Poultry Housing Information Series

Planning for Commercial Layer Expansion or Renovation

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An egg producer considering the possibility of adding capacity or renovating existing buildings is faced with a complex problem. The producer must evaluate the suitability of various available types of equipment and house arrangements, and must determine the long-term feasibility and profitability of expansion or renovation. The initial investment costs are likely to be high, and the owner has to be concerned about his long-term ability to survive in the competitive egg business. The need for proper planning cannot be overstated. This publication outlines the most important factors that should be carefully considered *before* construction is begun or equipment is purchased. Topics covered include key planning factors, production technologies (high-rise and battery housing, including ventilation considerations), and manure management. The primary focus of this publication is on production houses; however, most information presented here should be applicable to both egg production and pullet houses.

Key Planning Factors

The most important items that any grower considering renovation or expansion should place on his planning checklist for careful consideration are:

1. *House and farm size appropriate for economic and technological constraints.*
2. *Bird stocking density, including equipment and management considerations.*
3. *Structural and operating cost considerations.*
4. *Land area needed for all operations.*
5. *Farmstead planning and siting factors.*
6. *Environmental considerations, primarily in relation to waste handling and disposal.*
7. *Labor requirements and projected availability and quality of farm labor.*
8. *Fly control measures needed.*
9. *Machinery and equipment selection, especially in regard to long-term costs and returns.*

Large houses such as these, set up for total environmental control in a hot climate, can be profitable where technology is available and market conditions are right. Under other conditions, smaller and simpler houses would be a better choice.

KEY PLANNING FACTORS

Choosing House and Farm Size

The answer to how big a house or farm should be depends both on available technologies (constantly evolving) and on economic constraints, including market demand and availability of needed inputs (also constantly changing). For example, one key factor that should dictate the size of a house (or farm) should be the availability of enough uniform replacement pullets to allow the success of management programs. If we engineer an enormous house that will satisfy the needs of the flock but do not have a sufficient high quality source of replacement pullets to fill it, our house is too big to match our other restrictions. Wide spreads in ages or sources of replacement stock can complicate management and should be considered carefully.

In the U.S. typical two-cycle production programs can be supported by one rearing unit for each five laying units. In countries that use the one-cycle production system, one rearing unit is needed for each three laying units. These relationships are contingent upon the age when pullets are moved and vacant time required between flocks. They are also contingent upon the producer's ability to quickly dispose of his spent hen flock and ready his facilities for the next flock.

Optimum house size also depends on available technology. Large houses, sufficient to house 80,000 or more hens, are commonly 14 by 150 meters (46 by 492 feet) in size. Large houses place severe constraints on many of our equipment systems – in particular, certain types of feeders and ventilation systems. Choice of waterers, and quality of available water, can also have a profound influence on bird performance. It is important to deliver uniform conditions to the entire flock if we are to have a successful management program. Failure to do this will lead to sub-optimum performance and higher costs.

In the U.S. we see very large houses being built with capacities in excess of 100,000 and in some cases even in excess of 250,000 hens. Individual sites (farms) may have one to two million hens or more. The economic advantages for operations this large may not be found in all countries, or even in all parts of the U.S. Smart egg producers know that bigger is not always better. The key to profitability is not size but efficient production to meet market demand.

Bird Stocking Density

Related to the issue of house size is the question of bird density. High-density facilities maximize production per house and may provide economic advantages, but only if the appropriate production technologies are used, the stricter management demands can be met, and the increased amounts of manure produced can be handled. Low-density houses are more forgiving and less demanding in terms of equipment and management, especially with regard to ventilation.

Many factors must be considered in deciding bird density, including effects of climate, whether construction is new or renovation, reliability of power and possible need for backup power generation, available labor and management, and costs and returns calculations.

Table 1 gives a convenient way to determine cage and bird configurations to achieve desired bird density. You can look up the bird space that will result from choosing a particular cage size and stocking a given number of birds per cage. If you know the bird space desired, the table shows the different cage sizes and stocking rates that can be used. For example, if you desire high bird density, such as in a controlled-environment battery-type house, with bird space in the 300-square centimeter range, the table shows options ranging from 5 birds in a 30.5 x 50.8 cm cage to 10 birds in a 61 x 50.8 cm cage.

The type of bird and its ability to handle cage crowding stress will determine both bird space requirements and the number of birds to be placed per cage. Larger cages and higher numbers of birds per cage are generally more efficient, but only to the point that social stress begins to reduce performance. Higher bird densities require higher levels of management control, especially with regard to ventilation.

Structural and Operating Cost Considerations

The cost of the structure that houses the flock will depend on the type of housing chosen. In general, the cost of the structure to handle a given flock size will be higher for a high-rise type of house than for a battery-style house. However, equipment costs for the high-rise house generally will be less than equipment costs for the same flock size in a battery house.

Another factor to be considered is operating costs, including electricity, maintenance and labor. Because battery-type houses generally require total environmental control, operating costs are usually higher in this type house than for a high-rise house.

Land Needs

The physical land requirements for a complex will vary with the cage configuration and the amount of buffer land (setback) planned to separate the poultry operation from neighboring properties. In general, we would prefer to see at least a 100 meter (328 ft) buffer zone between any poultry buildings and the property line surrounding the farm – the more the better. If the poultry operation can be kept out of sight, this would be preferred.

Assuming four tier houses and a one million hen complex, the space requirement for buildings, suitable separation of buildings and ancillary structures, and a 100 meter (328 ft) buffer zone would total about 20 hectares (50 acres). A complex based on greater flock separation would obviously require greater space allocations. Two one-hectare parcels (about two and a half acres each) would be required for the two pullet rearing facilities.

It must also be kept in mind that considerable land area may be required for disposal of manure. A 100,000-hen facility may require over 400 hectares (1,000 acres), depending on conditions.

Farmstead Planning and Siting

When considering new or expanded layer houses, farmstead arrangements should be taken seriously. Careful planning includes reviewing the present, assessing the near future and providing for the more distant future. It means looking at the whole business as objectively and as far into the future as possible. Generally, farmstead planning includes mapping where things are or will be, and evaluating how useful they will be now and into the future. As you do a farmstead plan you should look closely at all the farm's activities and try not to lose perspective. If you put a building in the wrong place today it is a 25-year mistake. There are four essential factors that should be considered in the farmstead planning factor process:

1. Adequate supply of water. It is very important that the water supply for any new or expanded operation be considered.
2. Drainage. Both surface and subsurface drainage is a top priority. Drainage influences the cost of building roads and drives to buildings. Periodic flooding around buildings is intolerable.
3. Production volume. Doubling the number of birds in a poultry operation does more than just double the space for the production facility itself. Feed storage doubles, machinery doubles, vehicular traffic increases and services such as water supply and electrical must be upgraded.

Table 1. Bird Space for Different Size Layer Cages and Numbers of Birds

	Birds per cage								
Cage size	3	4	5	6	7	8	9	10	Bird space
30.5 x 50.8 cm	516	387	310						square cm/bird
12" x 20"	80	60	48						square inches/bird
38.1 x 50.8 cm	645	484	387	323					square cm/bird
15" x 20"	100	75	60	50					square inches/bird
40.6 x 50.8 cm	687	516	412	344	295				square cm/bird
16" x 20"	107	80	64	53	46				square inches/bird
50.8 x 50.8 cm		645	516	430	369	323			square cm/bird
20" x 20"		100	80	67	57	50			square inches/bird
61.0 x 50.8 cm			620	516	443	387	344	310	square cm/bird
24" x 20"			96	80	69	60	53	48	square inches/bird

In an expansion, often supporting facilities become overtaxed.

4. Off farm factors. Farmstead development should consider many off site factors, including proximity of neighbors or urban areas and the possibility of nuisance complaints regarding odor, dust, or noise; local, state and other governmental building and zoning codes; and air and water pollution control standards. A legal restraint can stop your construction and prevent recovering investments. These items should be addressed before construction begins, not after.

Environmental Pressure

Environmental pressure on egg producers will vary depending on local conditions, but rest assured that as we move into the 21st century environmental concerns will be a major factor in the egg industry. The primary environmental issue for eggs producers is what to do with the many tons of waste produced each year.

Solutions to this problem will also vary with local situations. The solution in some locations will still be very basic and manure will continue to be spread on the land. In other locations, where land is limited and population density is higher, much more sophisticated handling and disposal techniques must be used. The cost of a production facility with automated manure handling capabilities will be higher per bird than for a similar facility with conventional manure handling. However, not only initial costs of disposal must be considered, but long-term costs and consequences of delays or failures in the disposal process.

It is imperative that plans for new construction or renovation of layer houses include economically practical and environmentally sound methods of handling, storage and use or disposal of the manure to be produced. How manure is handled is determined largely by the type of house and cage arrangement used. High-rise houses, where manure is dropped into a pit, generally require only infrequent manure handling and disposal, perhaps only once or twice during the life of the flock. About 70% of the layer houses in the U.S. are of this type.

Battery-type houses, where manure is collected on a conveyer belt beneath the cages, require much more frequent manure handling, but in smaller amounts. Many battery house managers feel it is best to move belts at least part way through the house on a daily basis. Battery-type houses make up about 20% of U.S. layer facilities.

A small fraction of U.S. operations, perhaps 10%, use either pit scraping or liquid handling. Both these approaches involve daily handling of fresh, wet manure, and neither is being considered for new construction in the U.S. Liquid manure handling for poultry operations is being ruled out in the U.S. primarily because of environmental constraints. These include requirement of permits for construction of manure holding ponds and lagoons, and permits that involve any agricultural operation that has the possibility of discharge of any liquid effluent into the environment. Neither pit scraping nor liquid manure handling is further considered in this publication.

Marketing schemes, for bulk as-is and especially for processed or composted manure, may be at least part of the answer in some situations. However, these should be looked at with great care. These types of enterprise place the egg producer into another business operation that requires additional management, cash and marketing expertise. The value of manure should not be overlooked as a fertilizer or feed, but the company in most cases should choose not to get into an additional enterprise unless this is absolutely necessary for the survival of the egg operation.

Fly Control Considerations

Fly control in layer operations can be a major concern. This is true especially where development of residential districts within prime agricultural areas is occurring. Flies dispersing from poultry operations in such areas can become a significant public nuisance and health problem, leading to conflict with neighbors and even lawsuits.

Sanitation, moisture control, and manure management are critical to successful fly control programs because these measures can break the fly reproduction cycle. The producer may use appropriate insecticides when necessary, but chemical control works best in conjunction with good sanitation practices. Prevention of heavy fly buildup is easier and less expensive than controlling large fly populations after buildup has occurred.

Most fly control problems in commercial layer operations can be traced to excess moisture, creating breeding sites around the house or in the manure. Manure management and fly populations go hand in hand. Moisture levels of 75 to 80 percent are best for fly egg-laying, larval development, and survival; and fresh poultry manure is about 75 percent moisture. Female flies usually will not lay eggs in manure with less than 70 percent moisture, and larvae develop poorly in manure that is less than 65 percent moisture.

Fly control is generally easier in battery-type housing than in high-rise housing, because the manure dries more rapidly on a conveyer belt than in a pit. However, a modern high-rise house can also perform very well with respect to fly control if proper ventilation is provided.

Labor Requirements

The number of workers necessary to operate a laying production facility has continued to decrease worldwide, but labor availability remains an issue to be considered. The problem of obtaining a reliable and adequate work force is much more severe in highly developed countries, so the ultimate weighing of the labor factor in the final decision to expand or renovate will be different in different parts of the world. If the past is a good predictor of the future, in countries which continue their development and strive to improve the quality of life for their citizens, it will become harder to find the unskilled labor still available in some parts of the world. The present and future labor situation must be considered carefully. Automated production technologies provide at least a partial solution to labor shortages or lack of adequate workforce quality.

Useful Life of Technology

In interviews with egg producers worldwide, a common theme most often voiced is to investigate thoroughly before investing in equipment. In other words, spend money looking at technology before you buy or expand. Take some time and look at installations in many locations. Look at lots of systems, talk to lots of owners, production managers, farm labor and maintenance men. Find out what is working today. Then go back and revisit the systems that seem likely to have possibilities for your operation.

Value for investment is important and the value of long life of cages, building, fans and processing equipment cannot be over emphasized. Unfortunately, most of the real problem situations with bad designs result from new facilities where bad buying decisions were made.

It should also be realized, however, that the best equipment may become technologically out of date in less than the expected life of the machine. In cases of handling equipment, ventilation equipment, or even cages the solution to this problem may be an update or modification of existing equipment. A minor modification of high-quality equipment can extend its technological life by up to 15 years, but if the life of structural members of cages, conveyors, or ventilation and feeding equipment is not adequate, then removal of equipment and replacing with new may be necessary. And if equipment is worn out because it was of inferior quality to start with, then it must be removed and replaced.

Choosing equipment that is up-to-date technologically and has long life allows the egg producer the luxury of spreading his investment over the maximum number of years possible. As in any phase of farming, this is the key to keeping long-run cost down and maximizing returns.

HIGH-RISE/BATTERY HOUSING ALTERNATIVES

There is debate among egg managers as to which housing method, high-rise or battery, is best. The question is perhaps better put as "which method is best for a given manager under certain given circumstances." The differences between the two methods have largely to do with bird density (and the management requirements thereof) and manure handling. High-rise housing is better suited to lower density stocking, with somewhat more moderate management and equipment requirements, and to managers or situations favoring manure handling and disposal infrequently (a cycle as long as the life of the flock) but in very large amounts. Battery housing is better suited to high-density stocking, with a higher level of management, technology and production, and to managers or situations favoring frequent (as often as daily) handling and/or disposal of manure.

High-Rise House Basics

High-Rise housing is the arrangement of cages for laying hens in such a way that manure is dropped through an open space between and beneath the cages, with room for storage and handling of manure underneath the house. The high-rise house therefore requires infrequent manure handling, with relatively simple equipment. Ventilation demands are also somewhat simpler than for a battery house. Bird density in high-rise housing, however, is lower than in battery housing. That is, for houses of the same size, fewer birds can be accommodated in a high-rise house.

In general, for cost minimization high-rise housing should be as long as possible so that the feeders, waterers, bins, fill systems, and central egg collection equipment are spread out over as many hens as possible. Long houses optimize equipment-to-bird ratios, where shorter houses tend to be less economical.

A high-rise house may have three to six rows of cages, up to five tiers high. The number of tiers and the number of rows used depend on producer preference and existing conditions. As the number of rows and tiers get higher the arrangements for manure dropping and handling change.

A common method of cage configuration is called the full stair step arrangement (Figure 1). This is seen in many older layouts. The practical number of tiers in such an arrangement is three.

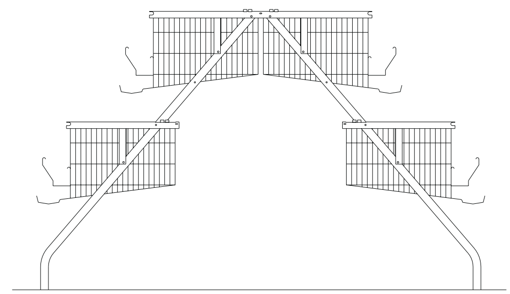

Figure 1. A simple two-level full stair step cage system.

Another type of high-rise cage arrangement is the A-frame manure curtain cage setup, where a plastic curtain is placed behind the cage to keep manure droppings from contacting birds in cages below. This technology decreases the width necessary for the cage row, since part of each tier of cages can be directly below the tier above. In this production arrangement houses generally have from three to five tiers of cages (Figure 2).

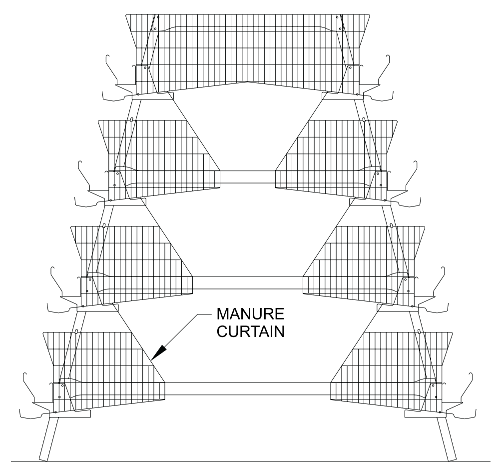

Figure 2. High-rise A-frame with manure curtains.

An arrangement that minimizes open space between cages and permits the highest possible density for a high-rise type house is an A-frame with dropping boards (Figure 3). In this type of arrangement the cages can be located almost on top of each other. Manure is removed from the dropping boards under the cages by mechanical

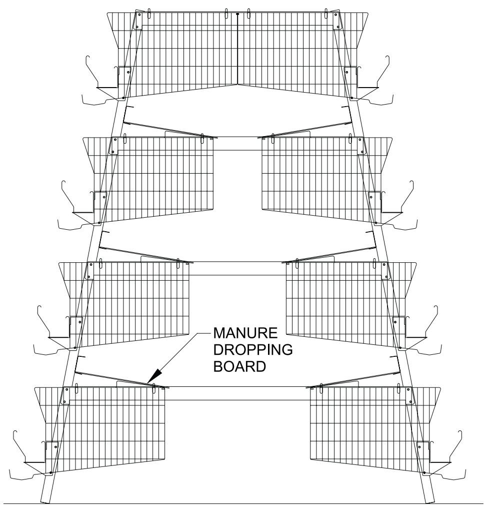

Figure 3. A-frame cage arrangement with dropping boards.

scraper and discharged through the open area between the cages into the pit underneath the house.

Manure Handling for High-Rise Housing

A particular philosophy of how to handle manure has shaped the high-rise housing concept. Many poultrymen prefer not to handle manure daily or every few days but rather prefer to deal with the manure from their hens in a given house once per year during molt or when flocks are changed out. With the high-rise concept, manure is handled once per year or on an infrequent basis and in a very intense manner. Then the task of manure handling must be faced all at one time. The owner must totally focus and concentrate on unloading the manure pit and moving this material to the land or alternate storage in a very short period of time.

For this infrequent manure handling concept to work, it is important in daily production management to make sure manure is not being wetted by leaking water systems and that air movement in the manure pit is adequate, so that the stored manure is dried and kept in a suitable condition for removal and spreading.

If pit manure does not have adequate air flow for drying, serious fly problems may develop, since moist manure is an ideal fly breeding site. In an open-sided house, the manure pit should be protected by curtains from being wet by blowing rains.

A common manure disposal method for high-rise operations, involving little or no cost to the producer, is to barter the manure to someone who will clean the house and haul the manure off site for the value of the manure.

Ventilation for High-Rise Housing

High-rise housing can be used successfully in many different climatic conditions, with bird density and type and configuration of cages adjusted to suit prevailing weather. A major key to success with high-rise housing lies in the ventilation system, preferably installed at the time of house construction. Producers should be aware that performance factors that affect profitability, such as feed conversion, egg uniformity and quality, and egg production, are related to temperature and air quality, and thus to ventilation. The need for a good ventilation system appropriate for the climate cannot be overstated.

Different ventilation systems or arrangements may be needed for cold and hot weather ventilating needs. Following is a list of different methods of ventilating high-rise operations, ranging from mild to very hot weather conditions.

1. Natural/open sided without curtains.
2. Natural/open sided with or without curtains and stirring fans for air movement in hot weather.
3. Tunnel ventilation either with solid or curtain sidewalls.
4. Tunnel ventilation with solid or curtain sidewalls and evaporative cooling.

In regions where blowing dust or rain may be a factor, open sided houses may need curtains for protection of the birds or to insure manure is not wetted.

Keeping birds warm is very important, although with today's modern insulated houses this may not be as big a problem as keeping birds cool in summer. Even when heating is needed, however, a certain minimum ventilation rate must be maintained to bring in fresh air and exhaust moisture from the house. Houses can use positive or negative pressure ventilation for cold weather.

As climate changes from mild to cold, the method by which incoming cold air is brought into the house in the winter time changes. The colder the outside air, the more important it is to adjust the ventilation rate and incoming air flow so as to blend outside air with the warm inside air, avoiding large swings in temperature and cold drafts blowing on the hens. Many different types of inlets are used to bring cold air into the house. These range from individual perimeter vents, continuous perimeter vents, vent doors around the perimeter, to variable slot openings over top of the rows.

It should be realized that even in cold weather we often are dealing with situations when we need not to provide supplemental heat but to get rid of built-up bird heat in the house, so that ventilation is needed for cooling. Again, the key is a smooth balancing of incoming and in-house air to achieve a uniform optimum temperature inside the house.

Stale air can be exhausted through the pit, through the end walls or through the roof, depending on the type of ventilation system that is chosen. Because there is such a large volume of air in the pit of most high-rise houses, some precaution may need to be taken not to spend large amounts of fan power ventilating the pit at the expense of the birds. In many cases where tunnel ventilation is necessary in closed high-rise housing, arrangements for baffles or deflector curtains are made to prevent incoming cool air falling into the pit instead of cooling hens.

Conditions in the pit affect manure drying potential, on the other hand, and care must be taken to provide some ventilation to the pit area. Warm and dry air promotes rapid drying of manure while cold and damp air does little to dry manure. This must be considered when choosing what type of ventilation system is best for the high-rise house in a given climate.

Battery Housing Basics

Battery style housing is hen housing in which cages of birds are located directly above cages of other birds. Battery layer housing can place many more birds into the structure than the typical high-rise. The density of battery layer housing is determined by the number of rows in the house and the maximum number of tiers. As many as ten rows can be installed in battery housing. However, traditionally the most common battery houses have between six to nine rows of cages. The number of tiers of cages ranges between three and eight. Increased density and reduction in construction cost for a given unit is obtained by going higher in tiers.

Manure is handled in the battery concept by a belt conveyor that separates layers of cages from each other (Figure 4). The belt must be operated at frequent intervals to remove the fecal material from the poultry house. A primary advantage of this system is that under proper operation the manure dries much more rapidly than in a pit house, reducing fly control problems and facilitating manure handling and disposal.

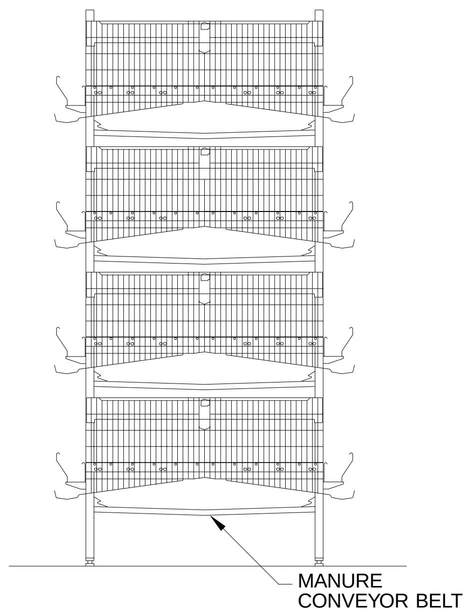

Figure 4. Battery-type cage arrangement with manure belts.

Because of increased density and the need to consider manure drying, it is imperative that the battery house be operated as a totally controlled house. Properly designed and managed ventilation systems are extremely critical to the successful operation of this house.

Ventilation for Battery Housing

Numbers of birds in a small confined space can be greatly increased using the battery concept. However, this places strict management considerations on how the birds must be ventilated to keep them comfortable and producing at maximum capacity. Most battery layer houses are set up to operate under negative pressure with evaporative cooling. Houses can be curtain or solid sidewall and often in hot climates these are set up to operate in fully tunnel ventilation mode with curtain sidewalls as a fail safe against power failure.

To gain the full benefits of the maximum bird density offered by the battery-type house, a totally-controlled in-house environment is advisable. If for any reason a situation does not lend itself to total house environment control, the high-rise arrangement may be a better choice for housing than the battery arrangement.

Some battery houses have air vents built into the cage system as a means for drying (Figure 5). Cage air systems deliver about 1/2 cfm per bird from ducts in the cages. This air is directed at the surface of the manure belt. In very wet climates, some growers provide supplemental heat to the manure belt ventilation air to speed up the manure drying process.

Manure Handling for Battery Housing

Manure handling for battery layer housing is a frequent chore. The basic idea is to get the manure to dry to a semi-solid state and then get it off the belts and out of the house, not letting it pile up on the belts. Generally, manure belts must be run at least every few days, and many growers move manure on a daily basis, or move the belts half the house length every day or so. Proper ventilation in a battery house speeds up drying, and therefore can decrease frequency of belt operation.

Manure coming off the belts must be hauled to a storage barn, applied to cropland immediately, or hauled off site. In rainy climates, it may be very inconvenient or difficult to land-apply manure on such a frequent basis. In such situations, it is imperative to have adequate manure storage facilities or reliable off-site disposal options.

Unloading belts and dealing with manure for a few hours daily or every few days instead of once per year, eliminating the need for massive cleanouts at the end of production or during molting, is preferred by many egg men. This keeps the manure problem minimized in terms of amounts to be handled at one time. On the other hand, storage facilities must be provided unless there is a dependable on- or off-farm disposal or marketing avenue available on a continuing, regular basis.

Manure handling aspects of the battery housing concept may affect the length of the battery-type house. The reason for this is that manure conveyors have only been designed to handle manure in the 500-foot range (150 meters). A house longer than this would require two manure handling systems rather than a single through-house system.

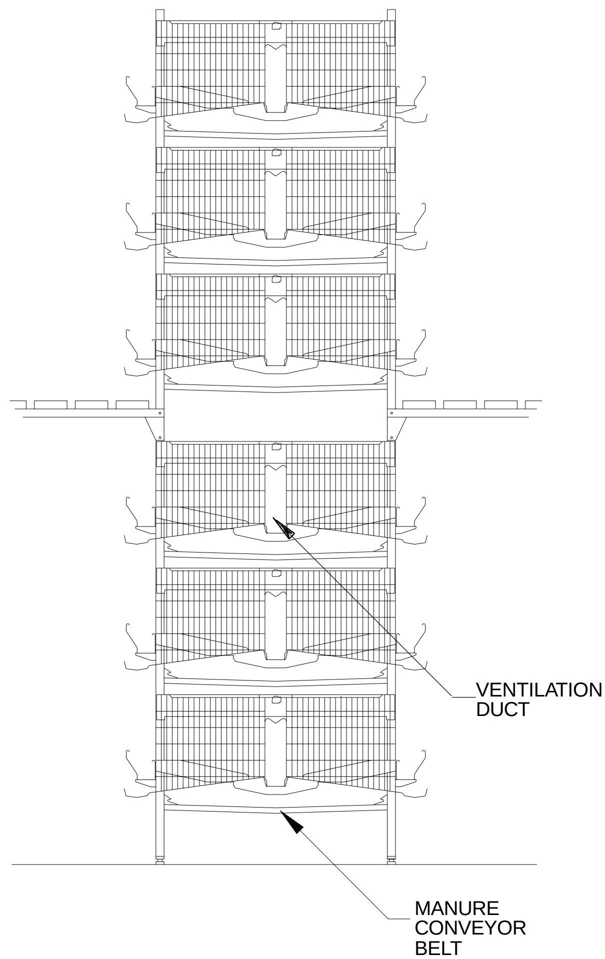

Figure 5. Battery cage arrangement with ventilation ducts.

PLANNING FOR MANURE DISPOSAL AND UTILIZATION

A major by-product of the layer business is the mountain of manure produced each day. Ultimately manure must be utilized for fertilizer on the farm or it must be marketed to producers of crops and pastures. Improper manure management can have serious environmental and economic consequences. On the other hand, poultry manure that has been properly managed has economic value and may be an additional source of cost recovery to the egg operation.

Amounts of Manure Produced

Just 10,000 caged layers will produce about a metric ton (2200 pounds) of manure a day, with a volume of about 50 cubic feet. A house with 100,000 layers will produce over 3600 metric tons (4,000 U.S. tons) of fresh manure a year, which even when dried totals some 1200 metric tons, with a volume of some 3,000 cubic meters (3300 cubic yards). Table 2 is a guide to typical amounts produced by week, month and year by different numbers of hens and pullets, showing both fresh wet and dried totals.

Manure Drying and Handling

In the broiler industry, handling of manure has become a standardized procedure. However, in the layer industry a variety of systems are used. Because several options are available, egg producers must carefully look at these options to decide which will fit into their operation and minimize costs associated with the manure handling problem. Many an egg producer has done an outstanding job of management in the hen house only to encounter problems in manure, odor, and fly management that have led to his ultimate demise.

Whether a high-rise or battery-type house is used, a key element in manure management is provision for drying (discussed above for both housing types). For convenience in handling, to avoid fly and odor problems, and to preserve fertilizer value, manure should be managed so as to dry it to 30% or less moisture levels as soon as possible. Fresh wet manure is about 75% moisture. As manure dries it loses moisture, weight and volume. Drying to 10% will reduce weight by about 72% and volume by almost half. Table 3 shows the weight reduction accomplished by drying manure to about 1/3 the moisture content of fresh.

Layer manure starts to dry immediately as it is exposed to the air. The climate, housing, type of ventilation, and management of watering systems all have a direct impact on the difficulties that will be encountered when manure handling time comes, either day by day or at yearly intervals. Hot and dry conditions accelerate manure drying, while cold and damp conditions make drying much more difficult. This is why the climatic conditions, the ventilation systems, and cage configurations have so much to do with the ease or difficulty of manure handling.

Fertilizer Value of Manure

Nutrient value by weight of manure increases as it is dried, and the faster manure is dried, the higher the end-product nitrogen value will be. Table 3 gives approximate nutrient percentage values for typical cage manure at three moisture levels. Analyses may vary because of the type and age of the flock that produced it, age of the sample, moisture content, history of handling, environment, and analytical and sampling variations. Artificially dried fresh manure often contains more than 5% nitrogen.

Economic Value of Manure

The economic value of manure is based upon its available N, P (P_2O_5) and K (K_2O) composition.

Table 2. Fresh and Dry Manure Production* - Metric tons/U.S. tons

	Per Week		Per Month		Per Year	
No. of Birds	Fresh	Dry	Fresh	Dry	Fresh	Dry
1,000 layers	0.76/0.83	0.26/0.28	3.03/3.33	1.00/1.10	36/40	12.1/13.3
10,000 layers	7.6/8.3	2.6/2.8	30.3/33.3	10.0/11.1	364/400	121/133
100,000 layers	76/83	26/28	303/333	100/111	3640/4000	1210/1333
10,000 pullets	1.33/1.46	0.45/0.49	5.31/5.83	1.77/1.94	64/70	21.2/23.3
100,000 pullets	13.3/14.6	4.5/4.9	53.1/58.3	17.7/19.4	637/700	212/233

*Fresh moisture content of approximately 75%; dry moisture content 1/3 that of wet manure or approximately 25%.

The dryer the manure, and the more rapidly fresh wet manure is dried, the higher the value. Rapidly dried fresh manure can have a nitrogen content in the 5.5 to 6.0% range. As manure ages, ammonia is released, thereby reducing the nitrogen content of the product. Rapid drying stabilizes the nitrogen and higher values are observed. Other factors to consider when using or marketing manure for fertilizer use include organic composition, ease of use, freedom from weed seeds and other nuisances, availability, uniformity and cost.

Market value of manure can be established by manure analysis and comparison to prices for commercially available nutrients. For example, in the U.S. currently the following per ton economic values of the nutrients in average dry manure (3%N, 1.5%P, 1.2%K) are typical.:

60 lbs Nitrogen (3%) @ $.26/lb = $15.60/ton
30 lbs Phosphorus (1.5%) @ $.32/lb = $9.60/ton
24 lbs Potassium (1.2%) @ $.20/lb = $4.80/ton

The nutrients in poultry manure have value only if the crop being produced is in need of that particular nutrient. Manure analysis and soil tests should be coordinated for maximum benefit of the nutrients in manure from an agronomic stand point.

Land Area Requirements for Manure Spreading

In planning egg operations it is important to keep in mind the total quantity of adjacent land that will be needed to utilize the manure that is produced. This land must be available year after year. And if manure is handled on a frequent basis, as in battery house facilities, some land that is suitable for spreading must be available each time manure belts are unloaded. If the manure cannot be land-applied immediately, for example because of weather and field conditions, then storage facilities must be built so that the manure can be stockpiled.

Poultry manure can be land applied at a rate of not more than nine metric tons per hectare (four U.S. tons per acre). This is the typical maximum rate for pastureland. However, manure usage must be limited to the amount of nutrients actually needed by the crop in question, and must be applied at the time when the pasture grasses or other crops can actually make use of the nutrients applied. Producers should check crop requirements

Table 3. Poultry Manure Approximate Analysis (by weight)

Moisture (type)	Percent Nitrogen	Percent Phosphorus	Percent Potassium
75% (fresh wet)	1.13	0.74	0.63
35% (moist)	2.36	1.31	0.98
10% (dry)	3.84	2.01	1.42

for N, P_2O_5 and K_2O in their area of use and estimate necessary land accordingly, based on the amounts of manure their operations will produce (see Table 2).

For example, a typical 100,000-hen facility will produce 1,210 metric tons (1,333 U.S. tons) of dried manure (25-35% moisture) per year from layers, and another 106 metric tons (116 U.S. tons) from 50,000 replacement pullets, for a total of 1,316 metric tons (1,449 U.S. tons).

The land area required for application of this amount (1,316 metric, or 1,499 U.S. tons) at four usage rates is:

1. @ 9 metric tons/hectare = 146 hectares
   4 T/A = 362 acres
2. @ 6.75 metric tons/hectare = 195 hectares
   3 T/A = 483 acres
3. @ 4.5 metric tons/hectares = 292 hectares
   2 T/A = 724 acres
4. @ 2.25 metric tons/hectares = 585 hectares
   1 T/A = 1,449 acres

Further Processing Manure

Some poultry producers process their poultry manure to make it more acceptable as a fertilizer, as a consumer product in bags or as a ruminant feedstuff. Such procedures will eliminate undesirable characteristics such as lack of uniformity, odor, dustiness, weed seeds, etc.. This, however, is a very specialized business enterprise, usually requiring significant investment. Anytime we add value to manure by processing it we are assuming that there is a market for this product. Careful evaluation of further processing options and markets must be done prior to making this a part of an egg enterprise. In general, manure handling, utilization, and marketing should be managed in the simplest ways possible to get the job done.

Planning for Commercial Layer Expansion or Renovation

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