Hatching Quality Chicks

Incubating and hatching domestic fowl eggs is popular among people who have a small flock for eggs and meat and hobbyists with ornamental and "fancy" birds. These people benefit largely from the refinements in egg incubation developed by commercial hatchery operators. The fundamental techniques of incubation remain the same, whether you are hatching millions of birds per year as a commercial hatchery owner or a dozen chicks as a backyard enthusiast.

This publication is designed to introduce the beginning hatchery person to the types of incubators and their operation for the hatching of chicken, turkey, waterfowl, game bird, and peafowl eggs. This publication is directed at the incubation of chicken eggs, but the basic principles are the same for eggs of all domestic fowl. The changes in incubation procedures, when appropriate, are listed.

Breeder Flock Management

Proper management of the breeder flock is essential to produce good hatching eggs. The vigor and health of a chick depends largely on the care of its parents before the egg is laid. All birds in the breeder flock should be reared with proper management practices. Information on brooding and managing flock replacements and breeders is in **Extension Publication 268 The Home Flock**.

Birds in the breeding flock should be healthy and free of physical shortcomings that can interfere with proper mating and egg production. The potential parent birds must be able to produce fertile hatching eggs before chick quality can be improved.

The phrase "selection as used in breeding" refers to choosing parents for the next generation. Base selection on—

1. the ability of parents to produce fertile eggs that hatch into strong, healthy chicks,
   and
2. genetic traits that can improve desirable traits or performance in offspring.

This publication deals with the first basis of selection.

Selecting for genetic traits requires much training before continued improvement can be expected. A breeder bird must not have a deformed beak, slipped wing, blindness in one or both eyes, or any defect that may interfere with normal eating, drinking, and maintaining social stature in the flock. Male birds must be aggressive and have straight, sound legs and toes. Females should reflect good egg laying traits and good health and vigor.

Any of four mating systems can be used to produce hatching eggs:

1. mass mating
2. pen mating
3. stud mating
4. artificial insemination

Mass mating means several males are allowed to run with a flock of females. This method, used to obtain the maximum number of hatching eggs, is the most common method of mating used in poultry flocks.

Pen mating is mating a pen or small flock of females with a single male. Use this system when you must know the ancestry of each chick. Use it, too, in a small flock in which more than one male is not necessary.

Stud mating consists of mating one female with a male in a single pen or coop. The females may be kept together but still be mated to different males. It is possible to mate more females to a single superior male.

Artificial insemination makes it possible to market birds of vastly different sizes. Artificial insemination also makes it possible to mate birds that would normally never mate. This method is used in unusual situations where other methods are impractical.

Provide the breeder flock with proper nesting facilities. Fill the nests with plenty of clean nesting material to prevent breaking or contaminating eggshells with dirt, manure, or other disease-transmitting substances. Follow good sanitation and vaccination programs to control disease and pest problems.

Provide ample drinker and feeder space and plenty of clean, fresh water and feed. Feed a scientifically formulated "complete" breeder ration to ensure proper nutrition and quality hatching eggs.

Selection and Care of Eggs

Collect the eggs at least once daily, more often when daily high temperatures are above 85–90 °F. Commercial hatching eggs may be collected as often as four or five times daily to ensure egg quality. Keep nest eggs separate from eggs found on the floor so disease organisms are not spread. Do not incubate dirty floor eggs; they may spread disease to clean eggs.

Check the eggs for cleanliness soon after collection. Save eggs free of clinging dirt or debris and those with a small amount of adhering dirt that can be easily removed. Never save dirty eggs for incubation. They can spread disease to other eggs and chicks.

Never wash hatching eggs. Bacteria may be forced through the porous shell and into the egg. Washing also removes the protective sealing substance from the shell, leaving it vulnerable to penetration by other bacteria.

Incubate only eggs of average size. Excessively large eggs hatch poorly; small eggs hatch into small, unthrifty chicks. Do not incubate abnormally shaped eggs; they probably will not hatch.

Discard all cracked or thin-shelled eggs. These eggs do not keep the moisture needed for proper chick development. Penetration by disease-causing organisms increases in cracked eggs.

Discard eggs with loose or bubbly air cells.

Fumigation

Sanitize eggs and equipment before storage or use by fumigating. Under-fumigation does not kill the bacteria, but over-fumigation can kill the chick embryo in the egg. Use recommended amounts of chemicals at the right time for the length of time specified.

A room or cabinet large enough to hold the eggs is required. It must be relatively airtight and equipped with a small fan to circulate the gas. Calculate the inside volume of the structure by multiplying the inside length by the width by the height.

Stack the eggs inside the room or cabinet on wire racks, in wire baskets, or on egg flats so air can circulate among the eggs. Remove eggs from the cases for good air circulation.

Formaldehyde gas is produced by mixing 0.6 gram of potassium permanganate (KmnO4) with 1.2 cc of formalin (37.5 percent formaldehyde) for each cubic foot of space in the fumigating structure. Mix the ingredients in an earthenware or enamelware container with a capacity at least 10 times the total volume of the ingredients.

Circulate the gas within the structure for 20 minutes and then expel the gas. The temperature during fumigation should be above 70 °F. Allow eggs to air out for several hours before placing them in cases.

Hatching Egg Storage

It may not be practical to place the eggs in an incubator immediately after collection. If you hold eggs for several days, keep them in a cool, humid room. The best storage conditions are near 60 °F and 75 percent humidity. Hatchability will be reduced if the temperature drops below 40 °F. The cool temperature delays embryonic growth until incubation begins, and the high humidity prevents moisture loss.

Humidity is best measured with a device called a psychrometer. The table shows the relationship between wet bulb readings and relative humidity at storage temperatures.

Table 1. Wet bulb reading for storage temperatures (° F).

Relative Humidity	55	60	65	70
55	47.2	51.4	55.5	60.0
60	48.1	52.4	56.7	61.2
65	49.0	53.4	57.8	62.3
70	50.0	54.4	59.0	63.5
75	50.9	55.4	60.0	64.6
80	51.7	56.4	61.0	65.8

Incubate eggs as soon as it is convenient. The hatchability of eggs stored for fewer than 7–10 days remains high with proper storage conditions. Eggs held longer experience reduced hatches. After 3 weeks of storage, the hatchability is near 0 percent.

If the eggs are not incubated within 3 or 4 days, turn them daily. Turning the eggs prevents the yolks from touching the shell and injuring the embryo. Store the eggs with small ends down and slanted at an angle of 30–45 degrees. Large numbers of eggs can be stored in egg flats and cases with one end of the case elevated to give the proper slant. Turn the eggs by elevating alternate ends of the case or flat each day.

The eggs should warm slowly before being placed in the incubator. The shock of warming the eggs too rapidly will cause moisture to condense on the shell. This may lead to disease problems.

Incubators

Fairly constant environmental conditions can be maintained in an incubator. Incubators are available in many different models and sizes with capacities ranging from two to thousands of eggs.

The larger incubators are rooms in which environmental conditions are carefully controlled. There are two basic types of incubators: forced-air and still-air incubators. The size and type of incubator selected depends on your needs and future plans.

Forced-air incubators have internal fans to circulate the air. Eggs are placed in stacks of trays. The capacity of these incubators is large. Most units have automatic equipment for turning the eggs and spray mist nozzles for holding proper humidity levels.

Still-air incubators are usually small but may hold 100 eggs or more. They do not have fans. Air exchange is made by escaping warm, stale air at the top and entering cool, fresh air near the bottom. Air circulation is limited, so only one layer of eggs can be incubated. Incubating temperatures in these machines must be about 2–3 °F higher than temperatures in forced-air incubators.

If you are incubating large numbers of eggs or setting eggs more than once weekly, use separate incubating and hatching units. The incubators should be large enough to hold a 3-week supply of eggs. The hatcher unit should be small but large enough to hold the largest setting of eggs.

Eggs at various stages of incubation are held in the incubator. The eggs are transferred to the hatcher on the 18th day and held in the hatcher until completely hatched. Clean and disinfect the hatcher after each group of eggs hatches.

Incubation Procedures

Place all incubators and hatchers inside a building away from severe weather. It is easier to check the temperature and humidity if the incubator is kept indoors. The room must be well ventilated and have a system for maintaining comfortable temperatures.

Start the clean, sanitary incubator 1 or 2 days before the eggs are set. Use the extra time to adjust the temperature, humidity, and airflow. If you have no recommendations for your unit, use those in this publication.

Temperature

Adjust the temperature to 100 °F in forced-air incubators and 102 °F in still-air incubators. The temperature in the hatching unit during the last 3 days may be 1 degree less than the incubating temperature.

In still-air incubators, locate the thermometer bulb about 1 inch above the screen floor. The thermometer must not touch the eggs or side of the incubator. Thermometer placement is not as critical in the forced-air incubator because of better air circulation. The sides and top of the incubator must fit tightly to prevent heat and moisture loss.

Temperature fluctuations of 1 degree or less are allowed, but there should be no prolonged periods of high or low temperatures. Hatching eggs can take much abuse, but they are sensitive to high heat. Many embryos die if held at 105 °F for 30 minutes. Incubating eggs at 90 °F for 3–4 hours will slow development and growth.

Humidity

Carefully control humidity to prevent unnecessary moisture loss from the eggs. Measure humidity with a hygrometer or psychrometer. Psychrometer readings are expressed as “degrees, wet bulb.” Convert these readings to relative humidity by using the table.

Table 2. Wet bulb reading for incubation temperatures (° F).

Relative Humidity	99	100	101	102
	Wet Bulb Readings			
45	80.5	81.3	82.2	83.0
50	82.5	83.3	84.2	85.0
55	84.5	85.3	86.2	87.0
60	86.5	87.3	88.2	89.0
65	88.0	89.0	90.0	91.0
70	89.7	90.7	91.7	92.7

Table 3. Incubation period and incubator operation for eggs of domestic birds.

Requirements	Chicken and Bantam Turkey	Turkey	Duck[1]	Muscovy Duck	Goose	Guinea	Pheasant	Peafowl	Bobwhite Quail	Coturnix Quail	Chukar Patridge	Grouse	Pigeon
Incubation Period (days)	21	28	28	35-37	28-34	28	23-28	28-30	23-24	17	23-24	25	17
Forced-Air Operating Temperature[2] (°F, dry bulb)	100	99	100	100	99	100	100	99	100	100	100	100	100
Humidity (°F, wet bulb)	85-87	84-86	85-86	85-86	86-88	85-87	86-88	84-86	84-87	85-86	81-83	83-87	85-87
Do Not Turn Eggs After (day)	18th	25th	25th	31st	25th	25th	21st	25th	20th	15th	20th	22nd	15th
Humidity During Last 3 Days of Incubation (°F, wet bulb)	90	90	90	90	90	90	92	90	90	90	90	90	90
Open Ventilation (day)	10th	14th	12th	15th	1st	14th	12th	14th	12th	8th	12th	12th	8th
Open Ventilation Holes Farther if Needed To Control Temperature (day)	18th	25th	25th	30th	25th	24th	20th	25th	20th	14th	20th	21st	14th

[1]Duck eggs reportedly hatch better in still-air incubators than in forced-air incubators.
[2]For still-sir incubators, add 2–3 °F to the recommeded operating temperatures.
[3]Better hatchability may be obtained if goose eggs are sprinkled with warm water or dipped in lukewarm water for half a minute each day during the last half of the incubation period.

The relative humidity in the incubator for the first 18 days should remain at 58–60 percent or 85–87 °F, wet bulb. During the last 3 days of incubation, increase humidity to at least 65 percent or 89– 90 °F, wet bulb. Don't open the incubator the 3 days before hatching, or vital moisture will be lost.

The chicks need added moisture when hatching to prevent the membranes from drying. Low humidity makes it more difficult for the chick to tear the tough shell membranes and may cause the chick to stick to the shell and die.

Goose eggs hatch better if sprinkled or dipped in clean, lukewarm (100 °F) water for 30 seconds each day during the last half of the incubation period. Use warm water; cool water may suck bacteria into the eggs.

Rarely is the humidity too high in a still-air incubator. The water pan should cover at least half of the floor area during the first 18 days. At hatching time, increase humidity by adding another pan of water or a wet sponge. Increasing the water surface area raises the humidity.

An excellent method of determining proper humidity is to candle the eggs and observe the size of the air cell. As incubation progresses, the size of the air cell increases because of moisture loss. Humidity adjustments can be made after each candling operation.

Ventilation

Proper ventilation is important for successful incubation. During embryonic development, oxygen enters the egg through pores in the shell, and carbon dioxide escapes in the reverse manner. As the embryo grows, it needs a larger supply of fresh air.

The air openings of the incubator are gradually opened as incubation progresses. When increasing the airflow, be careful not to reduce humidity. In still air incubators, the ventilation openings must be both above and below the eggs for proper air exchange. Never place more than one layer of eggs in a still-air incubator.

When the electric power fails, open a forced-air incubator immediately so fresh air can enter. If the incubator is left closed, the oxygen supply will be exhausted and the chicks will suffocate. Hold room temperature at 75 °F or higher. Eggs in a still-air incubator survive best if the incubator is closed to conserve the heat and humidity.

Turning the Eggs

In forced-air incubators, the eggs are placed small end down in special incubating trays that mechanically turn the eggs. If you use such a machine, be sure all trays operate properly. In still-air incubators, place eggs on their sides with the small end pointed slightly downward. This enables the embryo to turn itself into the proper position for hatching.

Turn the eggs at least 2–3 times daily during the first 18 days of incubation. Turning prevents the embryo from sticking to the shell membranes when left in one position too long. DO NOT turn eggs during the 3 days before hatching. The embryos are moving into hatching position and should not be disturbed.

An excellent method for knowing whether the eggs have been turned is to mark an "X" on one side of the shell and an "O" on the opposite side. Then you can always tell if the eggs have been turned. When turning, be sure your hands are clean. Be careful when turning eggs during the first week of incubation. The developing embryo has delicate blood vessels that may rupture if jarred or shaken.

Mark eggs incubated on different days with the date they were placed in the incubator. This prevents eggs from being overlooked and left in the incubator after they should have hatched.

All chicks should be out of their shells by the end of the 21st day unless proper incubation conditions were not maintained. Chicks hatched after the 22nd day are not usually healthy and vigorous. After the chicks have hatched and fluffed up, remove them from the incubator and place them under a brooder with feed and water.

When the hatch is completed, disconnect the incubator from the power supply and remove all shells, unhatched eggs, and debris. Wash the interior of the incubator with a warm detergent solution. Rinse with a sanitizing solution, and fumigate with formaldehyde as described earlier. Fumigate the incubator only after removing the eggs. After drying, the incubator is ready for reuse or storage.

Cleanliness and sanitation are the most practical and economical methods to prevent disease and produce quality chicks. Keep the hatching area and equipment clean and sanitary. Cover all windows, air intakes, and doors with screens to keep out insects and rodents. A good sanitation program has no substitute.

Testing for Fertility

Sometimes it is necessary to test the incubated eggs for fertility. If large numbers of infertile eggs are incubated, they can be found and discarded and the extra space used for additional eggs. This test will not injure the young embryos and is reliable for eliminating eggs that will not hatch.

Make a tester or candler by placing a light bulb attached to a drop cord inside a cardboard box. Cut a small, round hole in the top or side of the box, and let a narrow beam of light escape from the box. The hole should be one-half to three-fourths of an inch in diameter. You can see the internal features of the egg by placing it against the hole. A darkened room makes testing easier.

The eggs are normally tested after 4–7 days of incubation. Eggs with white shells are easier to test and can be tested earlier than dark-shelled eggs. Two classes of eggs can be removed on the basis of this early test: "infertiles" and "dead germs." "Infertile" refers to an unfertilized egg or an egg that started developing but died before growth could be detected. "Dead germs" refers to embryos that died after growing large enough to be seen when candled.

An infertile appears as a clear egg except for a slight shadow cast by the yolk. A live embryo is spider-like in appearance, with the embryo representing a spider's body and the large blood vessels spreading out much like a spider's legs. A living embryo during testing is illustrated. A dead germ can be distinguished by the presence of a blood ring around the embryo. This is caused by the movement of blood away from the embryo after death.

If you are not sure if the embryo is alive, place the egg back in the incubator and retest. You can make a second test after 14–16 days of incubation. If the embryo is living, you can see only one or two small light spaces filled with blood vessels, and you may see the chick moving.

Hatching Failures

When eggs fail to hatch properly, the reason is often hard to determine. The cause may originate in the management of the breeder flock, the incubation procedures, or any step between the breeder flock and final hatch. Table 4 will help you find the causes and correct hatching failures.

Table 4. Incubation trouble-shooting.

Probable Causes	Suggestions
Infertiles or clear eggs showing no development	
Too few males	Increase the number of males in flock.
Seasonal decline in fertility	Use young cockerels.
Males undernourished	Replace underweight males with vigorous ones.
	Provide feeders on roosts.
Interference between males during mating	Do not use too many males.
	Rear males together.
Diseased flock	Carry out approved disease control program.
Frozen comb and wattles	Provide comfortable housing.
	Use proper drinking fountains.
Old males	Replace with younger males.
Selected mating in pens	Artificially inseminate infertile hens.
	Place with another male in different pen.
Male sterility	Replace with another male.
Eggs stored too long	Set eggs within 7–10 days of laying.
Eggs stored too cool	Store eggs between 50 and 65 °F.
Blood rings	
Improper storage or incubation temperature	Check accuracy of thermometer.
	Check thermostat, heating element, current supply.
	Check incubator recommendations.
Improper nutrition	Feed breeders a proper diet.
Improper fumigation	Check fumigation recommendations.
Many dead embryos	
Improper incubation temperatures	See suggestions for improper temperature.
Improper egg turning	Turn at least three times daily.
Inherited low hatchability	Avoid close inbreeding.
Improper ventilation	Increase ventilation of incubator rooms (avoid drafts).
	Add oxygen at high altitudes.
Pullorum disease or other salmonelloses	Use eggs from disease-free sources only.
	Blood-test your flocks.
Improper nutrition	Feed breeders a proper diet.
Pipped eggs not hatching	
Insufficient moisture	Raise wet bulb reading in hatching period.
Improper ventilation	Increase ventilation in incubator room or hatcher.
Malpositioned embryos	Set eggs small end down.
	Turn eggs properly.
Early hatching	
High incubation temperature	See suggestions for improper temperature.
Improper egg storage	Store eggs between 50 and 65 °F.
Late hatching or not hatching uniformly	
Low incubation temperature	See suggestions for improper temperature.
Old eggs or eggs of different ages	Set eggs at least once weekly.
Sticky embryos (dead)	
Low hatching humidity	See suggestions for insufficient moisture.
Lethal genes	See suggestions for breeding.
Crippled and malformed chicks	
High incubation temperature	See suggestions for improper temperature.
Low incubating humidity	See suggestions for insufficient moisture.
Improper turning or setting	See suggestions for improper turning of eggs.
	Set eggs large end up.

Heredity	Practice proper culling and breeding.
Slick hatching trays	Use trays with wire or crinoline on bottom.
Improper nutrition	Feed breeders a proper diet.
Abnormal, weak, or small chicks	
High hatching temperature	See suggestions for improper temperature.
Small eggs	Set only standard or larger size eggs.
Insufficient moisture	See suggestions for insufficient moisture.
High incubation temperature	See suggestions for improper temperature.
Riboflavin deficiency	Feed a complete balanced breeder ration.
Labored breathing	
Too much fumigant	Fumigate properly.
Respiratory diseases	Check with nearest disease laboratory.
Large, soft-bodied mush chicks; dead on trays; bad odor	
Low average temperature	See suggestions for improper temperature.
Poor ventilation	See suggestions for improper ventilation.
Navel infection (omphalitis)	Clean and fumigate incubator between hatches. Properly fumigate eggs.
Rough Navels	
Poor incubation temperature	See suggestions for improper temperature.
High hatching humidity	Maintain proper humidity.
Short down on chicks	
High incubation temperature	See suggestions for improper temperature.
Low incubation humidity	See suggestions for insufficient moisture.
Excessive ventilation	Reduce vent openings slightly.
Excessive yellow down color	
Improper fumigation	Avoid excessive fumigation during incubation.

Publication 1182 (POD-01-16)

Distributed in Mississippi by **Danny Thornton**, Extension Instructor, Poultry Science. Written by Dr. Tom Smith Jr., former Extension Poultry Science Specialist.

Produced by Agricultural Communications.

Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. GARY B. JACKSON, Director