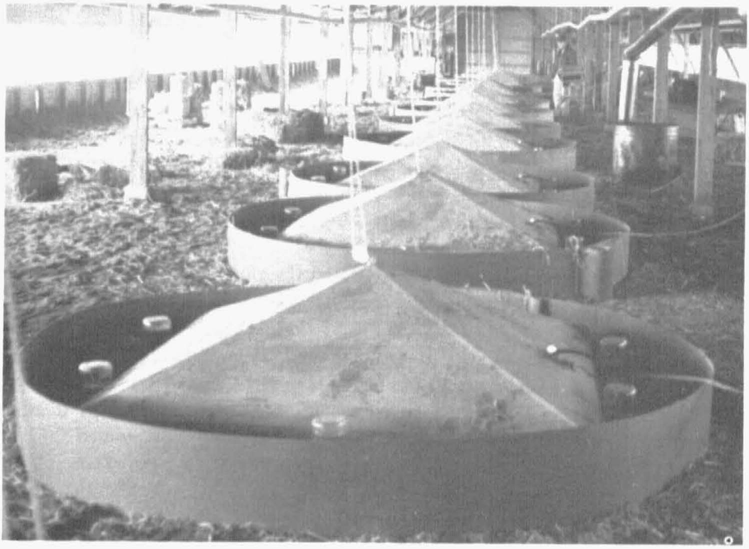
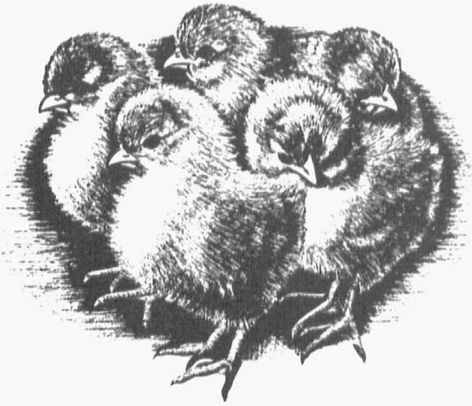
Cost and Performance of

ELECTRIC CHICK BROODERS

under Missouri Conditions





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CONTENTS

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COST AND PERFORMANCE OF ELECTRIC CHICK BROODERS UNDER MISSOURI CONDITIONS

K. L. McFate

Introduction

While brooding expense represents only a small percentage of the cost of raising a broiler, it is one of the "on-farm" expenses which producers can control. Numerous studies have shown that chicks can be raised satisfactorily under many different environmental conditions and with different types of brooders. The objective is to select one that is effective but operates at low cost.

The type of brooder used for a particular operation depends upon the effect it has upon performance of the chicken and upon the over-all cost of operating the particular brooding system. These factors, in turn, depend upon whether the "cool-room" or the "warm-room" system is employed, the performance of the specific brooder, the source of heat energy, brooder construction, repair and maintenance, house construction, and general management practices.

The goal of the warm-room brooding system is to maintain a comfortable condition throughout the house, usually about 60-65°F. In cool-room brooding, only that part of the room or house near the floor or under the brooder is warmed, with the remaining house temperatures free to fluctuate with outside temperatures. And in typical uninsulated Missouri broiler houses, this might be only a few degrees above the outdoor temperatures.

Six types of brooders performed equally well in typical uninsulated broiler houses of Georgia in experiments conducted by the Georgia Experiment Station*. The types tested were: underheat-electric cable, electric hover, heat lamps, cool-room gas, and warm-room gas brooders. Chicks grew slightly faster and had a slightly higher feed efficiency with hot air brooders than with cool-room brooders, when they were used as warm-room systems in uninsulated houses. The improved chick performance, however, was more than off-set by the higher fuel costs. In order of <u>decreasing</u> energy costs per chick, the brooder types ranked as follows: (1) hot-air, (2) warm-room gas, (3) cool-room gas, (4) heat lamp, (5) electric hover, and (6) underheat-electric cable.

In recent years, many Missouri broiler producers have turned to warm-room brooding in an effort to reduce high moisture problems in broiler houses, reduce condemnation rates, and improve feed efficiencies. Due to poor housing construction, however, brooding costs have been materially increased with the warm-room brooding practice. As a result, many producers have become interested in some means of reducing brooding costs, often with a dual heating system. Wood heaters and either wood or coal furnaces have been used to supplement heat produced by hover brooders. Where the furnace furnishes a major portion of room heat, labor has been somewhat increased during the winter period, but the furnaces usually lower total brooding costs.

The Ozark region has a plentiful supply of wood and labor. Researchers have worked closely with a few broiler producers there to obtain factual information on cost and performance of electric brooders, and of electric brooders used in conjunction with wood space heaters during the cold winter months.

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*Drury, L. N., Brown, R. H. and Driggors, J.C., Performance of Chick Brooder Types in Uninsulated Houses, Bulletin N.S. 101, April 1963, Georgia Experimentation Station, Athens, Georgia.

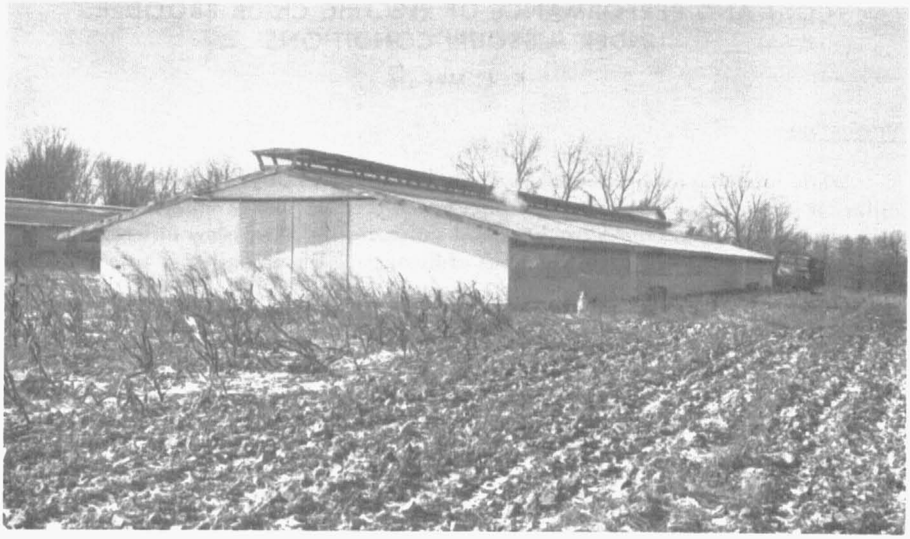

Fig. 1—The uninsulated 40' x 200' frame house, equipped with a ridge vent and 4 mil plastic curtain windows.

Fig. 2—Four small wood heaters placed between north wall and brooders were used for additional heat for October and January broods.

Facilities Used

The house in which chicks were raised under cool-room conditions was a 40 ft. by 200 ft. frame building with a continuous row of plastic windows on both the north and south walls. A continuous row of long metal doors was located under the windows to provide cross ventilation during warm summer months. The continuous ridge vent on top of the house was equipped with loose fitting doors. This construction was typical of that used in the area except that the "test" house had a concrete floor.

Each of the 17 commercial electric brooders used during the studies was 6 ft. by 6 ft. in size, with hover panels lined with 1-inch thick insulation material. A small circulating fan drew fresh air through the small vent holes at the apex of the brooder. This air, in turn, was used to distribute the heat produced by a 115-volt, 1500 watt circular heating element and the 7.5 watt attraction light. Each brooder element was, of course, thermostatically controlled.

During the first week of brooding, a cardboard barrier confined the small chicks to the immediate brooding area, where drafts were reduced and where feed and water were furnished in small portable containers. After the barriers were removed, water and feed were supplied with automatic waterers and mechanical feeders.

Four small wood heaters were used to provide additional space heat during the first few weeks of the October and January brooding periods. These heaters were placed between the north wall and the center of the house where electric brooders were located. Unlimited amounts of firewood were available on the farm. Wheat straw and sawdust were used for litter.

Brooding Practices and Procedures

During a ten month period from August 1 to June 1, four groups of chicks were brooded. While 38,000 commercial broilers were purchased, a total of 39,100 were actually started, with groups placed under brooders on August 1, October 1, January 10, and March 29. During each brooding period, the air temperature under the brooders was maintained at approximately 95°F during the first week and lowered 5°F at weekly intervals until brooders were turned off.

Electrical use data were obtained by kilowatt-hour meters; other fuel costs were calculated by measuring the amount of wood used. Indoor temperatures and relative humidities were obtained with recording hygro-thermographs placed near the center of the house and two feet above floor level. Outdoor temperatures and relative humidities were obtained in a shaded area near the south side of the house. Mortality, feed used, birds condemned at the processing plant, and other data were recorded by the farmer and/or the feed dealer.

During these investigations no attempt was made to change the operator's normal practice of providing ventilation by manually regulating the side and ridge vents or the windows and doors. No mechanical ventilation was provided and all chicks were raised under contract with the local feed dealer and his feed company.

While brooders were rated at a capacity of 750 chicks, they were never filled to that capacity and fewer chicks were placed under each unit during the colder months, a practice usually followed by producers using most types of brooders. The primary reason for the smaller number in two broods, however, was the limitation of birds received by the producer. After each brooding period, electric brooders were raised to the top of the brooder house for storage.

Group Investigations

Tables 1 through 4 show weekly temperatures, relative humidities, mortality, and amount of electricity used in each of four tests.

On August 1, the first group of 10,300 day-old chicks was placed under 16 brooders that operated until August 16. During this 16-day period, the outdoor temperature averaged 72°F and outdoor relative humidity averaged 79 per cent. A total of 1827 kilowatt hours of electricity was used. Indoor temperature and relative humidity data were not recorded for this brood because of instrumentation problems but with open doors and windows during much of the brooding period, conditions were quite similar to those outdoors.

TABLE 1 - TEST NO. 1 DATA, AUGUST 1 - SEPTEMBER 30, 1961

Week Beginning	Outside Conditions: Temperature, °F High	Low	Mean	Relative Humidity, % Mean	High	Low	Electricity Used (KWH)	Chicks Lost or Killed
Aug. 1	94	64	81	77	100	42	1048*	110*
7	95	63	78	82	100	42	673	100
14	88	62	74	76	100	40	106	70
21	92	52	72	79	100	45	----	33
28	90	61	77	77	100	47	----	22
Sept. 4	92	57	76	80	100	44	----	18
11	78	45	60	78	100	41	----	21
18	83	48	70	--	---	--	----	15
25	80	43	63	--	---	--	----	12
						TOTALS	1827	401

*6 day period 8/1 to 8/7

On October 17, another 9,250 day-old chicks were placed under 17 brooders that operated until November 20. A total of 2054 kilowatt hours of electricity was used during this 35-day period. Several ricks of wood were used in small heaters for supplemental room heat. Table 2 shows an indoor temperature differential of 43°F while the brooders were operating. Temperature ranged from a low of 45°F to a high of 88°F. During the last four weeks of the growing period, when weather

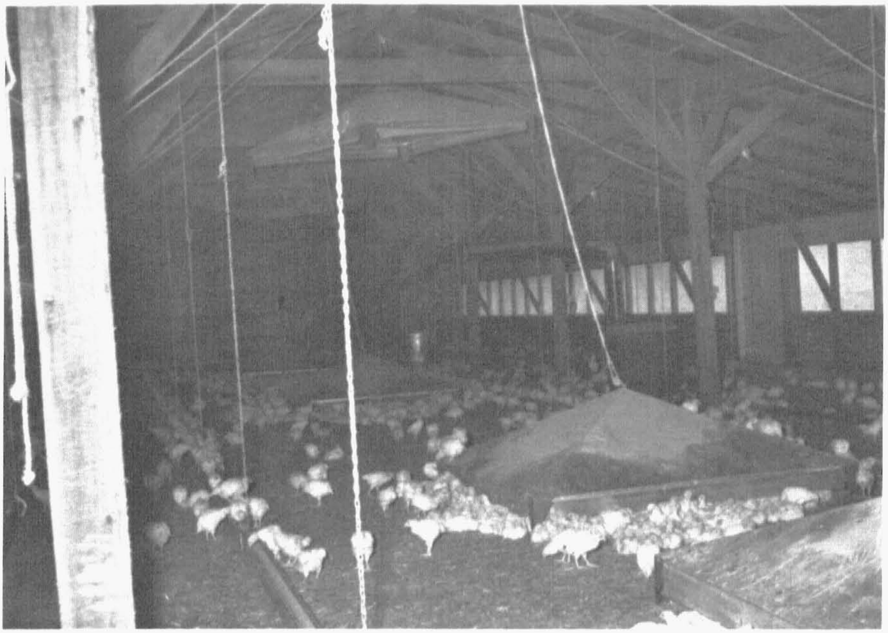

Fig. 3—When not in use, electric brooders were raised high above brooding area. Note heating element, attraction light, and fan motor under hover.

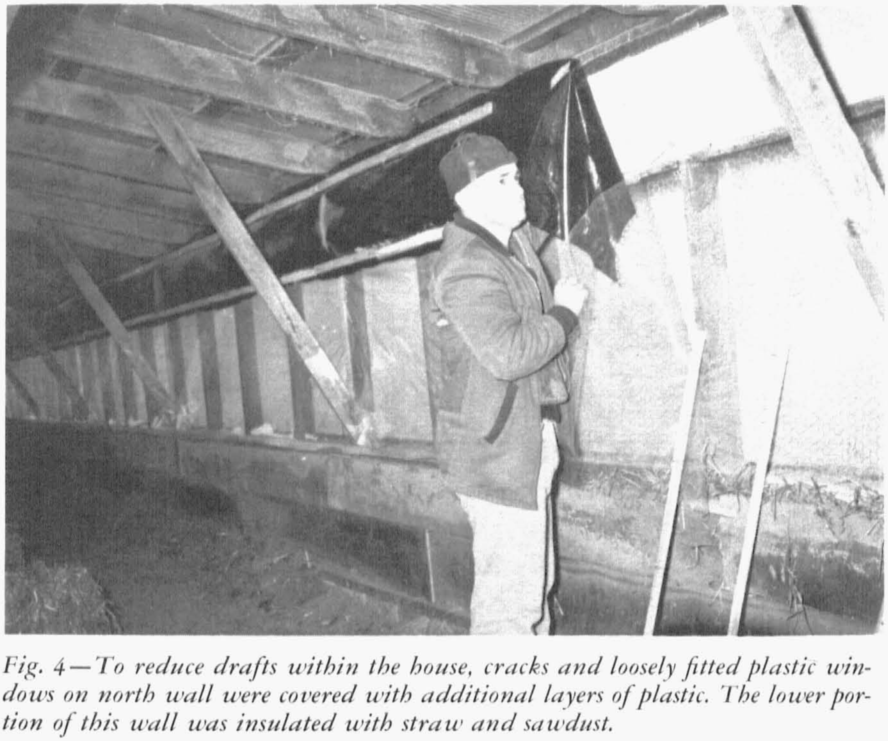

Fig. 4—To reduce drafts within the house, cracks and loosely fitted plastic windows on north wall were covered with additional layers of plastic. The lower portion of this wall was insulated with straw and sawdust.

TABLE 2 - TEST NO. 2 DATA, OCTOBER 16 - DECEMBER 17, 1961

Week Beginning	Outside Conditions: Temperature, °F			Outside Conditions: Relative Humidity, %			Inside Conditions: Temperature, °F			Inside Conditions: Relative Humidity, %			Electricity Used (KWH)	Chicks Lost or Killed
	High	Low	Mean Avg.	Mean Avg.	High	Low	High	Low	Mean Ave.	Mean Ave.	High	Low		
Oct. 16	79	34	58	68	100	25	84	45	64	66	100	38	1005*	46*
23	80	32	58	74	100	22	88	46	68	75	100	38	497	53
30	82	29	52	85	100	31	88	50	66	86	100	44	169	15
Nov. 6	78	26	50	75	100	30	79	49	65	67	100	34	232	23
13	56	30	42	85	100	40	72	56	62	84	98	52	131	10
20	71	30	50	80	100	26	76	49	61	77	98	30	20**	22
27	66	26	45	76	100	25	71	42	58	76	100	40	----	19
Dec. 4	66	26	38	80	100	26	70	41	52	74	100	36	----	22
11	49	0	38	78	100	25	64	44	56	80	100	41	----	24
												TOTALS	2054	234

*6 day period 10/17 to 10/23 **1 day only 11/20

TABLE 3 - TEST NO. 3 DATA, JANUARY 10 - MARCH 13, 1962

Week Beginning	Outside Conditions: Temperature, °F High	Low	Mean Avg.	Outside Conditions: Relative Humidity, % Mean Avg.	High	Low	Inside Conditions: Temperature, °F High	Low	Mean Avg.	Inside Conditions: Relative Humidity, % Mean Avg.	High	Low	Electricity Used (KWH)	Chicks Lost or Killed
Jan. 8	46	-7	28	64	92	28	60	25	46	66	85	39	1720*	645
15	45	4	29	78	92	31	63	31	45	82	97	58	2017	138
22	58	15	40	78	98	38	71	34	51	77	92	38	1036	56
29	--	--	--	--	--	--	83	43	60	62	93	23	440	39
Feb. 5	--	--	--	--	--	--	85	48	58	72	94	26	227	37
12	90	31	55	75	100	25	85	47	62	57	88	22	----	42
19	67	27	44	88	100	40	69	43	56	73	86	47	----	46
26	59	8	32	72	100	33	64	37	49	74	100	33	----	106
Mar. 5**	60	21	44	80	100	24	65	43	55	64	97	29	----	97
												TOTALS	5440	1206

*5 day period only, 1/10 - 1/15

**Dusted with C. R. D. on March 1, 1962

TABLE 4 - TEST NO. 4 DATA, MARCH 29 - MAY 31, 1962

Week Beginning	Outside Conditions: Temperature, °F High	Low	Mean Avg.	Outside Conditions: Relative Humidity, % Mean Avg.	High	Low	Inside Conditions: Temperature, °F High	Low	Mean Avg.	Inside Conditions: Relative Humidity, % Mean Avg.	High	Low	Electricity Used (KWH)	Chicks Lost or Killed
Mar. 27	Birds received on March 29. Temperature - Relative Humidity recorded from April 3.												1435*	52
Apr. 3	71	35	52	76	100	22	86	46	63	60	94	26	1474	54
10	78	34	51	65	100	24	84	47	63	60	88	26	885	23
17	86	47	68	62	100	22	90	54	72	46	95	18	189	30
24	91	55	70	72	100	30	83	58	72	55	94	23	----	22
May 1	89	42	70	64	100	23	92	51	75	48	80	20	----	14
8	95	65	78	70	100	33	94	67	78	50	83	28	----	23
15	90	65	77	75	100	35	92	68	79	53	83	27	----	30
22	92	62	79	74	100	30	95	65	82	58	90	22	----	32
29**	No Temperature - Relative Humidity Data obtained													
												TOTALS	3983	294

*5 days only **3 days only

was colder, indoor temperatures were as low as 41°F and as high as 76°F, indicating the poor temperature regulation within the house even with the wood heaters. Such variations might be expected, however, in uninsulated open-type structures with manually operated ventilators and infrequently fired supplemental wood heaters.

On the tenth of January, 10,300 day-old chicks were placed under 17 electric brooders. The inside house temperature was only 35°F, as supplemental wood heaters had been installed only four hours before the arrival of the chicks. To avoid extreme drafts, the single sheet plastic windows and cracks above the windows on the north wall were covered with an additional sheet of plastic. The lower portion of this wall was also insulated with sawdust and straw, as shown in Figure 4. The wide variation in indoor temperatures (from 25°F to 63°F) during the first two weeks of operation was due to extremely cold weather, drafts caused by the ridge ventilator, partially open because of icing conditions, and by the irregular firing of the wood stoves. Even with an average indoor temperature of 45.5°F for this period, only 5440 kilowatt hours of electricity were used.

On March 27, a final group of 9,250 day-old checks were placed under 16 brooders that operated until April 18. During this 23-day period, outdoor temperatures averaged 2°F lower than indoor temperatures and 3983 kilowatt-hours of electricity were used. Temperature and related data are shown in Table 4.

Results of Cool-Room Brooding Investigations

Though wood heaters were used, conditions under which chicks were raised were similar to cool-room environments. Table 5 summarizes data available on the four groups of chicks brooded under such conditions. The combined length of the October and January brooding periods was nearly twice as long as the combined length of the other two periods. This was due to the prolonged cold season and explains the wide variation in operating costs.

When compared with the October 17 group, the mortality of the August group was greater but feed efficiency was improved. This qualified the group for a premium payment from the processor.

Similar comparisons cannot be made with the January and March broods, as sufficient data were not made available. It should be pointed out, however, that the market weight of the broilers started March 29 and marketed at an older age (9 weeks) is not just for the chicks that were brooded electrically; it is for a combined group, part of which were reared under electric and part under gas brooders.

It was felt that chilling of the January chicks upon or shortly after arrival contributed much to the high mortality rate of 7.7 per cent during the first two-week period. As the season was one of the coldest on record in southwest Missouri, all brooders remained on until the end of the fifth week during this trial.

TABLE 5 - SUMMARY: RESULTS OF BROODING FOUR GROUPS OF BROILERS;

COOL ROOM BROODING - ELECTRIC BROODERS

Date Started	Aug. 1, 1961	Oct. 17, 1961	Jan. 10, 1962	Mar. 29, 1962
Birds Purchased	10,000	9,000	10,000	9,000
Extra Birds	300	250	300	250
Total Birds Started	10,300	9,250	10,300	9,250
Birds Lost or Killed	401	234	1206	294
Market Age	8wk., 6da.	8wk., 5da.	8wk., 6da.	9 wks.
Market Wt., lb./bird ave.	3.50	3.65	3.61	3.80[d]
Livability, per cent [a]	99.1	100	90.9	99.5
Feed Conversion, lb. feed / lb. gain	2.22	2.35	N.A. [e]	N.A.
Condemnation	0.0028	0.0065	N.A.	N.A.
Length of Brooding Period, days	16	36	35	23
High Indoor Temperature	--	88°F	63°F	95°F
Low Indoor Temperature	--	45°F	25°F	46°F
Average Indoor Temperature	--	65°F	45°F	70°F
Low Outdoor Temperature	63°F	26°F	-7°F	34°F
Average Outdoor Temperature	72°F	78°F	39°F	68°F
Degree--days, Actual Brooding Period	--	376	938	318
Electricity Used, KWH	1827	2054	5440	3983
Electric Brooder, Operating Costs, Costs per bird, mils	2.76	3.42	8.16	6.64
Wood Fuel Used, Ricks	None	7.5	8.5	None
Brooding Operating Cost per bird, mils[b]	2.8	6.3	11.1	6.6
Production Costs per lb., cents[c]	13.45	14.51	N.A.	N.A.

(a) Based on number of birds actually charged to grower.

(b) Includes cost of both electricity and wood used.

(c) Does not include housing costs or grower's labor. Electricity @ 1.5¢/KWH. Wood at $3.50/rick.

(d) Market weight is an average of this and other groups brooded with electric and fuel fired units.

(e) Information was not made available to researchers.

Analysis of Cool-Room Brooding Costs

To determine the cost of brooding and heating, electricity was calculated at the local rate of 1.5 cents per kilowatt-hour. The value of wood used in the small unit heaters was estimated at $3.50 per rick. On this basis, the total operating cost of brooders and heaters combined was 2.8, 6.3, 11.1, and 6.6 mils per chick for groups 1, 2, 3, and 4, respectively.

Assuming a ten-year life of the brooder and 50,000 chicks raised annually, the cost of owning the brooding equipment was 0.25 cents per chick. The first cost of the brooders used in this study included a one-year insurance policy that covered any chick losses that might have arisen from any "off-the-farm" electrical power interruptions. The average cost of owning the wood heaters was approximately 0.03 cents per chick.

Electric Wiring

The electric wiring system for the broiler house in which electric brooders were used was carefully designed to serve the large electric heating load, and the lighting, feed handling, and watering equipment loads. Heavy wiring was run from the meter pole to the broiler house and from the service entrance panel to individual brooders. Three individual No. 1 AWG conductors were attached to the rafters with insulators and run from the 200 amp panel to the center of the house. From this point, three additional individual No. 3 AWG conductors extended over the remaining length of the building. A three-conductor, No. 12 AWG wire cable served each grounded 115-volt, 1500 watt brooder, each of which was protected with a time delay fuse.

Based on a 15-year life expectancy, the installed cost of the wiring system charged to the brooding operation was approximately $30.00 per year or 0.06 cents per chick. This includes not only the wiring in the broiler house but also that used for the new meter loop and the heavy wire from the meter pole to the broiler house.

Weather and Brooder Heating Loads

Because of the facilities used in this cool-room brooding study, the indoor temperatures fluctuated almost directly with outdoor weather conditions. During the brooding and growing period for both the October and the January groups, indoor temperatures averaged 13°F above outdoor temperatures. For the March group, indoor temperatures averaged only 5°F higher than outdoor temperatures.

The approximate numbers of degree-days for October, January, and March broods were 376, 938 and 318 degree-days, respectively. The average temperature reported by the nearest U.S. Weather Bureau station during the January 10 - February 13 brooding period was 27°F, for a total of 967 degree-days, one of the coldest such periods for the area.

While these degree-day figures provide a guide to the relative home heating load for the area, the brooder heating load can best be related to chick-degree-days. Drury defines this term as "the desired hover temperature minus the mean outdoor temperature for the day." By subtracting the mean outdoor temperature of the day from the desired hover temperature, we show relative heating loads of electric brooders under both cool-room and warm-room brooding situation in Figure 5.

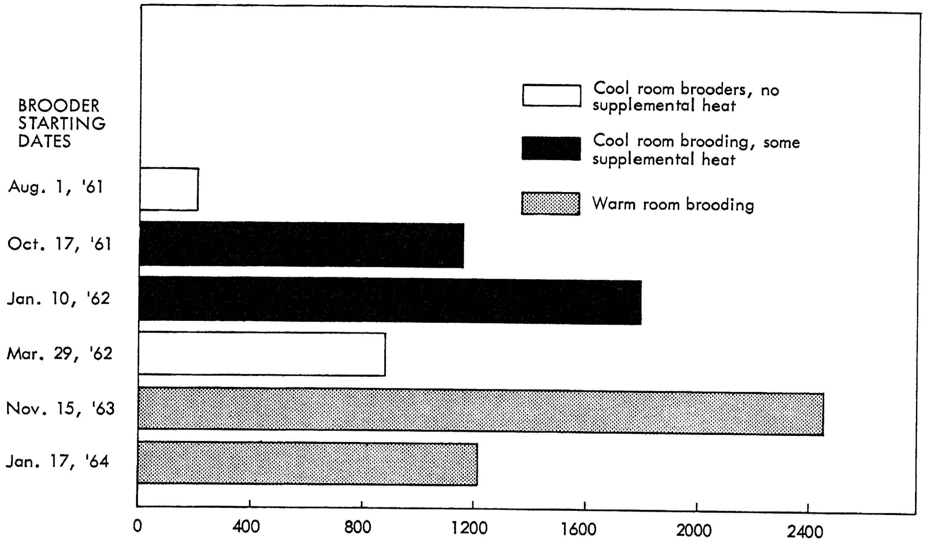

Fig. 5 - Relative heating loads in chick-degree-days for each of six groups brooded under varied broiler house conditions.

Fig. 5—Relative heating loads in chick-degree-days for each of six groups brooded with electric brooders under varied broiler house conditions.

Other Studies - Electric Brooders In Warm House

To determine the cost of operating electric brooders under warm-room conditions, three electric hover brooders were used along with nine gas brooders in a 34 ft. by 150 ft. well-insulated central Missouri house between November 15, 1963, and March 5, 1964. During a six-week brooding period beginning November 13, 1963, when indoor temperature averaged 66°F, the cost of operating three electric brooders, similar to those previously described, was 15.8 mils or 1.58 cents per chick started.

During a three-week brooding period beginning January 17, 1964, when indoor temperature averaged 70°F, the cost of operating the three electric brooders was 9 mils (0.9 cent) per bird started.

The average outdoor temperature during the November 13 - December 27, 1963, period was 26°F. During the January 17 - February 7, 1964 period it was 36°F. During both brooding periods, high indoor temperature was maintained with heat furnished by the nine uninsulated gas brooders and the three electric brooders as no other form of heat was used in this insulated house during these investigations. Each of two electric brooders was bounded on one side by a feed bin as shown in Figure 6, and each used about 1.7 times more electricity than the third unit bounded by a gas brooder on each side. The higher brooding cost in the first test was due to a much longer brooding period and colder weather which combined to make the greater heating load shown in Figure 5. In addition to this, the brooders were used to pre-warm fresh wet sawdust litter that covered the floor of the house. Thus, the electricity used for drying and pre-warming the litter two days before chicks arrived, is included in operating cost figures above.

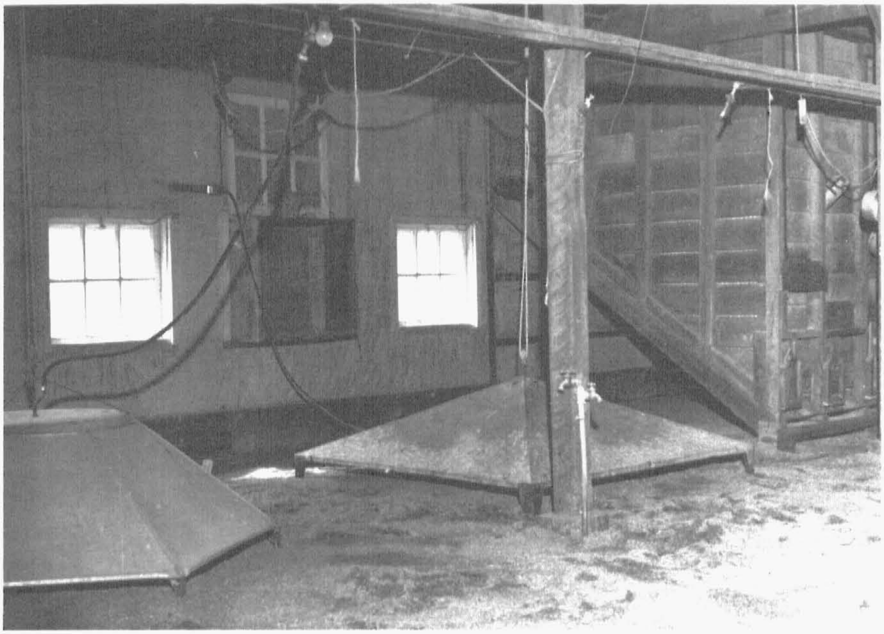

Fig. 6—One of two electric brooders used in warm room study and installed on either side of feed bin. The third brooder used was located between two L.P. brooders.

Summary and Conclusions

Electric brooders perform satisfactorily and economically when used for cool-room brooding if the house construction is good. They also are satisfactory in more poorly constructed broiler houses if used in conjunction with some form of supplemental space heat.

The cost of operating commercial electric brooders under "cool-room" Missouri conditions varied from a low of 0.28 cents per chick (August-September) to a high of 0.82 cents per chick (January-February) when supplemental wood heaters were also used. The average operating cost of brooding nearly 38,000 broilers between August 1 and June 1 was 0.53 cents per chick. With the cost of wood added, the average cost of brooding and heating was 0.66 cents per chick during the same period.

The cost of owning and operating electric brooders, when used on a year-around basis, was 0.97 cents per chick under cool-room conditions. The cost of owning the brooders and heaters was 0.25 cents per chick and additional wiring amounted to 0.06 cents per chick.

While wood stoves added heat to the building, they did not maintain even temperatures because of their manual and irregular operation. While they served to utilize home produced products (wood) they detracted from the inherent safety and convenience of electric brooders.

Type of electric brooders used in the study had the added advantages of dry litter and no gaseous fumes or burning of oxygen under the hover.

The insulated hover confined the heat under the canopy and reduced radiation of heat that would otherwise warm the space in the house. This is an advantage during warm weather months but makes the brooding system more of a "cold-room" system during the winter brooding periods unless other heat is provided.

When compared on an operating basis of 1000 chick-degree-days, electric brooders used 2.05 times as much electricity for the warm-room as for the cool-room, under winter time conditions.

The cost of operating fuel-fired brooders during January and February in this well-insulated, mechanically ventilated brooder house was only one-half the cost of operating identical brooders in adjacent non-insulated houses with manually controlled ventilators. Since supplemental heat was not used in the insulated building, the economics of better insulated housing coupled with reduced heat requirements should be carefully considered for any new construction.