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Some Effects of Environment on Laying Hens

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SOME EFFECTS OF ENVIRONMENT ON LAYING HENS

By

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This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and acceptable as meeting the thesis requirements for this degree; but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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INTRODUCTION

Environment plays an important part in the performance of laying hens. Yet everyone is not agreed as to what kind of an environment should be provided for laying hens.

Good management dictates that laying hens be confined; so, environment to a laying hen is made up of conditions within the house in which she lives. These conditions, in South Dakota, range from poultry houses that put the hen under conditions of stress to houses that offer the hen many comforts.

The principal question is, does money spent on improving the conditions within a house pay for itself? Payments could be in the form of lower mortality, increased production, better feed efficiency or a combination of any or all factors. Among the environmental conditions that may affect the hen's performance are the use of artificial lights, insulation, forced ventilation, cages and management practices.

Artificial lighting and insulation have been and are being studied. The merit of artificial light has long been recognized and its use accepted; however, the merit of insulation in poultry houses is a controversial subject and many houses in South Dakota remain uninsulated. The object of insulating is to hold heat produced by the birds in the house and to prevent outdoor temperatures from seriously affecting indoor temperatures. There is no point in insulating a chicken house unless there are economical benefits derived from insulation.

Ota (1956) reported that adverse temperatures seriously affected

egg production. He reported that hens held at a temperature of 23°F. consumed 19.0 pounds of feed per dozen eggs while hens held at 55°F. consumed 4.8 pounds of feed per dozen eggs. This increase in feed consumption with a decrease in ambient temperature raises the question of whether or not poultry housing in climates such as that in South Dakota is adequate without insulation. Normally, feed consumption constitutes 50 to 60 per cent of the total cost of egg production (Card-1952) and any large increase in feed consumption due to low temperatures will reduce profits to an undesirable level, see Table I below.

Table I. Calculations showing some effects of feed consumed per dozen eggs produced.

Lbs. feed per doz. eggs	Price of feed in cents per lb.	Feed cost in producing a doz. eggs	Sale value of doz. eggs in cents	Profit over feed cost per doz.
9.0	3¢	27¢	30¢	3¢
7.0	3¢	21¢	30¢	9¢
5.0	3¢	15¢	30¢	15¢

Low temperatures cause a hen's feed intake to increase, with the above normal intake being used for the production of body heat. As cited by the South Dakota Crop and Livestock Reporting Service, there are, in South Dakota, four months when the average monthly temperature is below freezing. It is not uncommon for outdoor temperatures to go below zero degrees Fahrenheit and remain there for several days. Thus, it is possible that outdoor temperatures could affect indoor temperatures

in noninsulated poultry houses and lower them to a point where feed consumption increases and/or egg production decreases.

TABLE II. Normal South Dakota temperatures from November through March[1]

Month	Temperature in degrees Fahrenheit
	Monthly normal
November	33.1
December	22.0
January	17.1
February	19.3
March	31.3

1. South Dakota Crop and Livestock Reporting Service. South Dakota Climatological Data. South Dakota Agriculture, p. 6, 1956.

Since temperature variations do occur in a laying hen's life, just what are their effects on production, mortality, and feed efficiency? Except for Ota's work, evidence accumulated along this line is lacking or does not adequately answer the question, particularly from the practical standpoint. The work reported in this paper is an effort to add additional facts to present knowledge of the values of insulation and the effect of different indoor temperatures on mortality, production, and feed efficiency. It is a common practice to call an insulated house "Warm Wall Housing" and a noninsulated house "Cold Wall Housing". This work was chiefly concerned with "warm wall" versus "cold wall" housing.

It was impossible to be certain that production differences were

entirely due to indoor temperatures since cages and fluorescent lights were used in the warm wall house and a floor system and incandescent lights were used in the cold wall house. It is also difficult to say whether cages help or hinder production since investigators report conflicting results.

Specifically, the objective of this paper is to present and compare information on temperature, production, mortality, feed efficiency and calculated income of laying hens in individual cages in an insulated, fan-ventilated house and in floor pens in a noninsulated, gravity-ventilated house.

REVIEW OF LITERATURE

In recent years research workers have given some attention to environmental effects upon laying hens, most of which has been done in the last ten years. However, as early as 1908, the importance of poultry housing was considered. Brigham (1908) stated that "by means of houses we seek to surround the fowl with an artificial climate." Temperature is important, he concluded, and burlap curtains can be put around the roosts and lowered on cold nights to hold heat near the birds and prevent them from getting cold. Previous to this date, little or no consideration was given to housing and its affect on the laying hens.

> Home Counties (1905) whose observations were made in the late 19th century in England, had contrasting ideas about poultry and poultry housing. He stated, "Often the most profitable hens are the ½ dozen kept by the cottager where he is at liberty to let them run. The birds are robust, healthy and pick up most of their own living. What food is given them consists chiefly of house scraps and garden waste, supplemented sometimes by gleanings. The house in which poultry roost is a roughly contrived structure of no great size on which the owner may have spent no more than half a crown (61 cents U. S. currency) in cash". He continued on to state that three per cent of the total expenditure for raising poultry should be in housing.

Carrick (1933) stated, "It is generally agreed that low temperatures affect adversely the hens comfort and thereby egg production". To test this theory he used four rooms, one insulated without artificial heat, one insulated and with a 20°F. minimum temperature, and one insulated and with a 40°F. minimum temperature. The fourth room was a control room similar to the ordinary single walled shed-roofed house with partially open front. There was no difference in numbers of eggs

laid per pullet from December through February. He concluded, " The differences appear not to justify the expenses of such heating". He also remarked that in the insulated house, air flow rates were so great that they allowed little retention of the heat given off by the hens.

Bruckner (1936) found that Leghorn pullets can adapt themselves to different environments readily, providing the change is not too sudden and too extreme. His comparison of insulated and noninsulated houses extended over eight years with supplemental heat being supplied in one insulated and one noninsulated house for a period of three years. Some conclusions he reached included: "1. Winter egg production of the various pens seemed to bear little relationship to annual production. 2. The high winter pens were usually low in production for the summer. 3. A mean temperature of 50° F. or higher in a heated poultry house decreased food consumption as compared to an unheated house." His work showed grain consumption to increase during severe temperature drops with an over all decrease in total feed consumed.

Egg size in the heated pens was significantly smaller than in the unheated pens but hens in the heated houses required less feed to produce a pound of eggs than hens in the unheated house. Mean temperatures of 50° F. in laying pens stabilized winter egg production and prevented slumps in production following cold periods.

Greenwood, of Edinburgh, Scotland, (1953) tested pullets under controlled conditions and conditions normal to that section of the country. Soon after hatching, chicks were divided into two groups, with one group going to the controlled environment and the other group

being maintained under intensive conditions normally used for raising chicks. The controlled environmental conditions were: temperature, 65° F.; relative humidity, 60 per cent; and artificial lighting, 12 hours daily. A dry mash supplemented with mixed grains were fed, without change, to both lots during the course of the experiment.

The hens came into production during the last part of August. At the end of April, the pullets in the controlled temperature room had laid an average of 171 eggs compared to 112 eggs for the pullets maintained under the usual conditions.

Hillerman and Wilson (1955) reported that "body temperature acclimation takes 3-5 days regardless of direction -- hot to cool or cool to hot." A sudden rise in air temperature caused the hen's body temperature to be above normal while a sudden drop in air temperature caused the hen's body temperature to be below normal. They state "It is evident that the 'normal' body temperature of chickens depends on the environmental temperature and also on the extent to which acclimation has occured."

The work of Ota (1956) as discussed previously, demonstrated that temperature had a great affect on feed consumption and egg production. His studies were carried on in oversized calorimeters with ten locally hatched Rhode Island Red hens used in each test. The hens were in their first year of egg production and were kept on litter. Air temperature, relative humidity, ventilation rate, lighting, water, feed and litter management were controlled. The investigation showed that as egg production fell off at low temperatures, egg size increased slightly, whereas small eggs with poor shells were laid at temperatures

above 80° F. to 85° F., see Table III. The least weight of feed per pound of eggs was required at temperatures between 45° F. and 65° F.; the pounds of feed consumed per dozen eggs at 35° F. was 40 per cent more than at 55° F..

The results showed that protecting hens from low temperatures saved feed, while protecting them from high temperatures allowed them to produce at a higher rate of egg production.

> Ota states, "Summer temperatures are much more uniform throughout the nation than are winter temperatures, the July average ranging from below 75° F. in zone 1 (zone 1 includes South Dakota) to above 80° F. in zone 4 (zone 4 includes Florida, South Texas). Maximum temperatures are above 100° F. in all zones. The average January temperatures in zone 1 are below 20° F. but often fall below -30° F. in the colder parts. Sudden temperature changes may cause severe slumps in egg production".

Wilson et al (1957) investigated the effect of various temperatures on egg production of White Leghorn pullets in cages. Three groups of pullets were selected on the basis of maturity and egg production from a larger group of hens. All pullets were hatched, raised together on range, brought indoors, and placed in cages before the selection was made. Two of the groups were put in a calorimeter with one group being held at a constant temperature of 65° F. and the other group at various temperatures starting at 95° F. with the temperature being lowered abruptly 10° F. every third week. Each test was of a three week duration with the first week being considered a time of acclimatization.

TABLE III.

Egg production and feed consumption of Rhode Island Red hens at various constant temperatures and 75 per cent relative humidity (1951-1954)[1, 2]

Air temperature	Eggs per day per 100 hens	Weight of eggs per doz.	Eggs per day	Feed consumption per day per 100 hens	Feed per lb. of eggs	Feed per doz. eggs
° F.	Number	Ounces	Pounds	Pounds	Pounds	Pounds
23	26	24.2	3.3	41	12.3	19.0
37	65	23.9	8.8	35	4.0	6.5
45	74	23.8	9.4	33	3.5	5.4
55	78	23.5	9.5	31	3.3	4.8
65	75	23.2	8.9	29	3.3	4.6
75	68	22.7	7.9	27	3.4	4.8
85	56	22.1	6.5	25	3.9	5.4

1. After a 10 to 14 day period of acclimatization, tests were run for 3 to 6 weeks. Ration was the same at all temperatures.

2. Reproduction from Ota's "Houses and Equipment for Laying Hens." U.S.D.A. Publication, No. 728.

Eight three week periods were observed. The third group was in an unheated room where the temperatures decreased with outdoor temperatures.

Following are portions of two tables from the work reported, consolidated into one table. A is the calorimeter group reduced 10° F. each week, B is the calorimeter group at constant temperature, C is the group in the unheated room.

TABLE IV

Temperature, percentage of egg production and feed consumption of A, B and C groups.[1]

	Period							
	1	2	3	4	5	6	7	8
Approx. Temp. ° F.								
A	95	85	75	65	56	47	35	27
B	65	65	65	65	65	65	65	65
C	77	77	75	67	56	55	55	50
Egg Prod. %								
A	58.5	66.7	64.1	51.8	63.0	54.7	39.2	26.7
B	62.5	77.6	70.4	51.4	67.5	65.3	60.0	55.7
C	72.0	78.6	72.3	59.3	62.0	69.4	60.4	54.7
Average Feed Consumption in gms./hen/day								
A	64	85	92	102	103	115	115	114
B	107	102	105	108	104	108	112	100
C	97	94	96	103	114	114	113	112

1. Figures taken from the studies of Wilson et al, "Temperature and Calorimeter Study on Hens in Individual Cages." Poultry Science 36: 1254-1261. 1957

Within the range of 48° F. to 85° F., egg production was not reduced by variations in temperature. A constant 27° F. temperature severely reduced production and increased group A daily feed intake per 100 hens over group B intake by three pounds. Group A showed the lowest average egg production and group C. the highest egg production.

Since results of research conflict as to whether cages are beneficial or detrimental to egg production, it might be of value to cite the results of some cage versus floor comparisons.

> Lowry et al (1956) reported, "In an experiment extending over four years the means and variabilities of egg production traits of pullets housed in floor pens were compared with means and variabilities for their full sisters housed in individual cages. The floor pullets were found usually to be superior in performance for the mean production of survivors while caged pullets always showed significantly lower mortality, heavier eggs and higher incidence of blood spots. Consistent significant differences could not be demonstrated for other traits studied, namely the production index and sexual maturity".

Gowe (1956) tested seven strains of White Leghorns in a cage versus floor experiment. His results indicated that some strains can adapt themselves to cages better than other strains. He concluded,

> "There was a highly significant interaction between strains and locations (floor, pen, and battery) with respect to survivor egg production and March body weight."
>
> "There was no evidence of any inter-action between strains and locations for the following traits, hen-housed egg production, sexual maturity, March egg weight and laying house mortality".

Robertson (1956) reported that during the 1954-55 laying season, cage layers, of the same strain as the floor layers, out produced the floor flock by eight per cent and required .94 less pounds of feed per dozen eggs produced. Using S. C. W. Leghorns in the 1955-56 laying year in six comparisons, he found that the average feed required by the cage layers was .35 pounds less per dozen eggs produced and that egg production was 4 per cent higher than the floor layers.

MATERIAL AND METHODS

Data presented in this study were collected at South Dakota State College, Brookings, South Dakota, from experiments being carried on at the Department of Poultry Husbandry.

Two different buildings were used for this work. One was a newly constructed frame 32' x 50' windowless, fan-ventilated and insulated house. Double blanket insulation was used in the walls with ground corn cobs used above the ceiling. A plastic vapor barrier protected the insulation with an inside wall of one inch shiplap protecting the vapor barrier and giving support to the insulation.

This house employed a thermostatically controlled fan ventilation system capable of delivering 3,250 cubic feet of air per minute at 1/8 inch static pressure. Exhaust ventilation was used during fall and winter months. This allowed air to move from the attic into the house through 3/4" slots which were in the ceiling and located next to each side wall. Louvers in each end of the attic allowed outside air to enter the attic and be prewarmed before entering the house. When the warmer temperatures of summer approached, the fan was reversed, thus employing intake ventilation and allowing air to exit by way of the three screened doors in the house. The ventilating system was connected to two thermostats which operated over a three degree range. One thermostat controlled a set of shutters behind the fan and regulated the volume of air the fan would move. The other thermostat was connected to the motor driven fan as a safety precaution. In the event the shutters would not close the

fan would shut off before the house temperature dropped too low.

All pullets in the insulated house were kept in cages. During the 1956-57 production year four hundred eighty birds were kept in individual 8"x16"x16" cages and two hundred twenty-nine birds in sixteen colony cages capable of holding twenty birds each. Two hundred forty more individual cages were added for the 1957-58 production year.

The insulated house also employed fluorescent lights and an automatic watering system. Time clocks on the lighting system were set to give the hens fourteen hours of light, coming on at 5:00 A. M. and going off at 7:00 P. M. The watering system consisted of individual water cups. Each cup serviced two hens in the individual cages while two cups serviced a colony cage.

The cold wall house was the north wing of a larger house. This house was a wooden structure. The ceiling consisted of a 3/4 inch insulation board over shiplap and under a 3-ply built-up tar paper type roof. Total insulation value, or resistance rating, of the ceiling was 4.07. A resistance rating of 15 was recommended by Bonser, et al, (1955), for South Dakota. The walls of this house consist of sheathing, building paper and drop siding with a total resistance rating of 2.64. A resistance rating of 10 is recommended for walls in South Dakota, (Bonser, et al, 1955).

In the insulated house the resistance rating of the wall was 10.06 and that of the ceiling, 24.0.

Because the resistance ratings in the cold wall house were so low, it was called a "noninsulated" house in this study.

Ventilation in the "noninsulated" house was controlled chiefly by closing and opening windows. A small 12 inch fan of unknown capacity was located in the north end of the house and was controlled by an off-on switch. Incandescent lights were automatically controlled to give the hens a fourteen hour day. All hens in this 120' x 30' wing were in floor pens. The wing was divided into 16-10' x 12' pens and 4-20' x 12' pens with each pen having trough type feeders. Each pen had a watering pan which was filled manually during mild and warm weather from a faucet within the pen. In cold weather, the water in the pipes located along the walls of the house could easily freeze so use of the pipes was discontinued and water was carried into the pens by a pail. A six foot alleyway through the center of the house allowed for entrance to each pen. The floor in the entire house was concrete and straw was used for litter. Eggs were gathered by hand from individual type trap nests.

Full sisters, hatched, brooded and reared together were used in the first year's study. At housing time, they were divided into two groups, one group going into the noninsulated floor pen house and the other group into individual cages in the insulated house. For the second year's study the pullets used in the insulated house in individual cages were one month older than their sisters in the floor pens of the noninsulated house.

Two types of laying hens were used in the studies with most of the hens being S. C. W. Leghorns from the College flock and the remaining hens being commercial hybrids. The hybrids were used only in the insulated house with a different hybrid being used each year as a comparison to the College stock.

Daily high-low temperature readings were taken within each house as well as outdoor high-low temperature readings. House temperatures were obtained by carefully locating the thermometers so as to give the most representative readings. Daily outdoor high-low temperatures were obtained from W. A. McMillan, Brookings volunteer weather observer, for the month of October 1956. Thereafter daily high-low outdoor temperatures were recorded on the same type of a high-low thermometer used in the two housing systems. Location of the outdoor thermometer was approximately half way between the two housing systems, which were about 450 feet apart. High, low and mean outdoor temperatures were compared with similar indoor temperatures in the two houses. Mean temperatures are an average of the high-low or maximum and minimum temperatures reached during each day.

Feed consumption for all pens was kept on a monthly basis.

Mortality and egg production were recorded daily and summarized monthly.

All hens were fed an all mash ration which was considered to be adequate for both cage and floor pen egg production.

As previously mentioned, all hens housed in both units were concerned with the temperature study in that they helped to maintain temperature. These numbers were 709 and 962 respectively in the insulated house for the 1956-57 and 1957-58 laying seasons. Eight hundred-eighty birds were started each season in the noninsulated house. Mortality, feed efficiency and production records were kept on 120 Leghorns and 120 hybrids in the insulated house and 336 Leghorns in the noninsulated house in the first season. Numbers for the second season were the same

in the noninsulated house while the numbers in the insulated house changed to 60 White Leghorns and 180 hybrids.

EXPERIMENTAL RESULTS

Temperature

Temperatures in the insulated cage house, as shown in Tables V and VI were near optimum, while temperatures in the noninsulated house were often below optimum. Ota (1955) showed 55° F. to be the optimum temperature for laying hens. The average low temperature in the insulated house for the 1956-57 laying year was 54.8° F. as compared to 42.8° F. in the noninsulated house. Averages include warm fall and spring months and tend to raise the low averages encountered in the heart of winter.

During the winter months of the 1956-57 laying year mean temperatures in the insulated house were well above those in the noninsulated house. January's outdoor mean of 7.9° F. produced a mean of 34.9° F. in the noninsulated house, as compared to a mean of 50.8° F in the insulated house. January's outdoor average low of -1.9° F. produced average lows of 46.6° F. in the insulated house and 29.1° F. in the noninsulated house. December's outdoor average low of 14.8° F. produced average lows of 52.8° F. in the insulated house and 39.4° in the noninsulated house. February and March showed results similar to December and January. The lowest monthly average encountered during the 1956-57 season in the insulated house was 46.6° F. as compared to 29.1° F. in the noninsulated house. The data for the 1957-58 season verified that obtained in the 1956-57 season. A severe outdoor temperature drop caused a severe temperature drop within the noninsulated house but not within the insulated house. These fluctuating temperatures in the noninsulated house subjected hens to temperature changes within short periods of time.

However, insulation did not keep the insulated house cool on warm days. A rule of thumb during spring and fall months was that high temperatures in the insulated house would be approximately ten degrees warmer than the outdoor high. High temperatures in the non-insulated house were also above the outdoor high for both seasons with the exception of October 1956.

TABLE V.

Average monthly high and low temperatures in the insulated house and in the non-insulated house, October 1956 through June, 1957.

Month	Thermometer location	Degrees Fahrenheit Average monthly high	Average monthly low	Difference	Monthly mean
Oct.	Insulated house	81.3	57.9	23.4	69.6
	Non-insulated house	68.0	47.5	20.5	57.8
	Outdoor	70.0	40.6	29.4	55.3
Nov.	Insulated house	65.7	51.8	13.9	58.8
	Non-insulated house	50.8	42.1	8.7	46.4
	Outdoor	40.7	30.0	10.7	35.4
Dec.	Insulated house	61.5	52.8	8.7	57.2
	Non-insulated house	48.4	39.4	9.0	43.9
	Outdoor	32.4	14.8	17.6	23.6
Jan.	Insulated house	55.1	46.6	8.5	50.8
	Non-insulated house	40.7	29.1	11.6	34.9
	Outdoor	17.7	-1.9	19.6	7.9
Feb.	Insulated house	56.2	49.6	6.6	52.9
	Non-insulated house	45.6	34.1	11.5	39.8
	Outdoor	30.8	9.7	21.1	20.2
Mar.	Insulated house	64.4	51.0	13.4	57.7
	Non-insulated house	50.1	37.3	12.8	43.7
	Outdoor	40.5	19.5	21.0	30.0
Apr.	Insulated house	67.1	54.0	13.1	60.6
	Non-insulated house	62.0	45.5	16.5	53.8
	Outdoor	57.4	33.0	24.4	45.2
May	Insulated house	74.2	58.6	15.6	66.4
	Non-insulated house	66.7	50.9	15.8	58.8
	Outdoor	66.1	44.3	21.8	55.2
June	Insulated house	83.8	71.0	12.8	77.4
	Non-insulated house	76.0	59.5	16.5	67.8
	Outdoor	73.8	55.2	18.6	64.5
Seasonal Average	Insulated house	67.7	54.8	12.9	61.2
	Non-insulated house	56.5	42.8	13.7	49.6
	Outdoor	47.7	27.2	20.5	37.4

The average of monthly mean temperatures showed temperatures within both houses to be in a desirable range.

An inspection of monthly high and low temperature means revealed that low temperatures in the insulated house moved slowly in the direction of outdoor temperatures. Lows in the noninsulated house were more inconsistent and followed outdoor temperatures to a greater extent. Warm fall and spring weather caused temperatures in the insulated house to approach the undesirable. Great differences existed between monthly highs and lows in the two systems with the greatest variation occuring in the noninsulated house. The noninsulated house operated over a more erratic and lower range of temperatures.

TABLE VI.

Average monthly high and low temperatures in the insulated house and in the non-insulated house, October 1957 through February 1958.

Month	Thermometer location	Degrees Fahrenheit			
		Average monthly high	Average monthly low	Difference	Monthly mean
Oct.	Insulated house	66.4	55.4	11.0	60.9
	Non-insulated house	60.4	48.1	12.3	54.3
	Outdoor	55.7	39.4	16.3	47.6
Nov.	Insulated house	57.7	50.9	6.8	54.3
	Non-insulated house	50.5	40.4	10.1	45.5
	Outdoor	38.3	24.8	14.0	31.8
Dec.	Insulated house	56.2	52.2	6.4	55.4
	Non-insulated house	48.3	37.9	10.4	43.1
	Outdoor	34.5	17.4	17.1	25.9
Jan.	Insulated house	59.2	53.0	6.2	56.1
	Non-insulated house	46.4	35.6	10.8	41.0
	Outdoor	30.0	13.6	16.4	21.8
Feb.	Insulated house	60.0	51.5	8.5	55.8
	Non-insulated house	44.9	32.3	12.6	38.6
	Outdoor	25.7	5.5	20.2	15.6
Aver-age	Insulated house	60.4	52.6	7.8	56.5
	Non-insulated house	50.1	38.9	11.2	44.5
	Outdoor	36.9	20.1	16.8	28.5

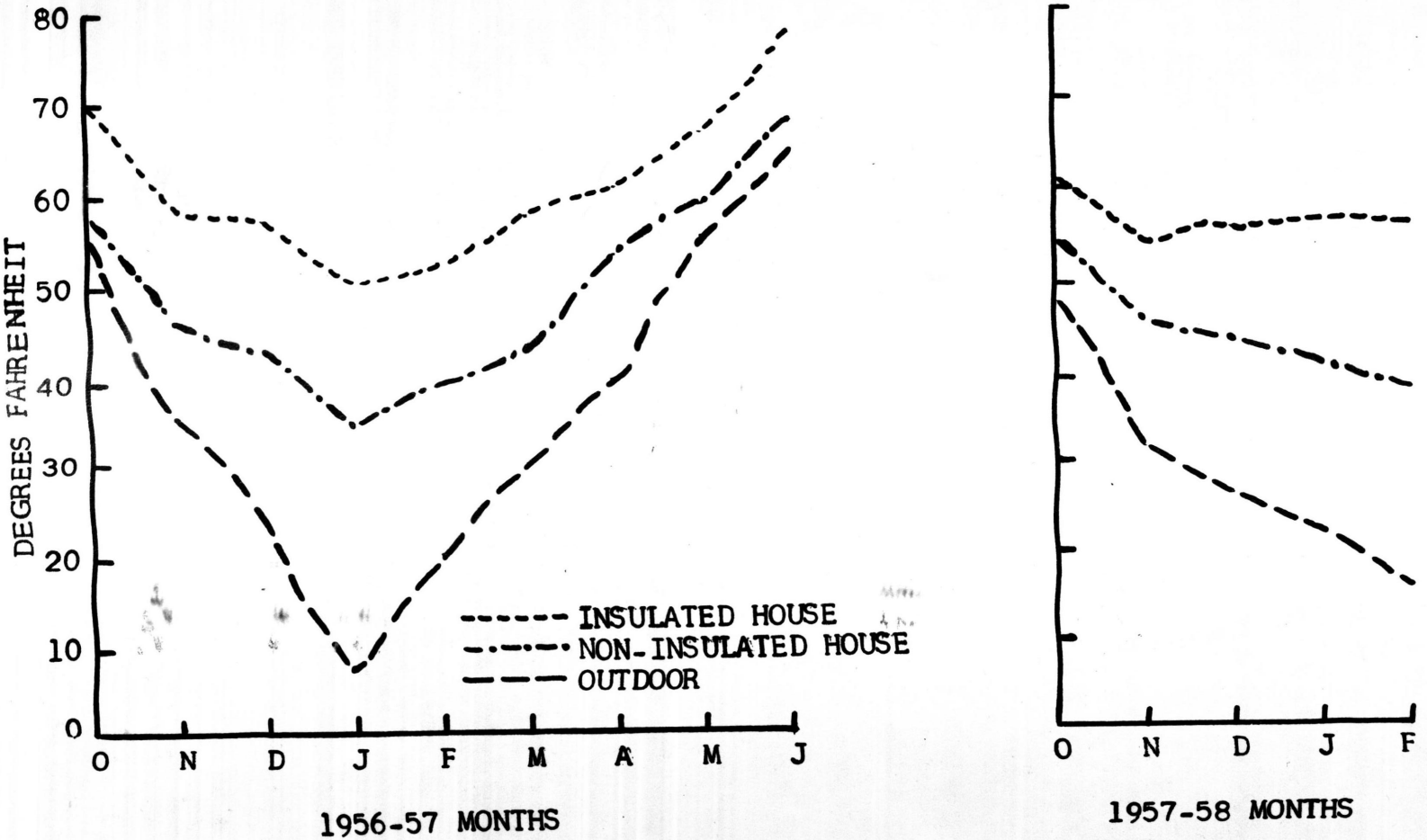

Figure 1. Monthly indoor and outdoor mean temperatures.
Department of Poultry Husbandry, South Dakota State College.

Egg Production

White Leghorns in the insulated house produced eggs at a higher over all rate during the months covered in both seasons, than did their full sisters in the noninsulated house, as is shown in Tables VII and VIII. Hybrids in both seasons out-produced the College open stock White Leghorns.

During the 1956-57 season, Leghorns in the insulated house had an average production of 60.67 per cent which was 5.91 per cent better than the 54.76 per cent average for the Leghorns in the noninsulated house. The Leghorns in the insulated house came into production faster, laying 23.8 per cent more eggs in September than their sisters in the noninsulated house. They held their advantage in production until February, after which they were slightly behind their sisters in the noninsulated house on the monthly basis. It appeared that the hens in the noninsulated house were compensating for low fall production by increased spring production.

> Card (1952) states, "In terms of annual egg production it is reasonable to assume that small eggs will be offset by large eggs and that the effect of low temperatures will be offset by periods of high temperature."

For the corresponding months of the two years the results were somewhat different with respect to the S. C. W. Leghorns in the two houses.

White Leghorns in the noninsulated house came into production faster in 1957-58 than in the previous season but lost their advantage with the onset of cold weather and fell behind their older sisters in the insulated house by 1.5 per cent at the end of February. Unfortunately exactly comparable groups were not represented in the two houses in the latter season.

TABLE VII.

Average percentage production for the 1956-57 production year

	Per cent Production*		
	Insulated house cage system		Non-insulated house floor system
Month	Leghorn	Hybrid A	Leghorn
September	63.8	75.4	40.0
October	72.8	75.1	58.9
November	70.4	72.1	51.5
December	66.5	69.3	57.9
January	59.8	62.8	55.8
February	57.0	60.6	57.2
March	58.6	62.8	60.5
April	55.5	57.7	59.6
May	52.5	55.4	55.5
June	46.4	53.3	53.5
Average	60.7	64.8	54.8

*Hen day basis

A comparison between the hybrids and Leghorns in the insulated house showed the hybrid A for the 1956-57 season to have a 4.1 per cent greater egg production average. Their monthly production was above the Leghorns for the entire season. Another hybrid versus Leghorn study for five months of the 1957-58 season showed the hybrids, which were different than the ones used the previous season, to be ahead in production by 11.28 per cent.

TABLE VIII.

Average percentage production, Oct. 1957 through Feb. 1958

Month	Per cent Production*		
	Insulated house cage system		Non-insulated house floor system
	Leghorn	Hybrid B	Leghorn
October	61.2	76.3	71.4
November	66.5	75.8	69.6
December	63.2	74.8	65.3
January	58.5	72.7	52.6
February	57.7	68.9	40.7
Average	61.42	73.70	59.92

*Hen day basis

Mortality

Mortality for Leghorns in the insulated house was considerably lower during the 1956-57 season than in the noninsulated floor house

as shown in Table IX; however, little difference was observed in mortality to the end of February for the 1957-58 season as shown in Table X. No consistent pattern was observed for mortality.

TABLE IX.
Average monthly mortality of hens for the 1956-57 production year

	Per cent Mortality*		
	Insulated house		Non-insulated house
Month	Leghorn	Hybrid A	Leghorn
September	1.7	.8	2.6
October	.8	.0	3.3
November	.8	.8	1.6
December	1.7	3.4	2.4
January	1.7	1.7	2.1
February	.9	.9	2.1
March	2.6	.9	1.8
April	3.6	3.6	1.8
May	.0	.0	4.1
June	.0	3.7	3.5
Average	1.4	1.6	2.5

*Hen day basis. Number of hens in a pen that died during a given month divided by the number of hens that began the month.

Hen housed mortality in the insulated cage house for the 1956-57 period was 13.33 per cent or 10.20 per cent less than mortality in the noninsulated floor house which was 23.53 per cent. Comparing hybrids to Leghorns in the insulated house on a hen housed basis for the same period showed the hybrids to have a 15 per cent mortality which was 1.67 per cent higher than the 13.33 per cent mortality in the Leghorns.

TABLE X.

Average monthly mortality of hens
for the months Oct. 1957 through Feb. 1958.

	Per cent Mortality*		
	Insulated house		Non-insulated house
Month	Leghorn	Hybrid B	Leghorn
October	1.7	.55	2.5
November	1.7	.0	1.3
December	3.4	.55	.32
January	1.7	.0	1.6
February	1.8	.56	4.0
Average	2.06	.33	1.94

*Hen day basis. Number of hens in a pen that died during a given month divided by the number of hens that began the month.

The results for October through February of the 1957-58 season showed that Leghorns in the insulated house had a hen housed mortality of 10.00 per cent which was .57 per cent more than Leghorns in the non-insulated house. For the same period in the insulated house, Leghorn mortality was 3.33 per cent greater than the hybrid mortality which was 1.67 per cent.

Average monthly mortality on a hen day basis was more erratic for hybrid A than for the Leghorns for the 1956-57 season. In five of the ten months, Leghorns in the insulated house had monthly mortality of less than one per cent in the noninsulated house. Hybrid B showed a much lower mortality rate than hybrid A, for the period compared, but different seasons may have had an effect on hens.

Feed Efficiency

TABLE XI.

Average monthly feed efficiencies for the 1956-57 production year.

	Pounds of feed per dozen eggs produced		
	Insulated house cage system		Non-insulated house floor system
Month	Leghorn	Hybrid A	Leghorn
September	5.01	3.64	6.31
October	4.69	3.92	4.83
November	5.12	4.49	6.44
December	5.53	4.69	5.81
January	5.61	4.72	8.24
February	6.23	5.68	6.20
March	6.33	5.25	5.80
April	6.39	5.07	5.41
May	6.19	5.04	6.44
June	7.67	6.24	5.66
Average	5.91	4.81	6.13

Leghorns in the noninsulated house consumed more feed per dozen eggs produced than hens in the insulated house for the 1956-57 production season as is shown in Table XI. No difference appeared in feed consumption between the two systems for months compared in the 1957-58 production year as is shown in Table XII. Hybrids required considerably less feed, than did the Leghorns, per dozen eggs produced during both seasons.

TABLE XII

Average monthly feed efficiencies
for
the months October 1957 through February 1958.

	Pounds of feed per dozen eggs produced		
	Insulated house cage system		Non-insulated house floor system
Month	Leghorn	Hybrid B	Leghorn
October	4.95	4.28	4.26
November	4.62	4.03	4.42
December	5.08	4.28	4.79
January	5.89	4.54	5.72
February	5.61	4.70	6.97
Average	5.23	4.37	5.23

Except for the S. C. W. Leghorns in the noninsulated house, the 1956-57 monthly average for pounds of feed required per dozen eggs produced increased gradually toward the end of the production year. Feed efficiency for the floor pen Leghorns during that season was erratic with consumption per dozen eggs ranging from 4.83 to 8.24 pounds. The figure for pounds of feed consumed per dozen eggs produced went to 8.24 in January, the coldest month of that laying season. Each house utilized a different type feeding trough with no measurement being made on feed wastage.

The amount of feed consumed per dozen eggs produced increased rapidly in June for the Leghorns and hybrids in the insulated house, while a decrease was observed in the noninsulated house. See Table XI, page 26.

Calculated income per hundred hens

Leghorns in the insulated house showed a much larger income over feed costs per hundred hens and per hundred hens started than did the Leghorns in the noninsulated floor system for the 1956-1957 laying season. Leghorns in the same two houses, for the period covered in 1957-58 were much closer in income over feed costs, with the noninsulated floor birds having a slight advantage. As compared to the Leghorns in the insulated house, hybrids showed a greater income over feed costs per hundred hens and per hundred hens started for both seasons. (See appendix A for tables showing these data.)

Each one hundred Leghorns started during the 1956-57 season in the insulated house netted $45.61 more, over feed costs, than their full sisters in the noninsulated house. This advantage might not have existed if the test were run for a full laying year. Nor was this advantage evident in the period covered in 1957-58 season. The S. C. W. Leghorns in the noninsulated house at the end of February were ahead of the S. C. W. Leghorns in the noninsulated house in income over feed costs per hundred hens started by $6.43.

Hybrid A, during the 1956-57 season showed $14.49 more calculated income over feed costs per hundred hens started than did the Leghorns in the same house. Hybrid B, for the period observed in the 1957-58 season showed $15.75 more calculated income over feed costs per hundred hens started than the Leghorns in the same house.

S. C. W. Leghorns in both houses for the 1956-57 season showed the highest monthly calculated income over feed costs per hundred in October.

Those in the insulated house showed a $27.86 excess over feed cost. Lowest calculated income was shown in January, by the S. C. W. Leghorns in the noninsulated house when feed cost exceeded income by $4.00 per hundred hens.

The highest calculated income by months, over feed costs per hundred hens was shown by the hybrids. In October of 1956, an excess of egg income over feed cost per hundred hens of $30.69 was shown, while in November of 1957, a $43.32 excess of egg income over feed cost was shown.

The best income from the S. C. W. Leghorns, during the period checked in the 1957-58 season, was shown in the noninsulated house. This occurred in November and for each hundred hens was $39.11 over feed costs. Similar November income for Leghorns in the insulated house was $35.43.

In both seasons, cold weather seriously reduced income in the non-insulated house.

DISCUSSION

For the 1956-57 production year, results obtained with the insulated house surpassed those of the noninsulated house in all aspects. Indoor temperatures in the insulated house were within the optimum range regardless of outdoor temperatures. Production was higher in the insulated house, mortality was less and pounds of feed required per dozen eggs produced was slightly less. Temperature in the noninsulated house dropped below freezing in severe cold weather which subjected hens to cold as well as fluctuating temperatures. Table XIII below shows a summation for the 1956-57 production year.

TABLE XIII.

Summation of average egg production, mortality, and pounds of feed required per dozen eggs produced, September 1956 through June 1957.

Month		Insulated house cage system		Noninsulated house floor system
		Leghorn	Hybrid A	Leghorn
September through June	Hen housed mortality	13.33	15.00	23.53
	Per cent production	60.67	64.81	54.76
	Pounds feed per dozen eggs	5.91	4.81	6.13

At housing time for the first year's study, the Leghorns and hybrids both had mild colds. Pullets going into the insulated house seemed to recover rapidly from this condition while those in the noninsulated house did not seem to recover completely. Lower and fluctuating temperatures

in the noninsulated house could have placed a stress on the pullets which kept them from recovering as quickly as the pullets in the insulated house.

The lower fall egg production, higher feed consumption and higher mortality could be partially explained on the basis of this increased stress. Pullets housed for the 1957-58 production year showed no symptoms of colds. After five months of production, the Leghorns in the noninsulated house were behind the older Leghorns in the insulated house by a negligible .86 per cent as compared to 13.85 per cent for sisters of identical age the previous year.

An average of the first five months of production for the two years showed the Leghorns in the insulated house to be ahead of their sisters in the noninsulated floor house in all aspects as shown by Table XIV. Hybrids in the insulated house for the same period were superior to the Leghorns in the same house.

Before the 1957-58 laying season began, cannibalism had broken out in the pullets. To prevent high mortality, all of the young pullets were debeaked. Debeaking appeared to be more detrimental to pullets put in individual cages, since they had to use their beak to operate the individual drinking cups, whereas it probably was not as severe a set-back for the pullets in floor pens drinking from pans.

TABLE XIV.

Comparison between and averages for the first five months of the 1956-57 and 1957-58 production years.

		Year			
		1956-57		1957-58	
		Leghorns	Hybrid A	Leghorns	Hybrid B
Insulated house cage system	Per cent Production*	66.67	70.94	61.71	73.81
	Hen housed mortality %	6.67	6.67	10.00	1.67
	Lbs. Feed per dozen eggs	5.19	4.30	5.17	4.35
Noninsulated house floor system	Per cent Production*	52.82		60.85	
	Hen housed mortality %	11.76		9.43	
	Lbs. feed per dozen eggs	6.33		5.18	

*Hen day basis.

Humidity in the insulated cage house was higher during the 1956-57 season than during the 1957-58 season. Factors that seemed to correct the situation for the second year included revamping the automatic watering system to prevent leaks, adding more hens, and a more adequate control of the ventilating system. To a greater extent during the first season, the wire cages would become damp, collect dust from the air and "wire mark" the egg as it rolled out of the cage. This "wire marking" was greatly reduced the second year.

The noninsulated house required frequent cleaning of the pens, or litter removal. Frost collected on the walls on cold nights and remained there continually during some cold periods. With a rise in day-time indoor temperatures, the frost melted, evaporated into the air or ran

onto the floors and increased the wet litter problem. This condition necessitated frequent cleaning of the pens and caused the production of a high percentage of soiled eggs.

From the results of this study with two commercial hybrids as compared to the College S. C. W. Leghorns, it appeared that buying chicks bred for high egg production paid dividends, even though there was a higher investment in chicks. Allowing for the cost of the hybrid chicks at $6h.00 per hundred and the Leghorns at $32.00 a hundred, the hybrids still netted $1h.07 more per one hundred hens started in the 1956-57 season. Similar results were obtained for the months checked in the 1957-58 laying season. (See appendix A.)

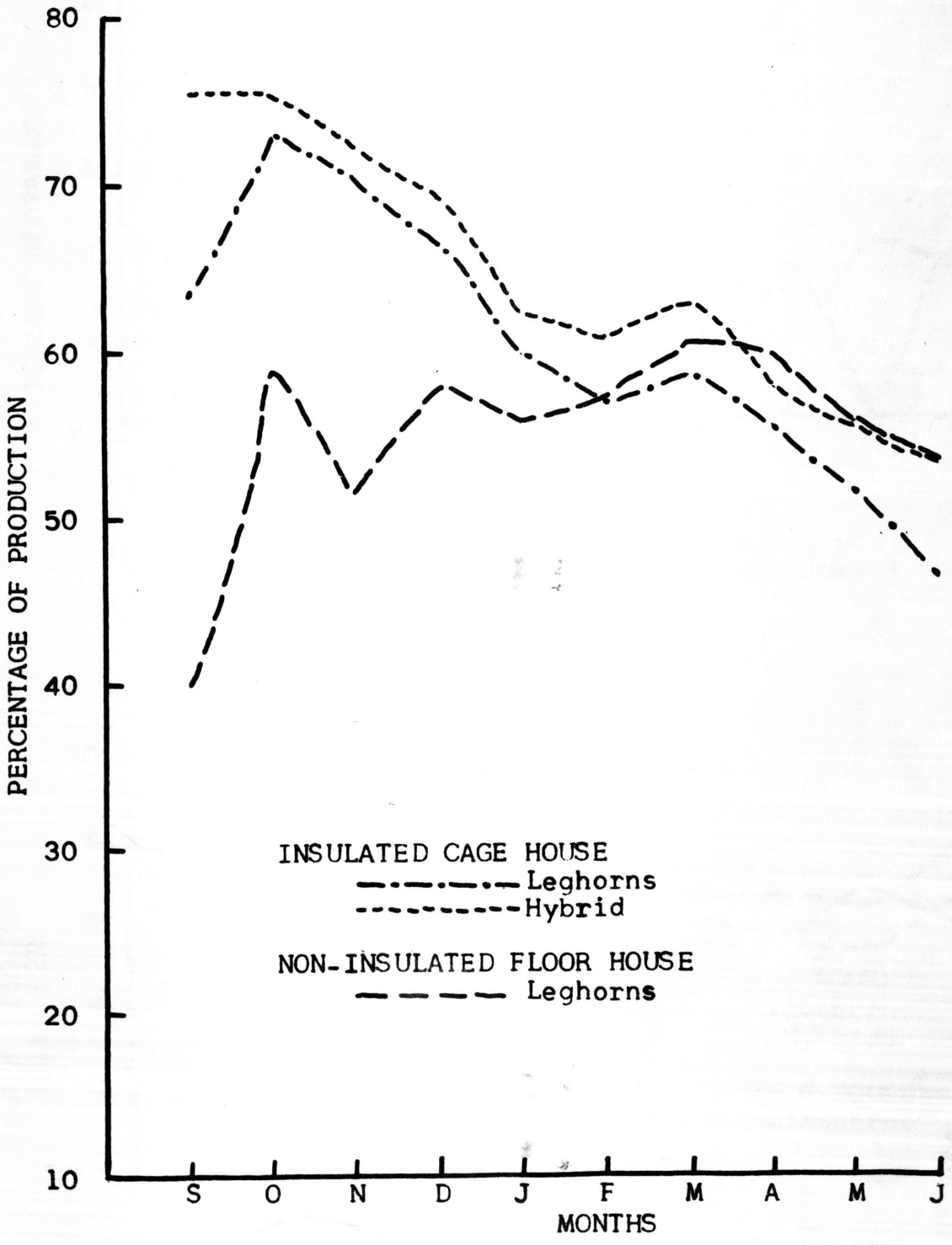

Figure 2. Average percentage of production by months from September through June for the 1956-57 production year.

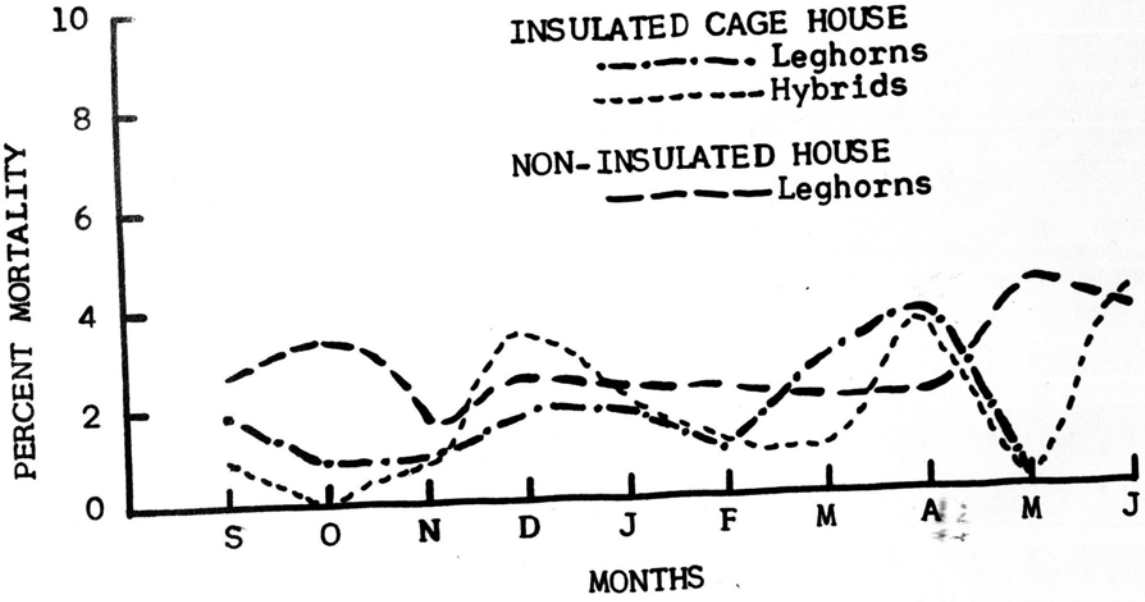

Figure 3. Average percentage of mortality by months, September 1956 through June 1957. Hen day basis.

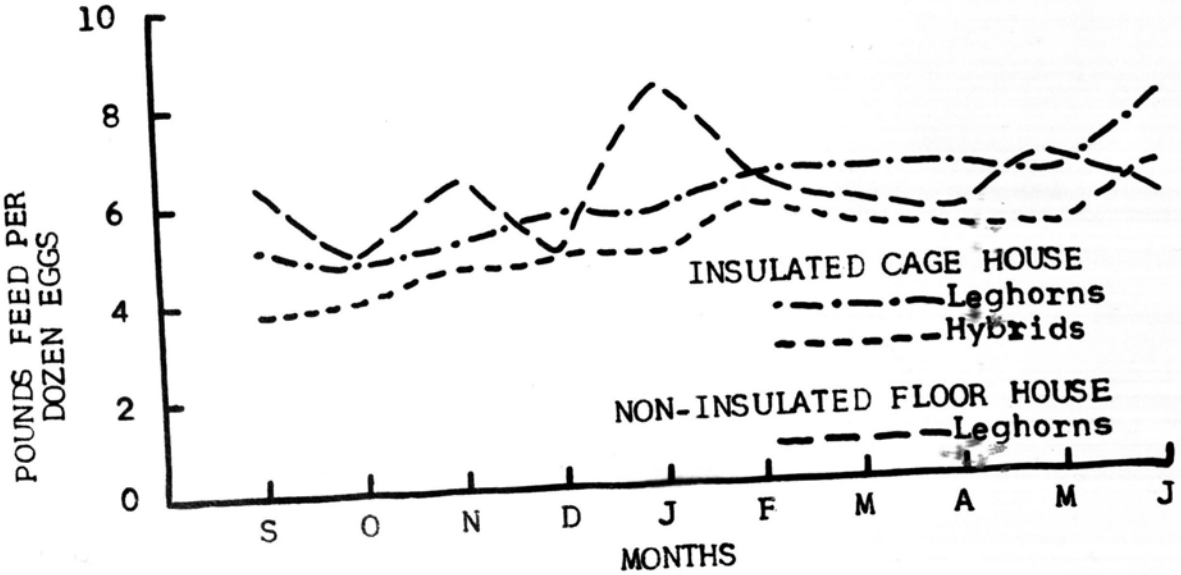

Figure 4. Average pounds of feed consumed per dozen eggs by months from September through June for the 1956-57 production year.

SUMMARY

Data presented here indicate that an insulated house provides a more favorable environment for laying hens and thus allows for more profitable egg production, particularly under conditions of stress, than is provided with a noninsulated house.

Temperatures in the insulated house remained near the optimum level during severe cold weather while temperatures in the noninsulated house dropped to below freezing. Pullets housed in the insulated house showed a higher percentage of production, consumed less feed per dozen eggs produced, and had lower mortality than pullets housed in the non-insulated house. In the insulated house commercial hybrids consistently out performed the closed flock Single Comb White Leghorns. More research should be carried out to substantiate these conclusions, particularly since the chickens in the noninsulated house were in floor pens with incandescent lights and those in the insulated house were in individual cages with fluorescent lights.

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APPENDIX

TABLE XV. Monthly income over feed costs for S.C.W. Leghorns in the insulated house, cage system, September 1956 through June 1957.

	Per 100 hens*								
Month	Cost of poultry ration per lb.**	S. D. eggs cents per doz+	Lbs. feed required	Feed cost in $	No. doz. eggs	Egg income in $	Income over feed costs	Per cent mortality accumulative	Income per 100 hens started!
Sept.	3.03	28.1	799.2++	24.22	159.5	44.82	20.60	1.67	20.26
Oct.	2.95	27.4	792.5	23.38	187.0	51.24	27.86	2.50	27.16
Nov.	3.00	24.9	900.8	27.02	176.1	43.84	16.82	3.33	16.26
Dec.	3.03	24.8	950.8	28.81	171.9	42.63	13.82	5.00	13.13
Jan.	3.03	22.2	863.8	26.17	153.9	34.17	8.00	6.67	7.47
Feb.	2.98	23.8	832.5	24.81	133.6	31.80	6.99	7.50	6.47
March	2.94	23.0	962.5	28.30	152.1	34.98	6.68	10.00	6.01
April	2.98	23.6	888.1	26.47	139.0	32.80	6.33	13.33	5.49
May	2.95	21.8	839.2	24.76	135.6	29.56	4.80	13.33	4.16
June	2.89	22.7	890.7	25.74	116.2	26.38	0.64	13.33	0.56
Total			8,720.1	259.68	1,524.9	372.22	112.54		$106.97
Cost per 100 chicks									32.00
Income less feed and chick cost									74.97
Salvage value of each 100 hens started				5.33 lbs. x 86.67 hens x 12¢					55.43
Income per 100 hens started									130.40

*Based upon monthly average number of hens.

**Cost of poultry ration per pound taken from Agricultural Prices by U. S. Department of Agriculture.

+Average price of S. D. eggs taken from Agricultural Prices by U. S. Department of Agriculture.

++Estimated pounds of laying mash consumed in September.

!Does not include labor, buildings or equipment depreciation or brooding and rearing expenses.

TABLE XVI. Monthly income over feed costs for S.C.W. Leghorns in the noninsulated house floor system, September 1956 through June 1957.

	Per 100 hens*								
Month	Cost of poultry ration per lb.**	S. D. eggs cents per doz+	Lbs. feed required	Feed cost in $	No. doz. eggs	Egg income in $	Income over feed costs	Per cent mortality accumulative	Calculated Income per 100 hens started!
Sept.	3.03	28.1	687.6++	20.83	100.3	28.18	7.35	2.93	$ 7.14
Oct.	2.95	27.4	720.9	21.27	149.3	40.91	19.64	6.16	18.43
Nov.	3.00	24.9	842.6	25.28	130.7	32.54	7.26	8.50	6.64
Dec.	3.03	24.8	878.1	26.61	151.1	37.47	10.86	10.46	9.72
Jan.	3.03	22.2	1,187.1	35.97	144.0	31.97	-4.00	11.76	-3.53
Feb.	2.98	23.8	832.5	24.81	134.3	31.96	7.15	13.72	6.17
March	2.94	23.0	912.0	26.81	157.3	36.18	9.37	14.70	7.99
April	2.98	23.6	808.9	24.11	149.5	35.28	11.17	16.99	9.27
May	2.95	21.8	926.7	27.34	144.0	31.39	4.05	20.59	3.22
June	2.89	22.7	758.3	21.92	133.9	30.40	8.48	23.53	6.32
Total			8,554.7	254.94	1,394.4	336.28	81.33		71.73
Cost per 100 chicks									32.00
Income less feed and chick cost									39.73
Salvage value of each 100 hens started					4.91 x 76.47 x 12¢				45.06
Income per 100 hens started									84.79

*Based upon monthly average number of hens.

**Cost of poultry ration per pound taken from Agricultural Prices By U. S. Department of Agriculture.

+Average price of S. D. eggs taken from Agricultural Prices By U. S. Department of Agriculture.

++Estimated pounds of laying mash consumed in September.

!Does not include labor, buildings or equipment depreciation or brooding and rearing expenses, and mortality.

TABLE XVII. Monthly income over feed costs for hybrids in the insulated house, cage system, September 1956 through June 1957

	Per 100 hens*								
Month	Cost of poultry ration per lb.**	S. D. eggs cents per doz.+	Lbs. feed required	Feed cost in $	No. doz. eggs	Egg income in $	Income over feed costs	Per cent mortality accumulative	Income per 100 hens started!
Sept.	3.03	28.1	764.0++	23.15	189.3	53.19	$30.04	.83	$29.79
Oct.	2.95	27.4	760.8	22.44	193.9	53.13	30.69	.83	30.44
Nov.	3.00	24.9	808.5	24.26	180.4	44.92	20.66	1.67	20.32
Dec.	3.03	24.8	840.5	25.47	179.2	44.44	18.97	5.00	18.02
Jan.	3.03	22.2	760.9	23.06	161.1	35.76	12.70	6.67	11.85
Feb.	2.98	23.8	800.9	23.87	140.9	33.53	9.66	7.50	8.94
March	2.94	23.0	854.2	25.11	162.7	37.42	12.31	8.33	11.28
April	2.98	23.6	765.4	22.81	151.0	35.64	12.83	11.67	11.33
May	2.95	21.8	721.3	21.28	143.2	31.22	9.94	11.67	8.78
June	2.89	22.7	831.1	24.02	133.3	30.26	6.24	15.00	5.30
Total			7,907.6	235.47	1,635.0	399.51	164.04		156.05
Cost per 100 chicks									64.00
Income less feed and chick cost									92.05
Salvage value of each 100 hens started				518 lbs. x 85 hens x 12¢					52.84
Income per 100 hens started									144.89

*Based upon monthly average number of hens.

**Cost of poultry ration per pound taken from Agricultural Prices by U. S. Department of Agriculture.

+Average price of S. D. eggs taken from Agricultural Prices by U. S. Department of Agriculture.

++Estimated pounds of laying mash consumed in September.

!Does not include labor, buildings or equipment depreciation or brooding and rearing expenses and mortality.

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TABLE XVIII. Monthly income over feed costs for Leghorns in the insulated house, cage system, October 1957 through February 1958.

	Per 100 hens*								
Month	Cost of poultry ration per lb.**	S. D. eggs cents per doz.+	Lbs. feed required	Feed cost in $	No. doz. eggs	Egg income in $	Income over feed costs	Per cent mortality accumulative	Income per 100 hens started++
Sept.									
Oct.	2.71	32.3	778.1	21.09	157.3	50.81	29.72	1.67	$ 29.22
Nov.	2.67	33.6	769.6	20.55	166.6	55.98	35.43	3.33	34.25
Dec.	2.59	32.7	821.9	21.29	161.9	52.94	31.65	5.00	30.07
Jan.	2.56	28.0	890.4	22.79	151.2	42.34	19.55	6.67	18.25
Feb.	2.55	27.0	754.8	19.25	134.5	36.32	17.07	8.33	15.65
Total			4,014.8	104.97	771.5	238.39	133.42		127.44
Cost per 100 chicks									$32.00
Income less feed and chick cost									95.44
Salvage value of each 100 chicks started			4.49 lbs. x 91.67 hens x 12¢ per lb.						49.39
Income per 100 hens started									144.83

*Based upon monthly average number of hens.

**Cost of poultry ration per pound taken from Agricultural Prices by U. S. Department of Agriculture.

+Average price of S. D. eggs taken from Agricultural Prices By U. S. Department of Agriculture.

++Does not include labor, buildings or equipment depreciation or brooding and rearing expenses, and mortality.

TABLE XIX. Monthly income over feed costs for Leghorns in the noninsulated house, floor system, October 1957 through February 1958.

Month	Cost of poultry ration per lb.**	S. D. eggs cents per doz.+	Per 100 hens* Lbs. feed required	Feed cost in $	No. doz. eggs	Egg income in $	Income over feed costs	Per cent mortality accumulative	Income per 100 hens started++
Sept.									
Oct.	2.71	32.3	786.6	21.32	184.5	59.59	38.27	2.52	37.31
Nov.	2.69	33.6	791.8	21.14	179.3	60.25	39.11	3.77	37.64
Dec.	2.59	32.7	809.3	20.96	169.0	55.26	34.30	4.09	32.90
Jan.	2.56	28.0	774.7	19.83	135.5	37.94	18.11	5.66	17.08
Feb.	2.55	27.0	661.7	16.87	94.9	25.62	8.75	9.43	7.92
Total			3,824.1	100.12	763.2	238.66	138.54		132.85
Cost per 100 chicks									32.00
Income less feed and chick cost									100.85
Salvage value of each 100 hens started			4.64 lbs. x 90.5 hens x 12¢ per lb.						50.41
Income per 100 hens started									151.26

*Based upon monthly average number of hens.

**Cost of poultry ration per pound taken from Agricultural Prices by U. S. Department of Agriculture.

+Average price of S. D. eggs taken from Agricultural Prices by U. S. Department of Agriculture.

++Does not include labor, buildings or equipment depreciation or brooding and rearing expenses, and mortality.

TABLE XX. Monthly income over feed costs for Hybrids in the insulated house, cage system, October 1957 through February 1958.

Month	Cost of poultry ration per lb.**	S. D. eggs cents per doz.+	Per 100 hens* Lbs. feed required	Feed cost in $	No. doz. eggs	Egg income in $	Income over feed costs	Per cent Mortality accumulative	Income per 100 hens started++
Sept.									
Oct.	2.71	32.3	844.0	22.87	197.3	63.73	40.86	.55	40.64
Nov.	2.67	33.6	763.6	20.39	189.6	63.71	43.32	.55	43.08
Dec.	2.59	32.7	826.3	21.41	192.9	63.08	41.67	1.11	41.29
Jan.	2.56	28.0	852.2	21.82	187.9	52.61	30.79	1.11	30.45
Feb.	2.55	27.0	757.2	19.31	161.2	43.52	24.21	1.67	23.81
Total			4,043.3	105.80	928.9	286.65	180.85		179.27
Cost per 100 chicks									64.00
Income less feed and chick cost									115.27
Salvage value of each 100 hens started			3.84 lbs. x 98.33 hens x 12¢ per lb.						45.31
Income per 100 hens started									160.58

*Based upon monthly average number of hens.

**Cost of poultry ration per pound taken from Agricultural Prices by U. S. Department of Agriculture.

+Average price of S. D. eggs taken from Agricultural Prices by U. S. Department of Agriculture.

++Does not include labor, buildings or equipment depreciation or brooding and rearing expenses, and mortality.