genes that influence the economic traits referred to as Quantitative trait loci (QTL) or Economic trait loci (ETL) or find markers closely linked to the genes. We must know in detail the genetic architecture (biological mechanisms/pathways) of the traits, the causal relationships between traits and the development of analytical tools for selection of genotypes with predictable performance.

The search for genes and markers have been conducted by researchers around the world for sometime and tremendous progress has been made in chickens and to a limited extent in turkeys. The chicken genome is now estimated to have between 50 to 80,000 genes on the 39 pairs of chromosomes. The rough draft of the chicken genome map has been completed through the collaborative efforts of scientists in the USA, the European Union and many other countries. The chicken genome map now has over 900 markers while in turkeys, the BUT/BUTA map is reported to have about 100+ markers.

With such tools, Geneticists will be able to use Marker Assisted Selection (MAS) to select for genes that control specific traits of commercial importance. Marker Assisted Selection, in general, is not new in poultry improvement. It has been used to improve productivity traits and resistance to Marek's disease. What is new is the power of molecular techniques to use DNA markers. Marker Assisted Selection could be used to augment selection for traits like egg production that can be measured only in one sex (sex - limited trait), to select at a very

early age, even at the embryonic stage when the trait is not expressed phenotypically, to type traits that are expensive to measure, and to select for resistance to specific diseases without direct challenge of pureline breeders. The Genetic testing and selection process could be accomplished more quickly. Furthermore, the accuracy of picking the best breeders to meet targeted genetic gains would be improved.

Alternatively, genes or markers may be isolated and inserted (transgenesis) into the germ line of different birds. This technology will also give us the ability to combine cells of different genotypes to obtain poultry that produce unique products. Research efforts toward developing routine and robust gene transfer techniques to produce transgenic chickens have been underway for many years. Much progress has been made and today, there are reports of transgenic birds developed to produce specific proteins. However, techniques to produce transgenic birds for commercial breeding of egg and meat strains are not yet finalized. When these techniques become routine and robust, they may have significant impact on the genetic improvement of many economic traits in poultry.

CONCLUSION

Although rapid advances are being made in poultry biotechnology, much more remains to be discovered about the chicken genome itself. For example, the delicate interactions of genetic background with genes of major effects is still an issue of great importance in selection. Various improvements in biotechnology will be achieved in steps and eventually biotechnology and conventional methods will be integrated to become standard tools for genetic improvement of poultry. It will be a marriage of necessity with the cultures of both technologies supporting each other. I hope that at

that time we could readily say to any audience that genetic improvement in poultry is by the application of traditional (conventional) methods and tools of biotechnology.

[Speaker: George Ansah, ISA Breeders, Inc., Ithaca, NY.]

SEASONAL VARIATIONS IN Carcinops pumilio DISPERSAL AND POTENTIAL FOR SUPPRESSION OF DISPERSAL BEHAVIOR

The hister beetle Carcinops pumilio is an effective predator of the house fly, Musca domestica, and is found in many New York/New England poultry facilities. Both the adult and larval forms of the beetle feed on fly eggs and small larvae, making it an ideal addition to a poultry fly IPM program.

Adult hister beetles are drawn to and can be effectively trapped in large numbers (i.e. >100,000 beetles/week) using black lights suspended in poultry manure pits. However, black light trapped beetles subsequently released into poultry houses are very difficult to relocate in houses, indicating a dispersal response. IPM Laboratories, Inc.,

Locke, NY has developed a trapping device called the Hister House™ for capturing hister beetles. Little is known about the dispersal responses of beetles captured with either black lights or the Hister House™. Several factors may affect beetle dispersal and colonization including: beetle age, manure moisture conditions, food availability, beetle density, and seasonal influences, such as photoperiod.

Recently completed studies at Cornell University suggest that beetle dispersal may be in response to time of year or photoperiod, as well as food availability. Other studies indicated that wild beetles could be successfully captured and transferred from a colonized poultry house to a recently cleaned facility on the same farm providing an excellent, low cost, on-farm source of biological control agents. A transfer of such large numbers of on-farm reared beneficial organisms provides a significant boost to the biological control component of a poultry producers fly IPM program.

A 1998 pesticide resistance survey of house fly populations collected from NY poultry farms showed that resistance was extremely high for 6 of 7 registered compounds examined, including cyfluthrin, the most recently introduced active ingredient. The benefits of using the hister beetle in an integrated program will become much more important as the implementation of the Food Quality Protection Act progressively removes the few remaining pesticides available to our poultry producers. Several New York poultry producers are currently utilizing hister beetle transfers. However, these innovative producers are implementing this new technology with little background knowledge regarding optimal deployment of beetles. Current practices involve capturing as many beetles as possible from one facility and releasing these beetles into a second. However, this requires

input of valuable labor and materials. If wild captured adult *C. pumilio* are to be effectively introduced into recently cleaned poultry facilities at various times in the year, a better understanding of the effects of photoperiod and seasonality is critical.

Please keep in mind that the study presented here is ongoing and the results are preliminary. Adult *C. pumilio* were simultaneously collected from a local poultry facility using various numbers of Hister House™ traps and two black light pitfall traps. The number of beetles collected with each trapping method was determined. Fifty adult *C. pumilio* were placed in each dispersal chamber. Every 24 hours, for 12 days, beetles that were found to have dispersed were counted and removed.

Once a month, for 10 months (February through November 1999), *C. pumilio* were collected and placed in dispersal chambers. Every second month, beginning in March 1999, a sub-sample of field-collected beetles were held in an incubation chamber where we simulated reverse photoperiod by decreasing or increasing the light:dark photoperiod by 10 min/day for 14 days. In March and May, the photoperiod was shortened, while in July and October, photoperiod was lengthened. This was done in an attempt to either force dispersal in those groups not currently dispersing or to suppress dispersal in those groups that were expressing dispersal behavior. Because the presence of food availability was found in previous studies to be a factor in suppression of dispersal, we further split the beetles into two treatment groups: a fed (house fly eggs) group and starved (water only) group. This resulted in four treatment groups: Hister House™ fed, Hister House™ starved, black light fed and black light starved. In October, an additional group of beetles were placed in dispersal

chambers following photoperiod alteration because of difficulties associated with the September study (low beetle recovery and subsequent beetle mortality in the incubator).

The number of *C. pumilio* collected with each trapping method was determined and is presented in Table 1. This information will allow producers to determine which method will provide the greatest return on their investment at a given time of year. From our initial data, it appears that the black light trap has an advantage over the Hister House™ from March through June. The Hister House™ gathers large numbers of beetles from June through August and demonstrated less variability throughout the year. When considering that a producer has a limited number of black lights available for trapping and black light traps are not very effective, it may be advantageous to utilize a large number of Hister House™ traps during the mid-to late summer period. In November, beetle collections with both trapping methods were very low.

The monthly average percent dispersal for each trapping method and number of beetles captured per trap are presented in Figure 1. The largest number of beetles captured with black lights (201,000) occurred in April while the greatest dispersal (70%) in the arenas occurred with beetles collected in May. The greatest dispersal (68%) from Hister House™ collections occurred in April with June collections providing the greatest number of beetles per trap. Regardless of trapping method, dispersal and beetle collections declined from June through October. The trend in November indicated that although beetles were difficult to collect in traps, those that were placed in experimental arenas dispersed at a high rate (40 to 50%).

Dispersal of *C. pumilio* following exposure to an altered photoperiod resulted in varied responses. In March, dispersal was relatively low

in the initial study (~12%), but following exposure to a shorter photoperiod, a large increase in dispersal was observed in all but the black light starved group (Figures 2 and 3). In May, the dispersal decreased in all but the Hister House™ fed treatment. An increasing photoperiod in July, when daylength is normally becoming shorter, resulted in similar dispersal. Exposure of October collected *C. pumilio* adults to an increasing photoperiod resulted in an increase in dispersal activity. Sufficient data do not exist at this time to make a conclusive interpretation of our results.

[Speakers: Phil Kaufman and Don Rutz, Department of Entomology, Cornell University.]

Table 1. Number of *C. pumilio* collected in 24 hours per Hister House™ and Black Light Trap.

Collection Date	Estimated No. Beetles per Trap	
	Hister House	Black Light
February 9	—	—
March 8	705	11,542
April 14	892	200,991
May 11	318	16,069
June 8	4,375	33,041
July 12	952	438
August 10	1,565	4,024
September 14	491	1,817
October 11	65	1,371
November 8 ^a	27	171

^a48 hour collection.

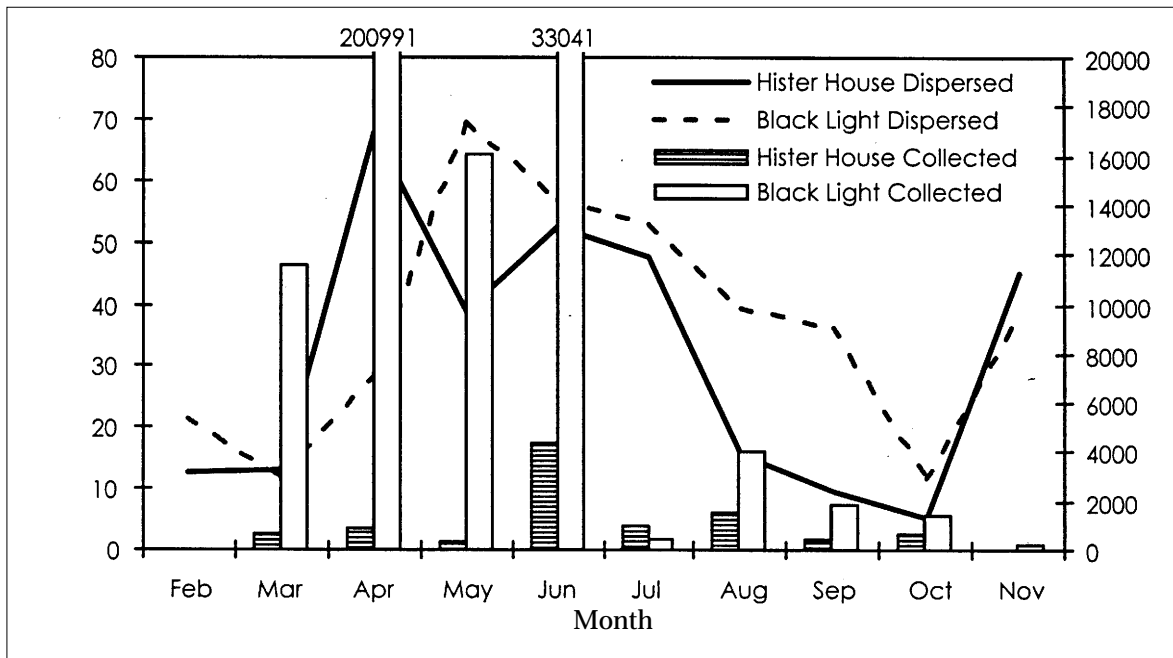


Figure 1. Monthly collection and dispersal of *C. pumilio* collected using two trapping methods.

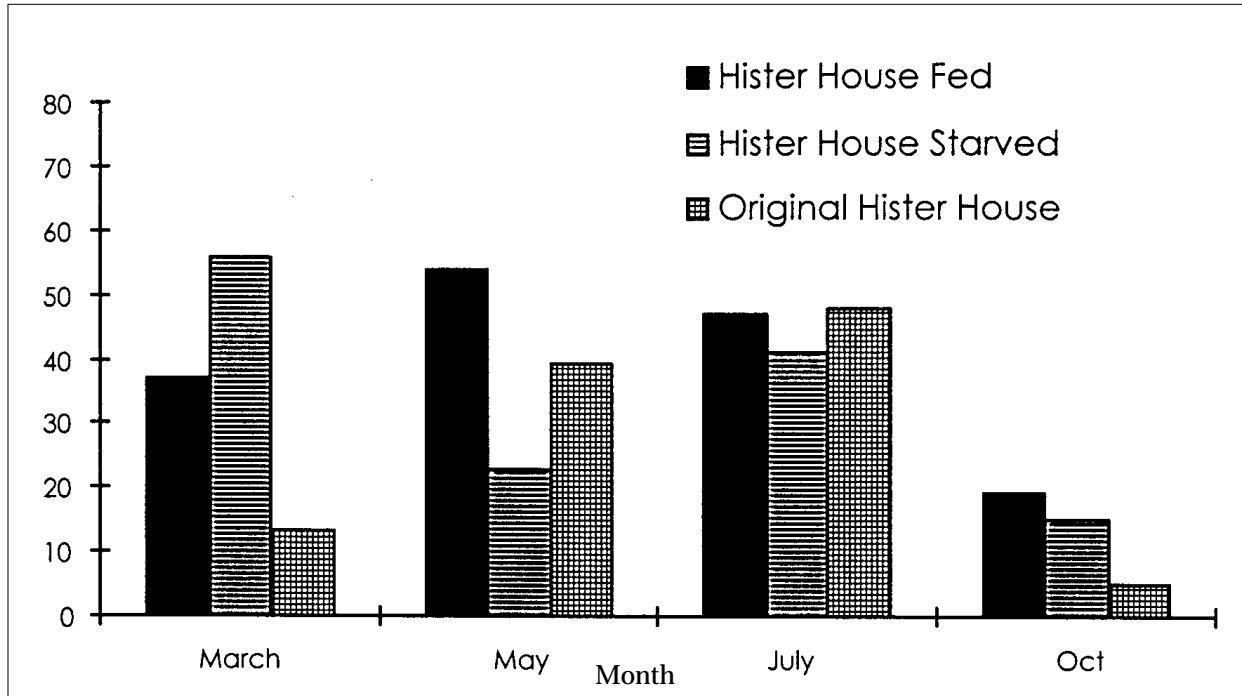


Figure 2. Dispersal of Hister House™ collected *C. pumilio* immediately following collection and following a two-week photoperiod alteration.

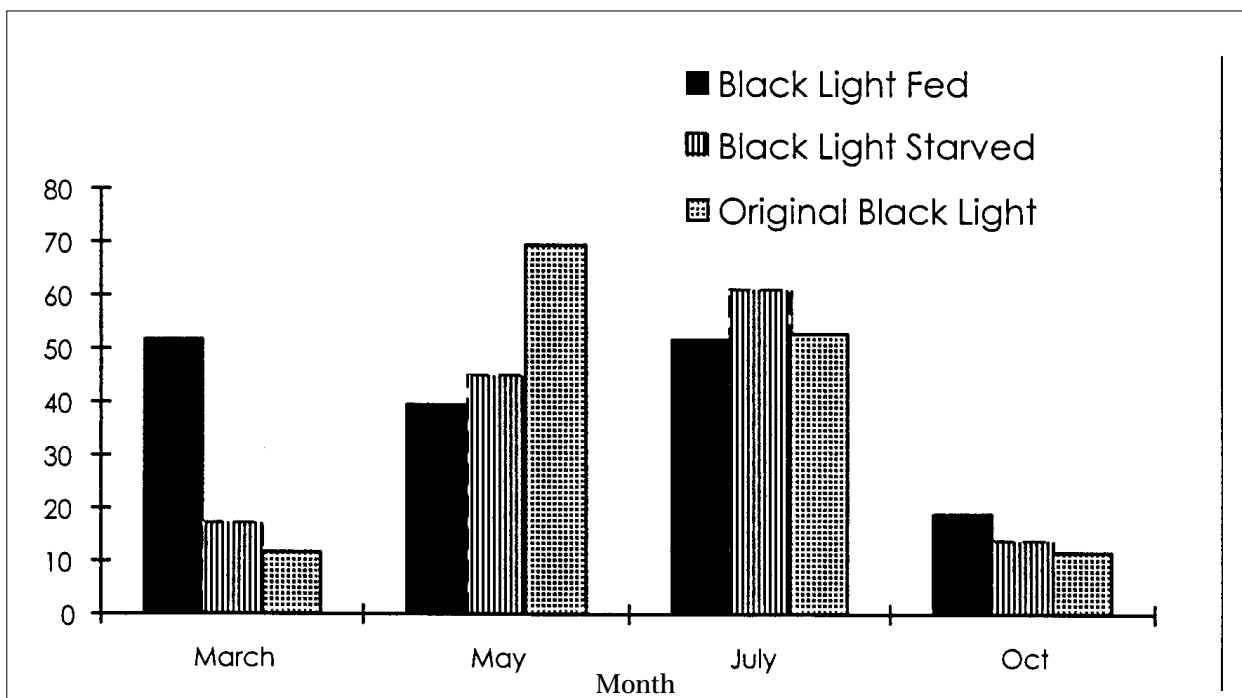


Figure 3. Dispersal of Black Light collected *C. pumilio* immediately following collection and following a two-week photoperiod alteration.

STRATEGIES TO IMPROVE THE VALUE OF CAGE LAYER MANURE

The manure from caged laying hens is rich in plant nutrients, making it a good fertilizer when applied to land. However, cage layer manure also has problems associated with it. Since commercial layer farms house many thousands and sometimes even millions of hens, large quantities of manure are produced in small areas. The spreading of this manure onto an insufficient land base overloads soils with nutrients and pollutes ground and surface waters. Manure management systems which require manure to be removed from a house on a regular schedule regardless of season and weather are labor intensive and inconvenient if the manure is handled as a solid. Flush systems are more convenient, but require the maintenance of manure lagoons which can pose a threat to water quality in environmentally sensitive areas. Manure lagoons also can produce offensive odors. Due to the high water content of fresh layer manure and especially of lagoon effluent and sludge, it is not cost effective to move these materials very far from the site of production. When left to accumulate, as in a high-rise house, layer manure is a good breeding ground for flies, sometimes making high-rise houses unsuitable for areas where large numbers of people live. Anaerobic conditions in high-rise house manure produce bad odors when the manure is spread. Moreover, fly eggs, larvae and pupae can be transported with the manure to fields where the manure is applied, producing sudden increases in fly populations in those areas. High-

rise layer manure also may not have the consistency to allow it to be spread in a thin, even swath. Local flies can be attracted to lay eggs in chunks or piles of layer manure in fields. Under good conditions, new generations of adult flies can be produced in cycles of 5-7 days.

Another problem with layer manure is that the amounts of plant nutrients it contains are not balanced in regard to the agronomic requirements of crops or forages. If the manure is land applied at rates which would supply the needs of a crop for nitrogen (N), an excess of P_2O_5 (P) is applied. This does not create a problem until the soil becomes overloaded with P. In many regions with high concentrations of poultry and other agricultural animals, P overloading of soils has been demonstrated. Water quality in rivers, lakes, and estuaries can be degraded when this occurs. If layer manure is spread at rates which meet the phosphorous requirements of a crop, a much larger land base is required to dispose of the manure. This may be difficult to find in the vicinity of a farm, particularly in areas with a large animal production industry, and it is expensive to transport the manure to sites remote from the farm. An additional expense and inconvenience is that N must be supplemented to soils where layer manure is applied to meet the phosphorous requirements of a crop.

Strategies to improve the value of cage layer manure must address one or more of the problems mentioned above. At present, relatively few strategies or procedures are commercially available for the specific purpose of improving layer manure value. Some options are available for a company to develop "in house" to achieve specific objectives. Other possibilities are currently in the research stage at universities.

Improving the value of layer manure as a product can be looked at from several angles. One way to

produce a better producer would be to bring the plant nutrient composition of the manure into better balance with agronomic requirements of crops or forages by manipulating levels and availability of specific nutrients. For example, formulation of phytase enzyme concurrently with reduction of phosphorous inclusion into layer diets can reduce excretion of P in feces. The resulting manure would have a higher N:P ratio, reducing risk of P overloading in soils.

Addition of alum to manure binds P into a form which is largely unavailable to plants and may greatly reduce the pollution potential of P in layer manure. Alum can also lower manure pH, conserving N in the manure by inhibiting the volatilization of ammonia (NH_3). Research continues in this area, but it appears that the addition of alum to layer manure may increase its effective agronomic N:P ratio and reduce risk of P pollution of surface waters.

The value of layer manure might be improved by processing which concentrates nutrients to increase its value per tonne, or which improves its handling characteristics (friability) for manipulation and spreading, or which increases its acceptability as a product, e.g., by minimizing (improving) odor, controlling moisture, reducing flies. Composting has the potential to achieve all these objectives.

Composted or otherwise processed layer manure could also be incorporated with other materials to produce products, such as fertilizers, soil amendments or synthetic soils, targeted to specific markets. These other materials may themselves be waste products of industrial activity. For the most part, these possibilities are still in the conceptual stage and await research and development.

The effective value of layer manure can be improved by increasing the accessible land base

upon which the manure can be spread. In many situations, this could convert a farm's layer manure output from a liability to an asset. Some crop or horticultural producers do not recognize the fertilizer value of layer manure for their operations or find it too disagreeable a product to wish to have it spread on their land. The former issue is a matter of education, but the latter, i.e., the disagreeableness of raw manure, can be reduced by composting. Another way to increase the land base for spreading manure would be to apply it to forest land. In areas with a substantial forestry industry, it may be possible to land apply considerable amounts of layer manure with little environmental risk and gain the benefit of increased growth rates of trees.

It not being possible to adequately discuss all possible strategies, this presentation will focus on research currently being conducted at the University of Georgia.

THE VALUE OF LAYER MANURE

By virtue of the fact that layer manure contains plant nutrients, it has a fertilizer-equivalent value based on the sum of the values of its component plant nutrients. Table 1 shows estimates of the annual manure production (dry weight) of a commercial egg-type laying hen and the manure nutrient concentration for flocks in different types of high-rise housing. Table 2 presents estimated annual manure nutrient production per hen and the cumulative annual value of these nutrients based on prices typical for these nutrients in commercial fertilizers marketed in the southeastern United States. These values do not include the additional intrinsic value of layer manure as an organic soil amendment.

If an egg producer could obtain full value for the nutrients output in the manure of a flock, the manure would be worth \$0.40 - \$0.45 per hen per year. Given the fact that the long-term average profit on sale of

eggs in the U. S. is about \$1.00 per hen, the value of the manure represents a substantial amount of money. If this value could be accessed by sale or use of manure product, egg producers would receive the benefit of an additional revenue stream. If egg prices fluctuate, as they do in the U. S., causing egg producers to operate at a financial loss in some years, a reliable cash flow based on manure product sales could greatly enhance the economic stability of an egg company.

The potential value of layer manure relative to that of eggs highlights the importance of manure management strategies which increase the likelihood that the manure can be used or sold even if no value is added to the product over and above that inherent in the plant nutrient components themselves.

MANURE DRYING DURING STORAGE

Although total plant nutrient output in the manure of equivalent flocks of hens will not differ much, the final nutrient concentration and the value per tonne can be greatly influenced by drying and natural composting of the manure during storage. A mature hen voids about 41 kg fresh feces annually containing 75-80% moisture (North and Bell, 1990). A study of layer flocks in conventional forced air high-rise houses in Pennsylvania, U.S.A. found that after long term storage, the manure accumulation per hen was reduced to an average of 12.6 kg per hen with a moisture content of 59% (Patterson and Lorenz, 1996). In comparison, studies at the University of Georgia (UGA) found annual per hen manure accumulation to be 13.6 kg with 64% moisture in a naturally ventilated high-rise house and 8.9 kg with 40% moisture in a tunnel ventilated high-rise house. Given the fact that the final dry weight manure accumulation per hen is similar in

the Pennsylvania and Georgia situations (Table 1), the differences in manure accumulation mass are probably due largely to differences in manure drying.

Table 3 gives the values (\$/tonne) of the different manures based on their plant nutrient concentrations. It is evident that the concentration of nutrients by simple mass reduction greatly increases the value of manure in a per tonne basis. The driest manure, from the tunnel ventilated high-rise house, had a fertilized equivalent value of about \$50.00 per tonne. An egg producer who is able to control the rate of air movement over stored manure could effectively increase the land base available for manure application by drying his manure. Loads of manure having higher economic value can be moved farther before transportation costs become prohibitive. Once at the land application site, a load of manure with higher nutrient concentration can be spread over a larger area as well.

IN-HOUSE COMPOSTING OF CAGE LAYER MANURE

Manure mass reduction and nutrient concentration

Composting of layer manure is not a new strategy to create a value-added product. Until now it has typically been in the form of outdoor windrow composting or in-vessel composting. Windrow composting may have added expenses associated with erosion and run-off control to minimize risk of water pollution and may incur difficulties due to bad weather. In-vessel composting has the cost of building and operating an expensive composting facility which is separate from the house where hens produce manure. Composting layer manure, nonetheless, can produce a friable, esthetically agreeable product which can be marketed through channels not available to the raw manure product, effectively increasing the land base available for layer manure

distribution. One potential drawback of composting is that it can encourage volatilization of N in the manure, leaving a product with a lower N:P ratio than might be desired from an agronomic standpoint.

The authors have carried out a project to investigate the possibility of composting cage layer manure in the manure storage areas of high-rise commercial layer houses. The rationale is that manure composting might be more feasible to egg producers if it could be done using relatively inexpensive equipment and without having to build a separate composting structure or having to remove large volumes of manure regularly from the house to a windrow site. The project was conducted in both a curtain-sided, naturally ventilated commercial high-rise layer house and a tunnel ventilated commercial high-rise layer house. In each, approximately 13 cm, 25 cm, and 38 cm of fresh pine sawdust was laid down under different sections of cage row before manure deposition. Using a prototype compost turner built for the project by Farmer Automatic, Inc., the manure compost piles were turned on a 2-week cycle. Compost temperatures, volume and mass were measured on regular schedules. Nutrient analyses were performed on compost samples. For comparison, the same set of measures was taken from uncomposted manure allowed to accumulate in the normal fashion. The trials lasted 246 days in the curtain-sided house and 280 days in the tunnel-ventilated house, ending in each case when the compost mass exceeded the capacity of the prototype turning machine. In the curtain-sided house, the 13 cm treatment was abandoned on day 125 of the trial due to overloading of the sawdust with wet manure which made it impossible for the compost turner to work through it.

Table 4 shows the estimated

annual manure/compost output per 100,000 hens and the moisture content for each compost treatment in the curtain-sided house. Composting dried the manure considerably and reduced its mass by as much as 42% compared to uncomposted manure. Compost volume was reduced accordingly so that, by the end of the experiment, the 38 cm treatment had the lowest mass and volume. For a flock of 100,000 hens, this would amount to an annual reduction of about 570 tonnes of material (approximately 30 tractor trailer loads). As suggested earlier, the total plant nutrient output in the manure, as indicated by concentration on a dry weight basis remained about the same regardless of treatment (the different initial levels of sawdust had little influence of dry weight nutrient composition by the end of the experiment). On the other hand, contrary to what might be expected, compost turning on a 2-week cycle appeared to cause little increase of N volatilization relative to that from the uncomposted manure, resulting in all treatments, including the control, having similar N concentrations on a dry weight basis. Table 5 shows that composting in the naturally ventilated house concentrated plant nutrients and increased the value of the composted layer manure on a per tonne basis.

In contrast to the curtain-house, the attempt to compost layer manure in the tunnel-ventilated house did not reduce material mass, even though some drying was evident in the compost treatments (Table 6). All of the treatments, including the control, were too dry to support substantive composting action. Similar to the results for the curtain-house, there was no indication that absolute nutrient amounts in the end product were affected by compost treatment. As would be expected by the extent of manure drying in the tunnel-ventilated house, fertilizer-equivalent values were high for all

treatments and comparable to the best from the naturally-ventilated, curtain-sided house (Table 7).

In summary, layer manure composting was most effective in a high-rise house with a ventilation system which had the least ability to provide drying air flow over accumulating manure i.e., natural ventilation. The treatment providing the greatest amount of initial carbon source (38 cm sawdust) resulted in the greatest manure mass and volume restriction, leading to a product equivalent to manure produced in a tunnel-ventilated house in terms of mass and nutrient value per tonne. The tunnel-ventilated house demonstrated great ability to dry manure, so much so that it appeared to inhibit composting action. It has been noted in personal observations that when compost treatment material from the tunnel-ventilated house is exposed to rainfall, the wetted portion takes on the consistency and appearance of wet, uncomposted layer manure. The authors believe that layer manure could be composted effectively to achieve additional mass reduction and nutrient concentration in commercial tunnel-ventilated layer houses if appropriate amounts of water were added to the sawdust/manure mixture. The authors have also found that the addition of water to manure in a high-rise layer house is a difficult concept to sell to commercial egg producers. Although no measure of differences was made, compost from the curtain house appeared genuinely unattractive to flies and had no offensive odor, whereas the manure/sawdust mixtures from the tunnel-ventilated house could attract flies and produce odors if wetted. Although the manure/sawdust treatments in the tunnel-ventilated house were very friable due to the action of the compost turner, the uncomposted manure tended to break up into chunks when removed from the house. These chunks could

support fly breeding if made wet by rainfall after the manure is spread on land.

Fly Control

Even if in-house composting were not to add an economic value to cage layer manure, itself, the process could be considered to produce value if it were to improve the sustainability or profitability of commercial egg production. Control of fly production in the layer house by in-house composting might achieve these things. High-rise layer houses are noted for fly production in the stored manure, often making these types of houses objectionable in populated areas. Commercial egg producers in some regions face increasing nuisance complaints from neighbors, forcing them to spend significant amounts of money on pesticides to control flies, and even to consider relocating their production facilities to more remote areas.

During the experiment in the naturally-ventilated house, it was noticed that fewer fly larvae appeared to emerge from the compost piles and pupate in the space beside the piles compared to the uncomposted manure. An attempt was made to quantify this difference by using specially constructed pans to intercept maggots as they came out of the piles. Eight times as many fly pupae were collected from pans adjacent to the uncomposted manure lines as from the compost lines. This difference, however, was not statistically significant due to the small size of the study and the variability of maggot emergence from different places in the piles.

A more rigorous study of fly production was done in the tunnel-ventilated house. Fly emergence traps were placed on the compost treatments and the uncomposted manure control to intercept flies emerging from the surface of the piles. Flies were counted daily for twelve days beginning the day after

the compost was turned. Even though the weather turned hot and dry at the start of the trial, causing manure surfaces in the house to dry considerably and apparently reducing overall fly breeding in the house, significantly more flies emerged from the uncomposted manure line than from compost lines during the first six days after the compost was turned. Fly eggs and pupae which are incorporated into the pile when it is turned are probably killed by the heat, reduced moisture and increased ammonia in the piles resulting from the composting action. Pitts et al. (1998) has also noted reduced fly numbers in in-house composted layer manure.

In-house composting of cage layer manure, therefore, has potential to improve the viability of commercial egg production in populated areas by reducing the negative impact of excessive flies on neighbors and by reducing costs of pesticide use in the layer house. Reduced pesticide use can also give consumers greater assurance of a safe food product.

PINE FOREST FERTILIZATION USING POULTRY MANURE: EXPANDING THE LAND BASE AVAILABLE FOR APPLICATION OF MANURE

In regions with high densities of poultry and other agricultural animals, layer manure has become a liability due to competition for traditional areas for land application, i.e., crop land and pastures. Even if an egg producer cannot recover the value of the plant nutrients in the manure, the value of a farm's cage layer manure could effectively be increased by expanding the land base available upon which to spread the manure. Non-traditional uses for the manure must be found. Regions with a substantial forestry industry would have a large land base available for application of cage layer manure if the forest could be accessed and if the manure were to stimulate growth of trees.

Research on the effects of cage

layer manure fertilization of pine trees has just begun at the University of Georgia, and as yet no field trials have been completed. The results of a greenhouse study of pine tree seedlings will be reported. To further explore the subject, the results of research on the effect of broiler litter on pine forests will be discussed as well.

Merka et al. (2000) tested the effect of in-house composted layer manure on growth of potted Loblolly pine seedlings planted in soil obtained from the Coastal Plain region of Georgia. Soils in this area, which has a large forestry industry, are sandy and tend to be acidic and low in P. Composted layer manure should stimulate seedling growth by adding necessary P. The high calcium content of the manure also should help make plant nutrients available by raising soil pH somewhat. It was found that an application rate equivalent to about 4.5 tonnes per hectare increased above ground tree mass growth by almost four times that of unfertilized trees over a six-month growing period.

Pine forests can benefit from fertilization at stand establishment and periodically during the growth of the trees to harvest size. Bush et al. (2000) demonstrated in several field trials that first and second year growth of two species of pine seedlings was significantly improved by fertilization with pelletized broiler litter at a rate of 2.25 or 4.5 tonnes per hectare (the pelletized litter had about twice the N concentration and an equivalent concentration of P as in-house composted layer manure). The growth response was better than or equal to the growth of seedlings fertilized at an industrial standard rate using diammonium phosphate. Bush et al. (2000) also cite studies reporting that growth of established stands of pine trees could be increased by poultry litter spread at rates of 4.5 to 10 tonnes per hectare per application. Moreover,

application of 4.5 to 9 tonnes of poultry litter per hectare every five years can greatly increase annual pine straw harvest (needle yield). According to rates of nutrient application for pine plantations recommended by Moorhead (1998), in-house composted layer manure applied at 4 to 15 tonnes per hectare per application would supply the need for N, and 1 tonne per hectare would supply the agronomic requirements for P.

Assuming that 2.25 tonnes per hectare of poultry litter is as good for establishing pine plantations as the industrial-standard application rate of diammonium phosphate, Bush et al. (2000) calculated, using prices in the southeastern United States, that the cost of transporting and spreading 2.25 tonnes of poultry litter per hectare within a 40 km radius was comparable to the aerial application cost per hectare to spread diammonium phosphate. A circle having a radius of 40 km encloses an area of about 502,700 hectares. If a flock of 100,000 hens were to produce 850 tonnes of in-house compost (tunnel-house manure) per year, about 380 hectares of forest land per year would be needed to receive the annual manure output of the flock at a rate of 2.25 tonne/ha. Such an area comprises less than 1/10th of a percent of the total area within a circle having a 40 km radius. This calculation is for illustrative purposes only, serving to indicate the amount of area needed for manure application in relation to the total area within reasonable manure transportation distance of a farm. The farm itself must be in an area with suitable land unutilized for manure application.

Current forests often do not lend themselves to poultry litter/compost application. Rough terrain and tree spacing can prevent equipment access, and tree height may limit swath width during litter broadcast. Nevertheless, as forestry practices become more intensive and sophisticated, it may be feasible to

establish stands so as to be amenable to fertilization with poultry manure products.

SUMMARY

Although at present there are relatively few options readily available for egg producers to improve cage layer manure so as to increase its value, a review of research and development efforts gives reason for encouragement. Just from a plant nutrient standpoint, layer manure has substantial value, and simply by adopting housing systems which promote drying of the manure, the plant nutrient value can be concentrated into a smaller mass, increasing value per tonne. Layer manure can be composted to improve handling and odor characteristics, making a product with expanded marketability. Layer manure may be blended with other products to target specific purposes. The management of manure within high-rise houses, e.g., by in-house composting, has potential to improve the viability of egg production in populated areas by reducing fly population. Reduced expenditure on pesticides and elimination of the cost of building and operating a separate composting facility would help counterbalance labor and capital costs of an in-house composting system. Layer manure may become less a liability and more of an asset if non-traditional uses can be found for it, such as using it to fertilize forested areas. Such non-traditional uses increase the effective area of land application, reducing risk of water pollution due to over application of plant nutrients in limited areas.

REFERENCES

• Bush, P. B., W. C. Merka, and L. A. Morris, 2000. Application of pelletized poultry manure at time of planting. Proceedings of the Mississippi Water Resources Conference, April 18, 2000. Eagle Ridge Conference Center, Raymond, MS.

- Merka, W. C., P. B. Bush, S. A. Thompson, L. A. Morris, and A. B. Webster, 2000. Utilization of in-house composted layer manure as a nutrient source for pine seedlings. Proceedings of the Mississippi Water Resources Conference, April 18, 2000. Eagle Ridge Conference Center, Raymond, MS.
- Moorhead, D., 1998. Fertilizing pine plantations: A county agent's guide for making fertilization recommendations. Athens, Georgia: University of Georgia Daniel B. Warnell School of Forest Resources.
- North, M. O., and D. D. Bell, 1990. Pages 879-885 in: Commercial Chicken Production Manual. 4th ed. Chapman & Hall, New York, NY.
- Patterson, P. H., and E. S. Lorenz, 2000. Manure nutrient production from commercial White Leghorns. J. Appl. Poultry Res. 5:260-268.

[Speaker: William C. Merka, Department of Poultry Science, University of Georgia, Athens, GA. Information was taken from a paper by: A. Bruce Webster, William C. Merka, Department of Poultry Science, University of Georgia, and Sidney A. Thompson, Department of Biological & Agricultural Engineering, University of Georgia, which was published in the Proceedings of VII Seminario Internacional Produccion y Pathologia Aviar, May 24-26, 2000, Universidad Austral de Chile, Valdivia, Chile. Pages 175-183.]

Table 1. Estimated annual production per egg-type laying hen and plant nutrient concentration of cage layer manure produced in high-rise houses (dry matter basis).

House Type	kg/hen	Total N	P ₂ O ₅	K ₂ O	Ca
Curtain ¹	4.9	2.1	8.6	5.4	15.7
Tunnel ¹	5.3	3.4	7.9	4.8	16.0
Conventional ²	5.2	4.8	6.8	3.9	15.6

¹University of Georgia study.

²Patterson and Lorenz, 1996.

Table 2. Annual manure nutrient production per hen.

House Type	Total N	P ₂ O ₅	K ₂ O	Ca	Value ³
Curtain ¹	0.10	0.43	0.27	0.53	0.40
Tunnel ¹	0.18	0.42	0.26	0.85	0.45
Conventional ²	0.25	0.35	0.20	0.81	0.44

¹University of Georgia study.

²Patterson and Lorenz, 1996.

³Assumes the following values: N=\$0.66/kg; P₂O₅=\$0.55/kg; K₂O=\$0.26/kg; Ca=\$0.03/kg.

Table 3. Cage layer manure nutrient composition and value per tonne calculated on an “as is” basis.

House Type	Total N	P ₂ O ₅	K ₂ O	Ca	H ₂ O	Value ⁴
						\$/tonne
Curtain ¹	0.8	3.1	2.0	5.7	64	29.56
Tunnel ¹	2.0	4.7	2.9	9.6	40	49.99
Conventional ²	1.8	2.7	1.6	6.4	59	33.14
Fresh, Unstored ³	1.3	1.1	0.6	2.0	75-80	16.91

¹University of Georgia study.

²Patterson and Lorenz, 1996.

³North and Bell, 1990.

⁴Assumes the following values: N=\$0.66/kg; P₂O₅=\$0.55/kg; K₂O=\$0.26/kg; Ca=\$0.03/kg.

Table 4. Estimated annual in-house layer manure compost production and dry basis nutrient composition in a curtain-sided, naturally ventilated, commercial high-rise layer house.

Treatment	Annual Prod.	% H ₂ O	Total N	P ₂ O ₅	K ₂ O	Ca
	__tonnes/100,000 hens__		__% dry basis__			
Control	1359	64	2.1	8.6	5.4	15.7
13 cm Sawdust ¹	1160	56	1.9	7.2	2.2	16.9
25 cm Sawdust	868	40	2.0	8.5	6.9	18.5
38 cm Sawdust	787	44	1.9	8.9	4.8	16.9

¹Refers to the initial depth of sawdust laid down under cage rows before deposition of manure.

Table 5. Nutrient composition and value of in-house manure compost from a curtain-sided, naturally ventilated, commercial high-rise layer house, calculated on an “as is” basis.

Treatment	Total N	P ₂ O ₅	K ₂ O	Ca	Value ²
	__kg/tonne__				__\$/tonne__
Control	7.6	31.3	19.5	56.9	29.30
13 cm Sawdust ¹	8.5	31.6	9.8	74.1	28.08
25 cm Sawdust	11.7	50.8	41.2	110.9	50.31
38 cm Sawdust	10.5	49.7	26.9	94.1	44.58

¹Refers to the initial depth of sawdust laid down under cage rows before deposition of manure.

²Assumes the following values: N=\$0.66/kg; P₂O₅=\$0.55/kg; K₂O=\$0.26/kg; Ca=\$0.03/kg.

Table 6. Estimated annual in-house layer manure compost production and dry basis nutrient composition in a tunnel-ventilated, commercial high-rise layer house.

Treatment	Annual Prod.	% H ₂ O	Total N	P ₂ O ₅	K ₂ O	Ca
	tonnes/ 100,000 hens	% dry basis				
Control	873	35	2.7	7.6	3.9	20.3
13 cm Sawdust ¹	909	30	2.9	5.4	3.2	16.8
25 cm Sawdust	900	32	3.1	6.6	3.9	19.2
38 cm Sawdust	881	23	2.4	6.7	3.6	18.2

¹Refers to the initial depth of sawdust laid down under cage rows before deposition of manure.

Table 7. Nutrient composition and value of in-house manure compost from a tunnel-ventilated, commercial high-rise layer house, calculated on an “as is” basis.

Treatment	Total N	P ₂ O ₅	K ₂ O	Ca	Value ²
	kg/tonne				\$/tonne
Control	17.5	49.3	25.1	131.8	49.76
13 cm Sawdust ¹	19.9	37.3	22.2	116.9	43.46
25 cm Sawdust	21.3	44.9	26.9	131.0	50.29
38 cm Sawdust	18.5	51.4	27.7	140.3	52.54

¹Refers to the initial depth of sawdust laid down under cage rows before deposition of manure.

²Assumes the following values: N=\$0.66/kg; P₂O₅=\$0.55/kg; K₂O=\$0.26/kg; Ca=\$0.03/kg.

NEW YORK STATE DISEASE REPORT 1999 - 2000

Few infectious and nutritional diseases were diagnosed in New York State (NYS) from July 1999 to June 2000. Of the infectious diseases, avian influenza (AI) and most cases of infectious bronchitis (IB) caused mild or no clinical disease, and were diagnosed serologically or by sentinel birds. On the other hand, one outbreak of IB, the cases of infectious laryngotracheitis (ILT), coccidiosis, necrotic enteritis, caged layer fatigue and rickets caused clinical disease and significant mortality.

AVIAN INFLUENZA VIRUS (AIV) INFECTION

Of the 15 different distinct hemagglutinin groups: H1 to H15, the Poultry Diagnostic Laboratory H3, H4, H5, and H6, were isolated from ducks. AIV H7 and H9 were isolated from chickens, while AIV H5 was only serologically detected in chickens. All of the AIVs isolated in NYS from chickens were typed by the National Veterinary Services Laboratories as of low pathogenicity.

We should not be complacent with this results, because the viruses are of low pathogenicity. Even low pathogenicity AIV may cause losses in a commercial poultry operation, and particularly H5 and H7 have the potential to mutate from low to high pathogenicity. A highly pathogenic H5 or H7 may cause complete cessation of egg production, and mortality in excess of 90%.

From the human health stand point, there are concerns because recent evidence that some AIVs may infect and cause disease in humans. In 1997 an H5N1 AIV caused 8 deaths

in humans in Hong Kong. More recently, another AIV (H9N2) infected humans. To this day we have been lucky that no AIV has affected humans in the United States, but the emergence of any one of these strains would be catastrophic for the poultry industry. The poultry industry should remain vigilant of biosecurity measures, specially when waterfowl is present in close proximity to chicken houses.

Keep in mind that AIV infections may be the cause of anything from a mild drop in production to heavy mortality in chickens. An infection with a highly pathogenic AIV, or an AIV capable to infect humans will be a total disaster.

Remember that AIV vaccines are not approved for use in chickens.

I N F E C T I O U S LARYNGOTRACHEITIS (ILT)

ILT affected at least ten vaccinated flocks in six multiple-age farms. Of these flocks, eight were laying flocks, and two were pullets. In most instances pullets have been recently moved to the farm. Telephone interviews with producers revealed several interesting points:

Unvaccinated flocks were not affected.

At least three vaccine brands were used in farms with ILT outbreaks.

In two instances there was concomitant infection with fowl pox.

The outbreaks were not traced back to transportation and vaccination crews as has been the case in the past.

The birds have been vaccinated by spray or in the drinking water.

In view of this observation, and a paper by Fulton et al. that stresses the importance of proper administration of high titer ILT vaccines, attention should be paid to the quality of the vaccine and vaccination method. Fulton's paper underlines recommendation made over the years, regarding vaccination against ILT:

Eye drop protects better than water or spray application

Two vaccinations offer better protection than one

Protection is not as good at the end of the water line

Virus titer varies among manufacturers, from a low 3.1 to 5.1 (\log_{10}).

INFECTIOUS BRONCHITIS (IB)

In the only case of obvious IB, drop in production and poor egg shell and interior quality of the egg were observed. In several other flocks, where IBV was isolated using specific-pathogen-free chickens, the effects of IB were very mild to not noticeable. The IBVs have been typed using molecular techniques by Dr. Mondal at Dr. Naqi's laboratory. One isolate proved to be Arkansas 99 type, while others are variants found only in NYS. The NYS IBVs differ from each other, but share some genetic characteristics with Connecticut and 072. Surprisingly, respiratory distress was not reported in the affected flocks.

Studies are in progress to learn what is the best alternative for their control. In addition to biosecurity, it is important to remember that the introduction of new vaccine strains may cause more damage than good.

COCCIDIOSIS IN CAGED CHICKENS

While coccidiosis is rare in caged chickens, we observed it during 1999 and 2000. In one case the feeders are inside the cage in the pullet-growing house. In another case it was a layer house with manure belts. In both cases cage design permitted contamination of feed with feces. In the case of chickens raised in cages, that have had no contact with feces, and therefore are completely susceptible to coccidiosis, it is of utmost importance to prevent contact with feces. Birds that fall in the pit should be returned to the lowest cages. As soon as coccidiosis is diagnosed start treating with anti-coccidial drugs.

NECROTIC ENTERITIS

Necrotic enteritis (NE) is a disease caused by Clostridia, and it has been a nagging problem for broiler producers. In pullets and egg layers is often associated with coccidial infections by *Eimeria brunetti*. Most time is easily controlled with bacitracin and anti-coccidial drugs. Although NE is prevented mostly avoiding fecal contamination of the feed, other factors may play a role. Some of these factors are related to the feed: high levels of Clostridia, use of wheat, anaerobic conditions, but immunodepression and intestinal conditions play an important role also.

RICKETS

Clinical cases of rickets (vitamin D₃, calcium or phosphorus deficiency) were observed in several flocks of pheasants, and broiler chickens. The condition was corrected by addition of oyster shell to the feed, and water-miscible vitamin D₃.

CAGED LAYER FATIGUE

Caged layer fatigue lesions are often observed in daily mortality, but on occasion it is the cause of increased mortality in high producing laying flocks.

*[Speaker: Benjamin Lucio,
Department of Microbiology &
Immunology, College of Veterinary
Medicine, Cornell University.]*



Cornell
Cooperative
Extension

"The information given herein is supplied with the understanding that no discrimination is intended and no endorsement by Cooperative Extension is implied."