THE INFLUENCE OF DATE OF HATCH ON LENGTH OF LAY, EGG SIZE DISTRIBUTION AND SELECTED EGG QUALITY CHANGES IN A COMMERCIAL LAYING FLOCK

Thesis for the Degree of Ph. D.
MICHIGAN STATE UNIVERSITY
FLOYD W. HICKS
1961

This is to certify that the

thesis entitled

The Influence of Date of Hatch on Length of Lay, Egg Size Distribution and Selected Egg Quality Changes in a Commercial Laying Flock

presented by

Floyd W. Hicks

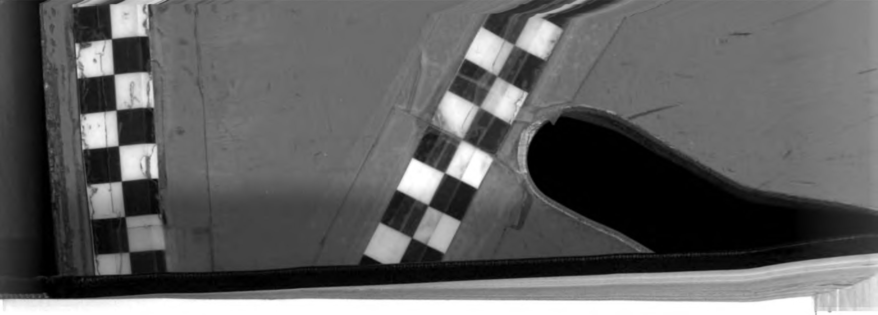
has been accepted towards fulfillment of the requirements for

Ph.D. degree in Poultry Science

Howard C. Zindel
Major professor

Date May 18, 1961

O-169



THE INFLUENCE OF DATE OF HATCH ON LENGTH OF LAY, EGG SIZE DISTRIBUTION AND SELECTED EGG QUALITY CHANGES IN A COMMERCIAL LAYING FLOCK

By

Floyd W. Hicks

AN ABSTRACT OF A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Poultry Science

1961

c

s

fr

bro

size

ABSTRACT

THE INFLUENCE OF DATE OF HATCH ON LENGTH OF LAY, EGG SIZE DISTRIBUTION AND SELECTED EGG QUALITY CHANGES IN A COMMERCIAL LAYING FLOCK

by Floyd W. Hicks

The recent and rapid expansion of the poultry industry plus the accompanying technological changes have tended to obscure many important egg production problems. These problems confront those poultrymen who replace their flock annually or replace their flock at periodic intervals throughout the year.

When utilizing present-day strains of laying hens, the pertinent question arises: "Are there differences in the optimum length of lay if economic considerations have included the hatching date?" The practical consideration of seasonal hatching dates by the commercial poultryman should result from an analysis of:

1. The length of lay.
2. The rate of lay.
3. The egg size distribution.
4. The changes in egg quality by age of birds.

A commercial poultry farm in Michigan was the site for the investigation reported herein. The management brooded chicks at various times of the year due to the size of the operation.

The commercial strains of laying hens used were Heisdorf & Nelson ("H & N") and "Hylines." The bimonthly hatching seasons utilized were: February 1, 1958; April 1, 1958; June 1, 1958; August 1, 1958; October 1, 1958 and December 1, 1958. Similar hatching dates were used in 1959.

Generally accepted managerial practices were employed by the operator in the brooding and rearing procedures regarding housing space, lighting, disease control and nutrition.

Pullets were housed in pens in various numbers, in keeping with the housing facilities on the farm. The number of birds tested varied from 750 to 2400 pullets. Individual pens of birds, representing the different hatching dates, were kept over for the extended lay period (six months of extra lay, to a total of 24 months of lay). The birds were 30 months of age at the end of the period.

The total egg production, seasonal egg size distribution, and selected egg quality factors were measured for the females tested which were hatched at different seasons of the year and retained for the extended-lay test period.

Representative pens of layers of the various strains were randomly selected for computations of seasonal egg size distribution. The egg size distribution, expressed in total numbers of dozens of eggs produced by the different strains of layers, was calculated from the egg

production data. Hatching date effects were investigated relative to albumen quality, shell thickness and blood spot incidence. Daily egg production records were kept by the farm poultryman, but two-day bi-weekly data were gathered by the investigator.

All possible comparison combinations were statistically analyzed by strains, by hatching dates and within years. Comparisons were also made between strains and between years when similar hatching dates were involved. All data were subjected to an analysis of variance and Duncan's Multiple Range Test.

The analyses of the data, under the particular environmental conditions of this study, have indicated that satisfactory egg production may be expected from females hatched at any time of the year. This study showed that the factor of age at sexual maturity did affect the curve of egg size distribution. Age at sexual maturity did not affect the total numbers of eggs produced. No consistent seasonal hatch effects on total egg production could be expected on the basis of season of hatch alone. Location effects within the poultry farm were not significant.

Egg weight distributions according to hatch date were important. Egg size decreased in the summer months in this investigation of the extended lay periods. The differences in egg weight distribution between strains were even more evident.

fecte

were s

months

pullet

chick

rather

Albumen quality and shell thickness were not affected by hatching date. The incidence of blood spots were significant in the very late summer, fall and winter months.

It can be concluded that, given the modern laying pullet, it is best for the poultryman to schedule his chick starting dates according to his own convenience rather than on a set calendar pattern.

THE INFLUENCE OF DATE OF HATCH ON LENGTH
OF LAY, EGG SIZE DISTRIBUTION AND SELECTED EGG
QUALITY CHANGES IN A COMMERCIAL LAYING FLOCK

By

Floyd W. Hicks

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Poultry Science

1961

Dr. H.
whose
Dawson
intere
the s
apprec

Henry
constr
sincer
ment,
analys

Mr. an
and en
acknowl
ciates
gather

to his
and pat
research

ACKNOWLEDGEMENTS

The author wishes to express his appreciation to Dr. H. C. Zindel, Professor of Poultry Science, under whose direction this study was conducted, and to Dr. L. E. Dawson, Associate Professor of Poultry Science. Their interest in this study and their effort in direction, and the supplying of materials and facilities were greatly appreciated.

The writer is indebted to Drs. Merle Esmay and Henry Larzelere for their helpful suggestions and their constructive review of this thesis. The author is also sincerely grateful to Dr. L. R. Champion for his encouragement, advice, and direction in planning the statistical analyses.

An expression of sincere gratitude is extended to Mr. and Mrs. Harry Burns for provision of data, facilities, and encouragement for this study. Appreciation is also acknowledged to Dr. R. G. Wheeler and those numerous associates who made visits to the commercial poultry farm to gather data or offer assistance.

Finally, the writer is indebted beyond expression to his wife, Dorothy, for her encouragement, sacrifice, and patience during this strenuous period of study and research.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

Tabl

61.

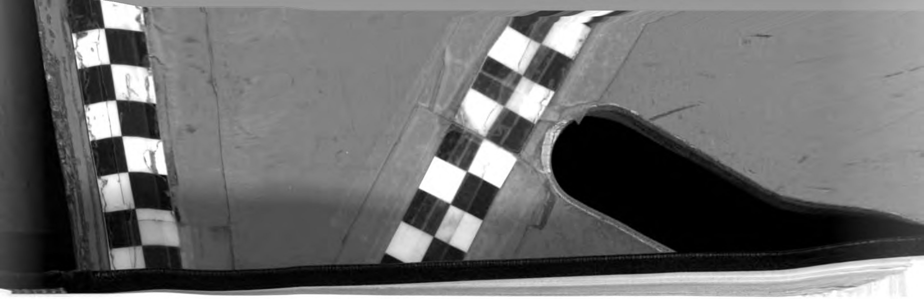
62.

63.

64.

65.

LIST OF TABLES (Contined)



LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF APPENDICES

INTRODUCTION

At the present time, the commercial poultryman is faced with narrowed margins and reduced income. Therefore, it becomes important that each poultryman scrutinize the effects of his management practices on production and make the proper managerial decisions accordingly. The recent and rapid expansion of the poultry industry, plus the accompanying technological changes that have confronted those individuals specializing in the production of eggs, have tended to obscure many important production problems. Poultry managerial problems could become very troublesome in the future if appropriate adjustments are not made.

Recent trends in the poultry industry in Michigan indicate that egg production is being concentrated on fewer farms with larger production units. Concurrent with these changes has been the introduction of "contract" poultry production and/or integration of the individual poultry farm with large commercial concerns.

With larger numbers of laying birds, the use of improved strains of laying hens, better rations, the adoption of complex disease control programs, and the widespread use of labor-saving mechanical equipment, it is vital that accurate, up-to-date data be obtained for costs of egg production and net returns. This is particularly important for those poultrymen who replace their flocks

once a year or for those individuals who partially replace their flocks at periodic intervals throughout the calendar year.

From an economic standpoint, using present-day strains of laying hens, the pertinent question arises: "Are there differences in the optimum length of lay if considerations include the month of hatching chicks or time of rearing pullets?" One approach to the problem would be to determine the relationship between month of hatch and total egg production for egg-strain chickens kept through 24 months of lay. Egg size distribution would also have a bearing on the problem since egg size affects gross income and net returns.

Poultrymen have long been aware of seasonal fluctuations in egg prices. The generally accepted recommendation to the egg producer has been that he should schedule the time of starting his chicks so that peak egg production and favorable egg size are obtained during the period when egg prices are relatively high. It is understandable, therefore, to presume that a study of the seasonal costs and returns should materially aid in explaining the advantages and disadvantages of hatching at various seasons of the year. Further, such a study would help the poultryman to plan an egg production program such that he could take full advantage of the seasonal price changes which occur for eggs of various weights.

It has become increasingly apparent in the egg-producing phase of the poultry industry that poultrymen must consider the rising costs of rearing replacement pullets to sexual maturity. If the poultryman can profitably keep his laying hens beyond the normal 12-month laying year, it is understandable that he will materially reduce expenses. It would be economically advantageous for the poultryman to adopt this practice of keeping layers for this extended laying period, if he could not replace the old hens with pullets profitably. Considerations should be given to: (a) the price of the salvage hens, (b) the cost of rearing the pullets to maturity, (c) the alternate use of the pullet housing facilities, and (d) the annual depreciation of the rearing equipment with respect to the limited use of the equipment.

Therefore, it has been suggested that the practical consideration of seasonal hatching dates by the commercial poultryman should become an analysis of:

1. The length of lay.
2. The rate of lay.
3. The egg size distribution.
4. The timing of hatching dates or the purchase of day-old chicks.

All of these factors must be considered in relation to costs and returns to the producer.

The null hypotheses formulated for purposes of this study are as follows:

(1) There are no significant differences in one or more of the economically important traits associated with total egg production between hatches of chicks brooded, reared, and housed at different times of the year.

(2) There are no significant differences in egg size distribution between hatches of chicks brooded, reared, and housed at different times of the year.

(3) There are no significant differences between the egg quality factors of shell thickness and interior quality as measured in Haugh units between hatches of chicks brooded, reared, and housed at different times of the year but kept beyond the normal laying period.

REVIEW OF LITERATURE

Trends in the Poultry Industry

In Michigan, the production of eggs constitutes the major portion of the poultry industry. The estimated gross income from Michigan poultry products in 1959 as presented by the Michigan Department of Agriculture Cooperative Crop Reporting Service is as follows:

	Estimated Gross Income
Chickens	$ 3,396,000
Turkeys	3,711,000
Commercial Broilers	3,542,000
Eggs	38,246,000
Total	$ 48,895,000

A further elaboration of poultry statistics from the same source indicates that the income from eggs has dropped in the past seven years:

Year	Gross Income, Eggs	Gross Income, Chickens
1953	$ 63,437,000	$ 16,941,000
1954	49,772,000	14,119,000
1955	53,062,000	11,417,000
1956	53,696,000	9,706,000
1957	49,915,000	6,055,000
1958	49,246,000	5,661,000
1959	38,246,000	3,396,000

The substantial drop in gross income from eggs over this period (1953-1959) is evident, but on a percentage basis, there was a greater decline in the gross income derived from the sale of chickens. This decline in the gross income from the salvage hens has been considered by some poultrymen when decisions were made to carry over the old hens into an extended laying period.

Poultry are no longer kept on seventy (70) percent of the farms in the State of Michigan. According to the Census of Agriculture (1954), only 86,214 farms out of the 138,943 farms reporting had flocks of laying chickens (62%). Of the 86,214 farms, 62,164 were commercial farms[1] having laying hens; and 24,050 non-commercial farms were reported as having laying hens. Of the number of commercial farms having laying hens, 32,255 farms report flocks containing less than 100 birds (Figure 1). There are a number of large "commercial" flocks (1,431 farms) with 800 or more layers per flock. Thus, flocks of chickens are becoming fewer but larger, and the industry, as a whole, is becoming more intensified. The 32,255 commercial farms having less than 100 layers per farm sold 5,048,000 dozen eggs in 1954. Whereas, the 1,431 farms having 800 or more layers reported the sale of 17,976,000 dozen eggs. Farm flocks (on 28,478 farms) consisting of 100 to 800 hens

---

[1] Census of Agriculture (1954), $1,200 or more income from farming.

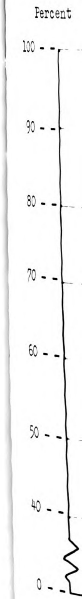


Figure 1

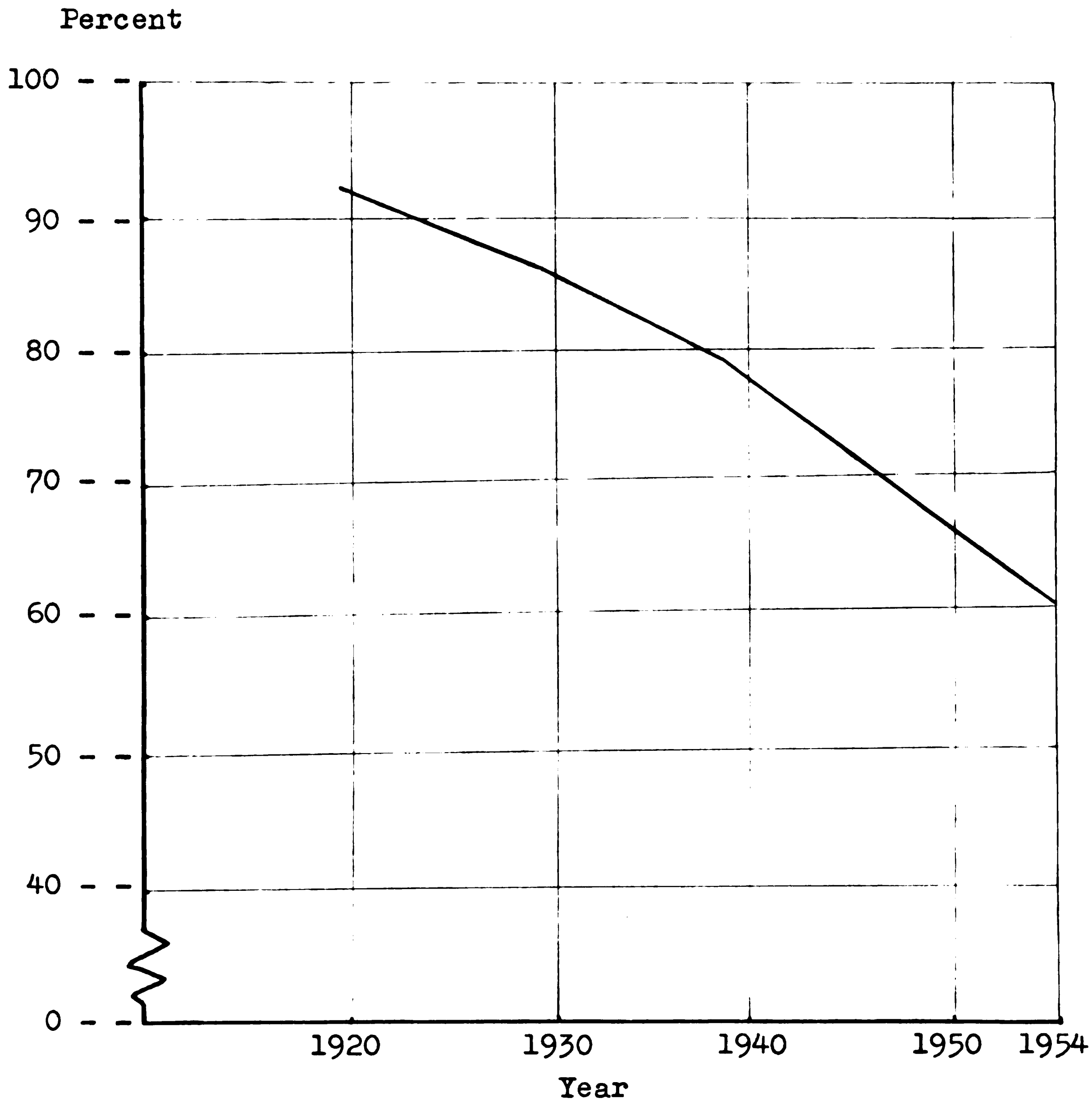


Figure 1. Percentage of Total Michigan Farms Reporting Chickens, (1954 U. S. Census of Agriculture).

produced 46,012,000 dozen eggs for sale during this same year.

Today, a smaller percentage of Michigan farmers keep layers than 25 years ago. However, those farmers who have continued the poultry enterprise keep larger flocks and thereby, produce more eggs than they did during the earlier years (Figure 2). The increased egg production per farm has been the result not only of larger flocks but also has been due to an increased annual egg production per layer. The increased egg production per layer has been due to improved breeding, improved control over environmental conditions especially housing, improved management and feeding practices coupled with improvements in rations fed.

According to the 1954 Census of Agriculture, during the 25 year period of 1925-29 to 1950-54, the average egg production per layer in the United States increased from 93 eggs per laying hen to 148 eggs per layer. This is a 60 percent increase. In Michigan, during the period of 1925-29, the average egg production per hen was 98 eggs per year, whereas, in 1950-54, the average annual egg production per layer was 153 eggs, an increase of 56 percent. The 1959 Census of Agriculture data showed that in 1958, the average annual egg production per layer in Michigan was 202 eggs, while the national average was 201 eggs per layer (Figure 3).

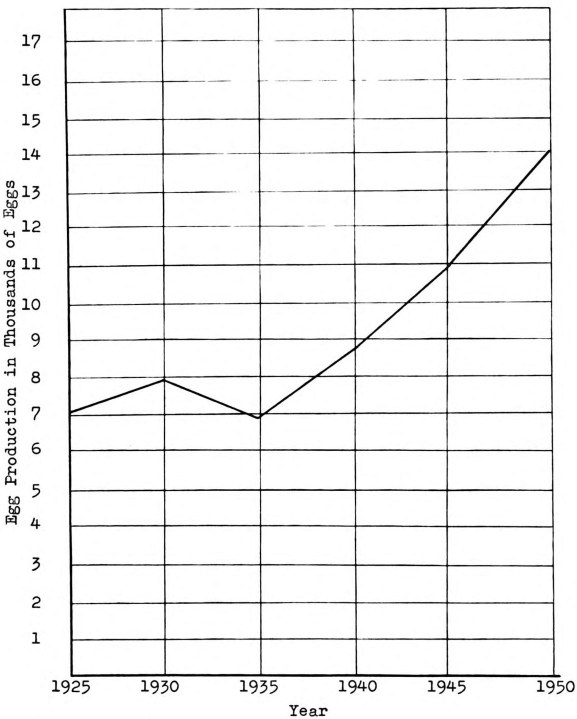
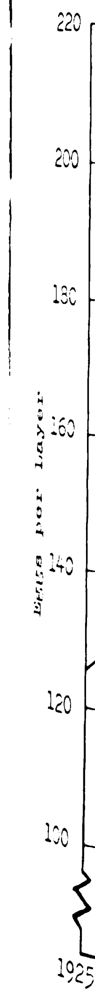


Figure 2. Egg Production per Farm, Michigan, 1925 - 1950, (Agricultural Marketing Service, U.S.D.A.).



Figure

[1] A
Poultry

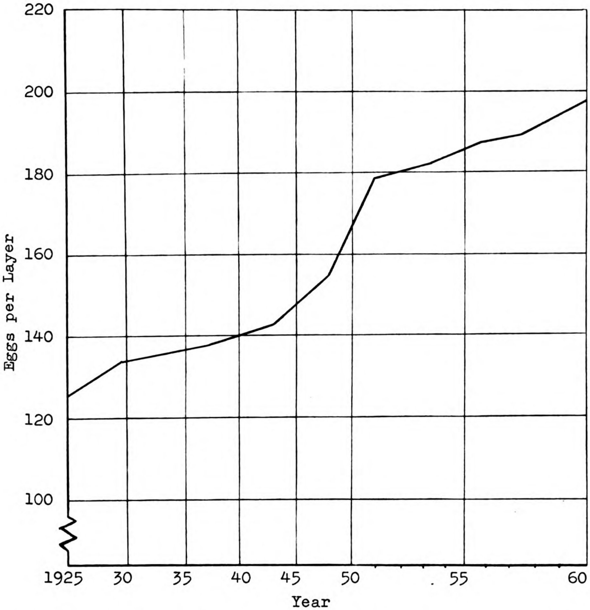


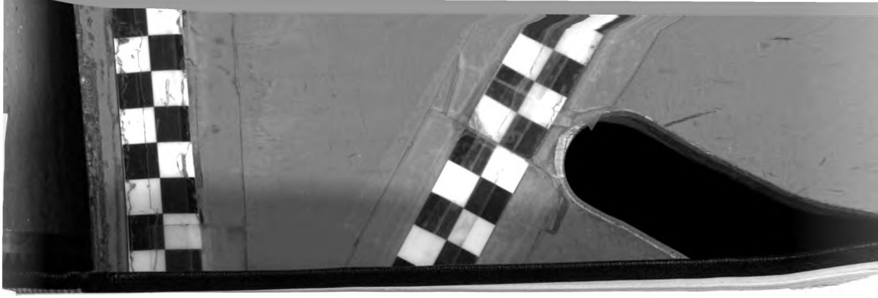
Figure 3. Eggs Laid per Average Michigan Layer Kept During Selected Years, 1925 - 59.[1]

[1]Agricultural Marketing Service, 1961 Outlook Issue, Poultry and Egg Situation, U.S.D.A.

Seas

ti.r
1956
5-),
and I
avera
figur
produ
as mu

had th
prices
above
the ar
droppe
ing th
season
average
egg pro
enced a
did Mi
larger
further
the seco
made to



Seasonal Variation in Egg Production and Prices

During the past 25 years, the seasonal egg production curve of the Midwest has gradually leveled (Mortenson, 1956; Figures 4 and 5). Over a period of 5 years, (1950-54), peak egg production during the months of March, April and May averaged only about 20 percent above the seasonal average; whereas about 25 years earlier, this percentage figure ranged up to 65 percent. Likewise the low point of production, in the fall of the year, did not drop nearly as much as it did 25 years earlier.

The leveling of the egg production curve has also had the effect of leveling the seasonal variation in egg prices. During 1925-29, egg prices peaked at 60 percent above the annual average as compared with 15 percent above the annual average egg price during 1950-54. Egg prices dropped 20 percent under the annual average egg price during the years of 1950-54; during the years 1925-29, the seasonal variation in egg price was 58 percent under the average annual egg price. Mortenson (1956) observed that egg producers in some areas of the United States experienced a more pronounced leveling out of egg prices than did Midwest poultrymen. These poultrymen not only had larger flocks but also kept them longer. This researcher further noted that in other areas the poultry flock was the secondary farm enterprise and that no real attempt was made to maintain uniform egg production throughout the

Figure 4.

[1]Morte

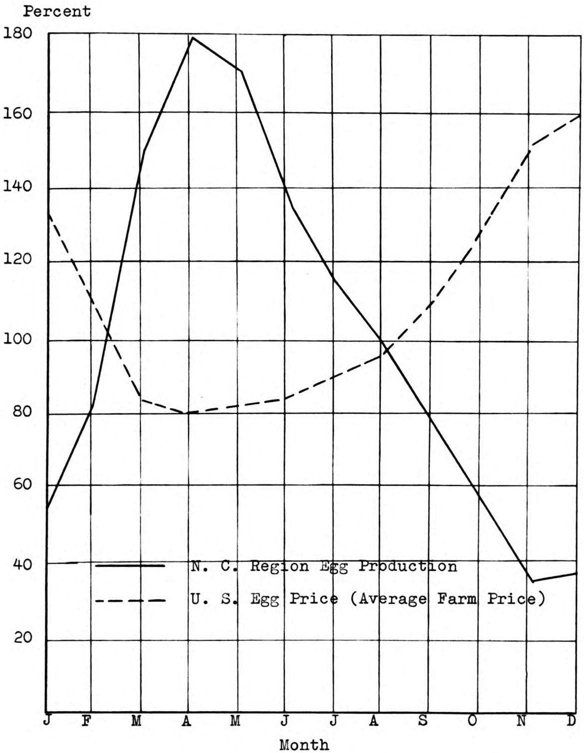


Figure 4. Monthly Egg Production and Egg Prices for the North Central Region in 1925 - 1929.[1]

[1]Mortenson (1956).

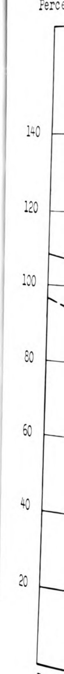


Figure 5.

[1] Morte

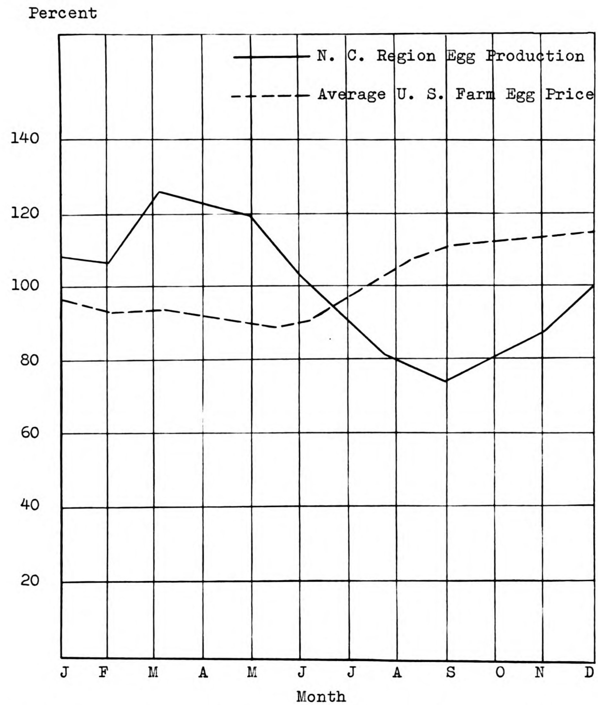


Figure 5. Monthly Egg Production and Egg Prices for the North Central Region in 1950 - 1954.[1]

---

[1]Mortenson (1956).

vari

flue

the .

exist

the r

of se

tiona

Are t

when

seaso

curve'

charac

partic

mercia

tended

which,

effects

tions e

body si

fore, it

for one

various seasons of the year.

Economically, the leveling of egg prices should influence the plans of a poultryman with respect to filling the laying house, if seasonal price advantages do not exist. Further economic consideration which may affect the management plans of an egg producer would be the factor of seasonal differences in total egg production. Additional questions which should be answered include: (1) Are there significant differences in seasonal egg prices when considering egg size? and (2) Are there different seasonal patterns of egg size in the total production curve?

Total Egg Production

The relative importance of the various production characteristics which determine the profitability of a particular strain of chickens is of great concern to commercial breeders of egg-type chickens.

As early as 1918, Goodale pointed out that hens tended to have a characteristic rhythm of egg production which, however, was obscured by irregularities and seasonal effects. Recently, Nordskog (1960) reported that correlations existed between the performance factors of egg size, body size, mortality and rate of egg production. Therefore, it may logically be expected that a strain superior for one characteristic would tend to be superior or infe

direc

posit

analy

which

value

a net

size

that t

tality

ferenc

Actual

tions

of egg

Season

duction

conside

Bray, F

must be

egg pro

utilize

Sexual M

C

age egg

inferior for another characteristic depending upon the direction of the correlations between the traits, i.e., positive or negative. Nordskog (1960) also found, upon analyzing the data from 21 separate random sample tests which involved Leghorn-type entries, that the expected value of a 10 egg increase in production would be worth a net value of 31.5 cents and a 10 percent increase in egg size would be worth about 19.2 cents. He further observed that two factors--the rate of egg production and the mortality rate--accounted for the major portion of the differences observed between the entries in net income. Actually, the results obtained from each of the test locations showed a remarkable consistency except for the trait of egg size.

Seasonal Effects

Abplanalp (1957) used fixed period measures of production and concluded that there was little to gain from considering hatch effects in the selection of breeders. Bray, King and Anderson (1960) noted that hatch effects must be considered as a possible source of variation if egg production data were to be efficiently analyzed and utilized.

Sexual Maturity

Oliver *et al.* (1957) reported that annual percentage egg production is little affected by age at sexual maturi

(1960)

ficant

from d

Nutrit

the ra

and st

former

at def

for to

found

11-mon

each o

Locati

ficien

differ

size,

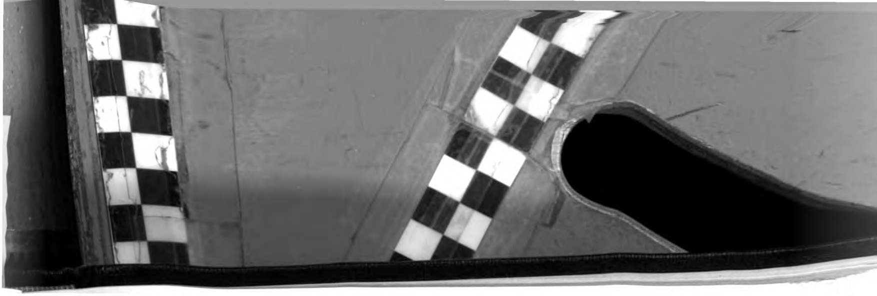
quentl

progra

the X

strain

produc



maturity. However, the more recent work of Bray et al. (1960) demonstrated that sexual maturity played a significant role in estimates of heritability when egg numbers from data of first egg was the measure.

Nutrition

Kurnick et al. (1960) varied the caloric content of the ration fed to Single Comb White Leghorn laying hens and studied the effect of season of hatch on their performance. The pullets were hatched so that they matured at definite intervals throughout the year. When the data for total egg production were analyzed, these researchers found that the production was exactly the same over the 11-month laying period for the females fed three diets, each of which varied in caloric content.

Location Influences

It is generally recognized that in order to make efficient performance comparisons between laying chickens of different breeding, it is important to know how sample size, testing location, and year of test influence the frequently observed differences in egg production.

A question of special significance in any testing program is that which pertains to the importance of genetic X environmental interactions. For example, will a strain of laying chickens that is superior for total egg production during one year at a certain location be sup

imp

is

die

gen

tic

prog

Howe

O'Ne

X lo

age

ent

widel

inter

of co

at di

Howev

ing of

select

"a pra

variet

siderat

ments o

superior at other locations and during other years? The importance of obtaining a correct answer to this question is becoming increasingly recognized, as more and more studies are being undertaken to determine the effects of genetic X environmental interactions on egg production.

Munro (1936) recognized the possibility that genetic X environmental interaction might seriously hamper progress in breeding for improvement in egg production. However, in the egg production studies of Gutteridge and O'Neil (1942), no significant interaction between genotype X location was found. These researchers also studied the age at sexual maturity and the egg weight of three different strains of Barred Plymouth Rocks tested at three widely scattered locations. They found that no significant interaction existed between genotype X location.

Gowe and Wakely (1954) stated, " . . . the practice of comparing the genetic worth of strains of fowl on test at different locations is of little value or no value." However, Hill and Nordskog (1956) stated that the "Testing of varieties in five locations and retesting of the selected varieties for one or two more years . . ." was "a practical procedure for evaluating strains or hybrid varieties."

Related to the location effects would be the consideration of pen effects. From a study of laying experiments on the semi-intensive plant at the Agricultural

Rese

clud

ence

cont

pen

was

Seaso

produ

seaso

tion

measu

egg n

concer

weight

that t

record

entire

betwee

cantly

annual

hens wh

Research Institute of Northern Ireland, Hale (1952) concluded that egg production was seldom affected by differences between pens that were treated alike. Hale (1959) continued the 1952 study and reported that no significant pen effects were evident. He also noted that hatch effect was significant in only one year.

Egg Size Distribution

Season

The relationship between egg weight and annual egg production has been studied by many investigators, and the seasonal influence on egg size has been well demonstrated.

Harris and Goodale (1922) reported that egg production during the fall, winter, or late summer was a better measure of total egg production than was the measure of egg numbers laid during the spring months.

Conflicting information exists in the literature concerning the relationship between average annual egg weight and total egg production. Parkhurst (1926) reported that there was no correlation between the egg production record for 365 days and the average egg weight during the entire year. Marble (1930) observed that the correlation between egg weight and annual egg production was significantly skewed and that the regression of egg weight upon annual egg production was significantly non-linear. The hens which were kept for an extended period of lay (the seco

of e

by M

weig

sele

annu

othe

othe

weigh

of eg

hold

in th

cies

pulle

Febru

weigh

serva

egg w

creas

(1934

during

bird o

laid b

second laying year) also showed a significant non-linearity of egg weight and annual egg production. Further studies by Marble (1931) involved the interrelationships of body weight, high egg production, early sexual maturity and the selection of certain size eggs for setting on the average annual egg weight. He concluded that there are numerous other undetermined factors which influence egg weight, other than those factors studied.

On the other hand, Blyth (1952) concluded that egg weight was negatively associated with a basic maximum rate of egg production. However, this relationship did not hold true for the poorer producers because irregularities in their egg production performance constituted divergencies from their maximum potential.

Poultrymen have long noted that for spring hatched pullets, egg weights usually increased from October to February or March, and that a gradual decline in egg weight occurs during the summer months. The foregoing observation was substantiated by Jull (1924) who found that egg weight increased from December to February and decreased from February to April and by Funk and Kempster (1934) who observed that the largest eggs were produced during the months of February and March.

The effect of season of the year and the age of the bird on egg size, egg quality and total numbers of eggs laid by hens of different ages was investigated by

Cunningham <u>et</u> <u>al</u>. (1960). These researchers found upon analyzing data obtained from layers kept under widely differing environmental conditions that the different environmental conditions did not affect seasonal differences of egg size distribution. The magnitude of the seasonal differences in egg size distribution was less than that which resulted from the effect of aging upon the bird.

<u>Age</u>

It is generally recognized that females lay larger size eggs during their second year of egg production. Clark (1940) noted that a significant increase occurs in the average egg weight during the second laying year. Jeffery (1941) suggested that egg weight was the result of the interaction of body weight, environmental temperature, and age.

<u>Sexual Maturity</u>

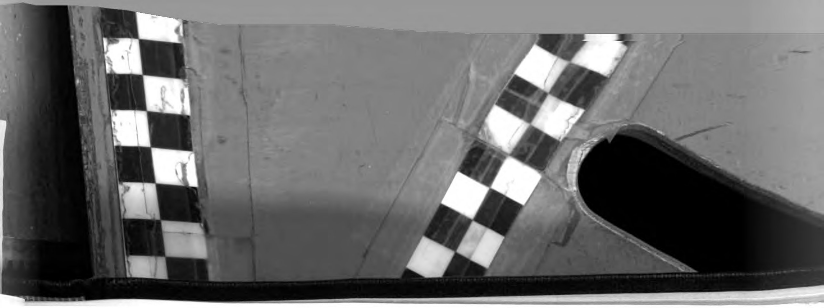
Tonaka and Rosenberg (1952) generalized that if a pullet matured too early in life that the initial egg size would be smaller than the egg size of pullets which matured later. On the other hand, they suggested that an early maturing pullet may lay for a longer period and consequently would produce a greater number of eggs. They also observed that "short-time" egg production records made during certain seasons of the year may be useful in predicting total annual egg production.

Temp

pera
corde
and
influ
Warre
durin
summe
(1951
a max
that
of la

was a
cal m
vided

in rec
poultr
of egg
able o
pullet
able o



Temperature

It has been postulated that high environmental temperatures reduce egg weight. Temperatures were not recorded for the different seasons of the year by Bennion and Warren (1933) and Warren and Schnepel (1940) when the influence of temperature on egg size was investigated. Warren *et al.* (1950) reported that the egg weight increased during the laying year if the birds did not encounter high summer temperatures. In Hawaii, Rosenberg and Tonaka (1951), working with New Hampshire pullets subjected to a maximum average temperature of 80° Fahrenheit, observed that egg size increased continually for the first 11 months of lay.

The influence of high temperatures on egg weight was also investigated by Hutchinson (1953), but no practical means of recording laying house temperatures was provided and therefore no seasonal effects were noted.

Egg Quality Studies

The availability of improved strains of laying hens in recent years has resulted in an increasing number of poultrymen who consider keeping layers for a second year of egg production. While adequate information is available on the changes in egg quality which occur during the pullet year, only limited experimental evidence is available on the effect of the age of the bird on egg quality duri

bume
been
Almqu
laid
conti
sprin
also
the p
drop (
by fe
vironm
albume
not d
(1954)
egg qu
months
ing the

curred
and cag
(1958)
the Haug
layers.
Seventh

during the second year of egg production.

As a general rule, the relative amount of thick albumen decreases with the length of time that the bird has been in production. Hunter et al. (1936) and Lorenz and Almquist (1936) studied the albumen quality of the eggs laid by birds during their pullet year and found that a continuous decline in albumen quality occurred from the spring months to the fall months. Warren et al. (1950) also reported a definite decrease in albumen quality as the pullet laying season progressed. They noted that a drop occurred in the albumen quality of the eggs produced by females housed in both controlled and uncontrolled environments. These researchers concluded that the drop in albumen quality was due to factors inherent in the bird and not due to external environmental factors. Sauter et al. (1954) investigated the effect of both age and season on egg quality and found that the eggs laid during the winter months were of a higher albumen quality than eggs laid during the summer months.

Grotts (1956) reported that a general decline occurred in Haugh units in the eggs produced by both floor and cage layers throughout the year. Froning and Funk (1958) also reported that seasonal variations existed in the Haugh units of the eggs laid by both floor and cage layers. Lamoureux (1957) analyzed the data from the Seventh California Official Random Sample Egg Laying Test

per
lai
ave
was
lig

and
trai
Howe
weig

Measu

cline
days
ing t
were
Spence
declin
break-
tion a
egg qua
tial dr
found t
Fahrenh
hours o
for any

pertaining to the average decline in Haugh units of eggs laid by March and April hatched birds. He found that the average decline in Haugh units during December to August was 13.3 units for the crossbreds and 10.4 units for the light breeds.

Strain and Johnson (1957) found significant hatch and strain differences during the month of October in the traits of egg weight, shell strength, and albumen quality. However, the hatch differences were maintained for egg weight and albumen quality throughout the year.

Measurement

Dawson and Hall (1954) found that the greatest decline in albumen quality occurred during the first three days after the egg has been laid, regardless of the holding temperature. Temperatures of 60° Fahrenheit or lower were found to be practical for normal farm holding of eggs. Spencer et al. (1956) observed that the albumen quality declined linearly with the logarithm of elapsed time from break-out. They also reported that individual hen variation and the age of the egg influenced the rate of loss of egg quality. Fry and Newell (1957) observed that the initial drop in egg quality was the greatest. They also found that at holding temperatures of 30°, 60°, and 90° Fahrenheit, the decrease in Haugh units for the first 48 hours of storage was significantly greater than the decrease for any succeeding 48-hour period.

Stra

King
that
vari
chic
above
rapi
and s

Age o

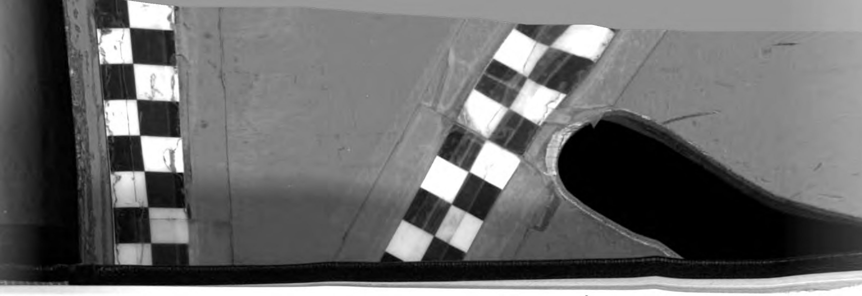
as la
that
to th
fluen
tigat
score
were
varia
secon
varia
Snyde
farms
declin
Qualit

Strain

Dawson *et al.* (1953), Cotterill and Winter (1954), King and Hall (1955), and Johnson and Gowe (1956) found that the initial interior quality of fresh shell eggs varied between and among different breeds and strains of chickens. May *et al.* (1957) confirmed the findings of the above workers and in addition, these researchers found the rapidity of decline of albumen quality also varied between and among the different breeds and strains of chickens.

Age of Birds

Jull (1953) found that interior egg quality declined as layers increased in age. Cunningham *et al.* (1960) found that the decline in Haugh units of eggs was due entirely to the aging of the bird. Seasonal changes did not influence the initial interior quality of eggs in this investigation. Mueller *et al.* (1960) noted that the lower Haugh scores observed during the second year of egg production were probably due to the effect of age of the bird. The variability observed in the Haugh unit scores during the second year of production was considerably higher than the variability during the pullet year. On the other hand, Snyder and Orr (1960), in a study of commercial poultry farms, found that length of lay did not affect the rate of decline in egg quality. In this latter study, the interior quality of the eggs laid by the oldest group of females



was found to be lower by approximately 10 to 13 Haugh units than those of the youngest group of females. In addition, the interior quality of the eggs from the older hens showed a greater variability.

Blood Spots

Meat and blood spots have long been recognized as a serious problem by poultrymen specializing in the production of table eggs. The literature on this subject is voluminous. One of the earlier reports was by Jeffery and Pino (1943) who suggested that heredity was an important causative factor in the production of blood spots in eggs.

To date, only limited experimental evidence is available on specific environmental factors which influence the incidence of blood and meat spots in eggs. The effect of season of the year on the incidence of these inclusions in eggs has been studied by Sauter et al. (1952) and Johnson (1956). Sauter et al. (1952) found that there was a definite and statistically significant seasonal variation in the incidence of blood spots. These workers observed that the percentages of total eggs having blood spots were lowest in December. Johnson (1956) observed a distinct seasonal trend in the incidence of blood spots increasing gradually from November to June.

Shell

ness
They
ing th
period

subjec
heit)
accepte
shell t
that sh
tion wa
ness du
that the
and seco
mental f
chickens
thicknes
of the bi
to be a s
effect on

Correlati
Size Distr

The
tal egg pr

Shell Thickness

Romanoff and Romanoff (1949) cite that shell thickness decreases from March to September of the pullet year. They noted that the variation in egg shell thickness during the second year of egg production, or over an extended period of lay, has not been investigated.

Warren and Schnepel (1940) demonstrated that hens subjected to high environmental temperatures (90° Fahrenheit) had a thinner egg shell than normal. High humidity accented the depressing effects of high temperatures on shell thickness. It was observed by Mueller et al. (1960) that shell thickness during the second year of egg production was significantly (5% level) higher than shell thickness during the pullet year. These researchers suggested that the differences in shell thickness between the first and second year of egg production were caused by environmental factors and not by the increase in age of the chickens. Pfost (1960) noted that the change in shell thickness appeared to be a straight line decrease with age of the bird. According to this investigator, there seems to be a seasonal effect on shell thickness but no seasonal effect on albumen height.

Correlation of Hatch Date, Annual Egg Production and Egg Size Distribution

The literature dealing with the relationship of total egg production, egg size distribution, egg quality

cha
The
tio
pat
rea
keep
prof
that
coin

of ha
the e
even
study
dates
the m
date (
egg-st
tion.

sion t
product
would s
cordanc
tern, a
be of pa

changes and seasonal egg price patterns is rather limited. The poultry farmer should be interested in such correlations, especially in view of a reliable expected egg price pattern. McKee and Gervais (1958) reported that seasonal rearing of replacement pullets in four separate hatches and keeping the laying birds to 22 months of age was the most profitable management system. These investigators stated that late summer and early winter months of pullet rearing coincide best with favorable egg prices later.

Kinder and Funk (1960) reported that seasonal effect of hatch date on production performance was marked and that the effect of hatch date on seasonal egg size pattern was even more pronounced. These workers utilized a three-year study with February, June, and September being the hatch dates. They found that February and June hatch dates were the most profitable. These researchers concluded that the date of hatch definitely affects the length of time that egg-strain layers should be kept for profitable egg production.

On the other hand, Platt (1960) reached the conclusion that satisfactory results could be expected in egg production despite the season of hatch. He noted that it would seem desirable for the poultryman to operate in accordance with his own convenience rather than on a set pattern, as over a series of years the hatching date may not be of particular economic importance.

De

the H
was t
appro
basis
ment
ful p
pens
peak

exclu
sales
outle
eggs
ployed

invest
"Hylin
follow

MATERIALS AND METHODS

Description of the Poultry Farm Used in This Study

The commercial poultry farm organization known as the Harry Burns Poultry Farm, Inc., of Millington, Michigan, was the site for the investigation reported herein. Since approximately 20,000 laying hens are kept on a year-round basis on this poultry farm, it is necessary for the management to brood chicks at various times of the year. Careful planning is therefore necessary to keep the laying pens full at all times if the management is to operate at peak efficiency.

The corporation's market for shell eggs (produced exclusively by the corporation flock) consists of retail sales at the Detroit Eastern Market and also the wholesale outlets of an egg-buying station and a retail store. All eggs produced on the poultry farm are processed by employees of the corporation.

Strains of Chickens Used

The commercial strains of laying hens used in this investigation were "H & N" (Heisdorf and Nelson) and "Hylines." The strains used and years of tests were as follows:

signa

sever

breed

year

that

H & N

stock

on ce

dates

ent m

mated

Strain Code	Commercial Name	Year
I	H & N	1958
II	Hyline	1958
III	H & N	1959
IV	Hyline	1959

It is recognized that although the commercial designation of a stock may remain the same over a period of several years, one does not have any assurance that the breeding procedures used by the breeder are the same from year to year or within years. Therefore, it is possible that the H & N stock of 1958 may differ greatly from the H & N stock of 1959. This could also be true of the Hyline stock.

In order to study the effects of seasonal hatching on certain egg production traits, the annual hatching dates selected for purposes of this study were six different months of the year. The different months are designated herein as "hatching seasons" and were as follows:

Hatching Season	Approximate Date of Hatch
A	February 1, 1958
B	April 1, 1958
C	June 1, 1958
D	August 1, 1958
E	October 1, 1958
F	December 1, 1958

Thes

cial

of a

brood

radia

house

hatch

Year S

1958

1958

1959 I

1959

was lin

reared

age in

reared

as H & I

of the r

D

periods,

These dates were selected not only to fit into the commercial poultry farm operation but also to be representative of a range of hatching dates over a period of one year.

Brooding and Rearing Procedures

The day-old chicks used in this experiment were brooded, using radiant heat and supplemental hot water radiators, at intervals of approximately two months in a house used exclusively for this purpose. The dates of hatch and the brooding schedule were as follows:

Year	Strain	Season, Month, and Day of Hatch											
		A		B		C		D		E		F	
		Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1958	I	22			4		4		6	27			3
1958	II				4				6				3
1959	III		4		1		6		5				
1959	IV		4		1								

During the brooding period, the intensity of light was limited to prevent cannibalism. The pullets were reared from six weeks of age to approximately 18 weeks of age in a separate rearing house. Hence, the females were reared in confinement. No special lighting program (such as H & N Controlled Lighting Program) was used during any of the rearing periods.

During all phases of the brooding and rearing periods, and during the egg production periods, strict

sanitation procedures were followed. Unauthorized personnel were not allowed in the brooder house or in the rearing house. The chicks of all hatches were vaccinated for Infectious Bronchitis and Newcastle Disease. The vaccines used were of the water type. No Fowl Pox or Laryngotracheitis vaccines were used.

Numbers of Females Housed

In the investigation reported herewith, the term "extended lay" is interpreted to mean that the laying females were retained for a period of time longer than is practiced in commercial egg production enterprises. The numbers of pullets housed each season (month of hatch) by years and the numbers of females kept for the "extended lay" test period were as follows:

Year	Strain	Season of Hatch					
		A	B	C	D	E	F
		(Number of Birds)					
1958	I	2000	1560	2392	1230	2400	750
1958	II		590		1210		750
1959	III	600	1204	2394	2327		
1959	IV	1215	1204				
"Extended Lay" 1958 Hatch		405[1]	1172[1]	500[1]	500[1]	1037[1]	750[1]

---

[1]Numbers of Strain I females used for extended lay study.

only

I we

whicl

senta

for t

were

ous 2

recor

used

weeks

Venti

were w

typica

equipp

moval

static

lee si

drawn i

laying

across

direct

From the foregoing, it can readily be seen that only a representative sample of the laying hens of Strain I were kept for the extended lay study. However, the hens which were used in all extended lay analyses were representative of the various hatching seasons. The hens used for the extended lay test period were retained until they were 30 months of age.

The term "period" in this study indicates the various 2-week periods (14 days) that the egg production records were kept. The term "period" therefore can be used to indicate the approximate age of the females in weeks by multiplying the "period" figure by two.

Environmental Conditions

Ventilation and Temperature Control

Annual temperatures in the laying houses or pens were within the range which are generally encountered under typical Michigan conditions. The laying houses were equipped with a mechanical ventilating system for the removal of moisture and for temperature control. Thermostatically-controlled ventilating fans were located on the lee side of the poultry houses. Essentially, the air was drawn in through attic louvers and pulled down into the laying pens by the fans. The ventilating air was drawn across the laying pens. Some pens were equipped with direct vents to the outside air, however.

55° F

tors,

stati

Fahre

for t

Appen

side

Febru

-10°

10, 1

Light

60 wa

of fl

vals

least

bird.

period

hour da

went to

The thermostatic controls of the fans were set at 55° Fahrenheit. Auxilliary heat, from steam heat radiators, was provided during the colder months. The thermostatic controls for auxilliary heat were set at 50° Fahrenheit.

The average monthly outside temperatures recorded for the nearby area of Flint, Michigan, are shown in the Appendix (Table 8). Farm records indicated that the outside temperature closely approximated 0° Fahrenheit from February 8 to 21, 1958. The farm records also indicated a -10° Fahrenheit temperature on January 6 and on February 10, 1958.

Lighting Procedures

The laying hens were given a 14-hour light-day. A 60 watt incandescent bulb was used for each 200 square feet of floor space. Light meters were used at periodic intervals to assure that the laying hens were receiving at least one foot-candle of light at the eye level of the bird.

The lights were turned on at 4:00 A.M. during the periods when additional light was needed to provide a 14-hour day. Evening lights were not used and the layers went to roost by natural daylight.

Nutri

laying
commer
plemen
layers

Miscel

cullin
remove

were k
financ
ment a
the Fo
omics
Table 1

gathere
eggs we
cial eg
used.
machine,
then ref
at a tem

Nutrition

The laying females were fed a 17 percent protein laying mash. This laying mash was made from a 42 percent commercial concentrate mixed with home-grown corn. Supplemental whey 50-pound blocks were provided for the layers.

Miscellaneous Environmental Factors

Except for the removal of obviously sick birds, culling of the laying flock was not practiced. All females removed for health reasons were recorded as death losses.

All pens of birds kept for all extended lay periods were kept intact. To avoid placing any possible undue financial hardship on the corporation, a deficiency payment agreement was drawn up between the corporation and the Poultry Science Department and the Agricultural Economics Department of Michigan State University (Appendix Table 1).

During the period of this study, the eggs were gathered in wire baskets and washed on the same day. The eggs were graded and sized on the following day. Commercial egg processing equipment, known as Eggomatic, was used. This equipment included a flash candler, a sanding machine, and a sizing machine. The eggs were cartoned and then refrigerated in a walk-in cooler which was operated at a temperature of 55° Fahrenheit and a relative humidity

75

and

thre

buti

the

year

able

ever,

strai

distr

bers

of la

egg qu

invest

bumen

whereve

75 percent. The egg processing room was air conditioned and/or heated to a constant 70° Fahrenheit temperature throughout the year.

Characteristics Measured

The total egg production, seasonal egg size distribution, and selected egg quality factors were measured for the females which were hatched at different seasons of the year and retained for the extended lay test period.

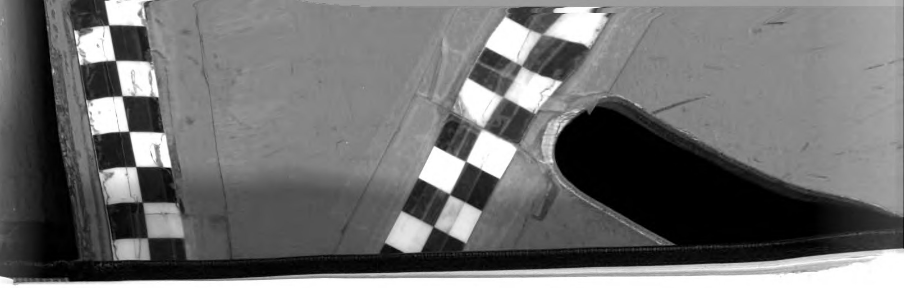
Complete data for total egg production were available for analyses of all strains of laying hens used. However, only representative pens of layers of the various strains were selected for analyses of seasonal egg size distribution.

The egg size distributions, expressed in total numbers of dozens of eggs produced by the different strains of layers, were calculated from the egg production data.

As stated previously, seasonal changes in selected egg quality factors, as affected by hatching date, were investigated. The egg quality factors measured were albumen quality, shell thickness and blood spot incidence.

In summary, data were collected and analyzed, wherever possible, for the following traits:

1. Total egg production.
2. Egg size distribution.
3. Egg quality factors.



4. Feed consumption.

5. Mortality.

The record-keeping forms that were used in this study are shown in the Appendix, Tables 2-6, inclusive.

Total Egg Production

Poultrymen are well aware that there are many different ways of expressing total egg production, e.g., hen-day[1] percent production, hen-housed[2] egg production, and survivor's production. In this study, daily egg production records were kept to determine the effect of hatching date on total egg production, and the statistical analyses are based upon hen-day production calculations. However, the analyses of numbers of dozens of eggs of the various size classifications are based upon numbers of females housed, i.e., hen-housed data.

Jerome, Henderson and King (1956) and Oliver, Bohren and Anderson (1957) suggested that mortality in the laying house "clouds" the exact measurement of egg production. For purposes of statistical analyses (and for selection programs) Bray, King and Anderson (1960) suggested

---

1

$$\text{Hen-day egg production} = \frac{\text{Total egg production for 2-week period}}{\text{Average number of females in pen during 2-week period}}$$

2

$$\text{Hen-housed egg production} = \frac{\text{Total number of eggs during the year}}{\text{Number of females housed}}$$

that the non-producing hens be removed prior to making calculations of total egg production. Therefore, these researchers use hen-day production. On the other hand, the practical commercial poultryman is vitally interested in hen-housed egg production.

Egg Size[1] Distribution

Egg size distribution data were kept on selected pens of layers. These data, expressed as percentages of total egg production, were collected on two consecutive days every two weeks.

Egg Quality Factors

Considerable research evidence is available in the literature on egg quality changes during the pullet year. However, experimental evidence of the effect of age on egg quality during the second year of egg production is, with the exception of egg size, relatively limited. Therefore, in this investigation, egg quality changes during the extended lay period were studied and are reported.

Records were kept on egg weight, albumen height, shell thickness and blood spot incidence for the extended lay females. Every two weeks during the extended lay

---

[1]Egg sizes are designated as weight in ounces per dozen: "Jumbo" - 30 oz. and over; "Extra-large" - 27 oz. to 30 oz.; "Large" - 24 oz. to 27 oz.; "Medium" - 21 oz. to 24 oz.; "Small" - 18 oz. to 21 oz.; and "Peewee" - 15 oz. per dozen eggs.

period, a random sample of two dozen eggs from the layers hatched at different seasons of the year were collected for egg quality measurements. The numbers of sized eggs (e.g. jumbos, extra-large, large and mediums) collected for quality measurements were drawn in proportion to the total number of dozens of eggs in each size classification.

The final quality measurements of the egg samples were made in the Poultry Science Department at Michigan State University. The procedure used for measuring interior egg quality was that of Brant and Shrader (1952). Currently, this method is in widespread use in egg quality research laboratories and is used in egg laying tests.

The egg weight, recorded to the nearest gram, was determined by the use of a Toledo balance. Each egg was broken-out on a level glass plate, which was supported by a metal stand. The albumen height was measured with a tripod micrometer. The albumen height and weight measurement were used to compute Haugh units as a measure of interior egg quality. (Haugh, 1937). The Interior Quality Calculator for eggs (American Instrument Company, Inc.) was used for the Haugh unit computations.

Shell thickness was determined by a thickness gauge calibrated in thousandths of an inch and both shell membranes were included in the measurement. All measurements were taken while the shell and the membranes were wet.

of
an
of
gl
he
inc
con
egg
rec
gra
blo
tha
spo
the
rea

were
eggs
tion

The
trib

femal
for t

The incidence of blood spots was noted at the time of albumen height measurement. The inclusion size, color and location on the broken-out egg was observed by means of eye with aid of mirrors located under and behind the glass plate which was used for measuring the albumen height. It should be noted that the observations of the inclusions were made <u>after</u> the eggs had passed over the commercial flash candler. For each two-dozen sample of eggs which were broken-out, the number of inclusions are recorded in actual figures. Therefore, although the egg graders (employees) had attempted to remove the obvious blood spots (which were recorded as percent blood spots at that time), they did fail to remove any pinpoint blood spots. The observations of each two-dozen egg sample was then, in reality, a record of the pinpoint blood spots not readily detectable by the process of flash candling.

The eggs with blood spots removed by the candler were recorded, and in addition, the cracked and checked eggs (undergrades) were included in the egg size distribution data.

The Relationship of Total Egg Production to Egg Size Distribution

In this study, the total number of eggs laid by the females hatched at different seasons of the year and kept for the extended lay period was tabulated according to egg size

femal

the s

cumul

Stati

used

Strai

males

ber a

to as

ticall

years

betwee

All da

1944)

size distribution. These data were converted to a 1000 female basis to facilitate and equalize computations for the strains of layers tested. These data are presented as cumulative monthly totals.

<u>Statistical Procedures Employed</u>

The four strains of commercial egg-type females used in this investigation are hereinafter referred to as Strains I, II, III and IV. As previously stated, the females were hatched in February, April, June, August, October and December. Again, these hatching dates are referred to as Seasons A, B, C, D, E, and F, respectively.

All possible comparison combinations were statistically analyzed with strains, by hatching dates and within years. Further, comparisons were made between strains and between years where similar hatching dates were involved. All data were subjected to an analysis of variance (Snedecor, 1944) and Duncan's Multiple Range Test (1955).

RESULTS

The data in this thesis are presented by individual hatching-season comparisons within years and within and between strains of laying hens. The hatching-season comparisons, i.e., hatching-season A versus hatching season B, are discussed in the following order:

Strain I Comparisons

A vs. B	B vs. C	C vs. D	D vs. E	E vs. F
A vs. C	B vs. D	C vs. E	D vs. F	
A vs. D	B vs. E	C vs. F		
A vs. E	B vs. F			
A vs. F				

Strain II Comparisons

B vs. D	D vs. F
B vs. F	

Strain III Comparisons

A vs. B	B vs. C	C vs. D
A vs. C	B vs. D	
A vs. D		

Strain IV Comparisons

A vs. B

Due to the cross-references necessary when individual hatching-season comparisons by strains are made, the Tables and Figures are included in one position in the thesis. These Tables and Figures are presented in pages 99 to 169, inclusive, in the order of the data outlined below.

Within the individual hatching-season comparisons, the following data are presented where information was available:

1. Total egg production.
2. Pen differences in total egg production.
3. Statistical analyses of total egg production.
4. Egg size distribution.
5. Haugh unit scores of eggs laid during extended lay periods.
6. Shell thickness of eggs laid during extended lay periods.
7. Blood spot incidence.
8. Dozens of eggs produced.

Strain I Comparisons

Season A (February hatch) versus Season B (April hatch)

The average numbers of eggs laid by the females hatched in Season A and B are presented in Table 1, and the average numbers of eggs per two-week period over the 34 bi-weekly periods are graphically plotted and shown in Figures 6 and 7. It should be noted that the egg production records began with bi-weekly Period 12, when the females were 24 weeks of age and when the egg production records were available for the females hatched in all six seasons of the year. Prior to Period 12, complete data were not available for all hatches of Strain I.

It is important to note that the females which were hatched in Season A were housed in one pen, whereas the females which were hatched in Season B were housed in three different buildings on three different farms. Therefore,

since pen X location interactions have been shown to exist, the logical step was to determine whether any differences existed between pens and locations for Season B hatched pullets. The analysis of variance of the egg production data showed that no significant differences existed between pens at different locations, (Tables 13, 14 and 15). Thus, the egg production data for Season B hatched females were pooled for comparison purposes.

The females hatched in February laid at the rate of 4.9 eggs per bird during Period 12. Whereas the females hatched in April laid at the rate of 1.9 eggs per bird for the comparable period. This higher production trend continued throughout the 34 two-week periods and was reflected in the production means of the two hatches (February, 9.27 eggs per bird per two-week period; April, 7.47 eggs per bird per two-week period). The mean differences of 1.80 eggs per bird per two-week period in favor of the February hatched females was highly significant ($P < 0.01$, Tables 5 and 6).

It will be noted in Table 1 that the February-hatched females reached a peak egg production of 11.9 eggs per bird per two-week period at 32 weeks of age; whereas the April-hatched pullets peaked at 10.6 eggs per bird at 34 weeks of age. Further, the February-hatched pullets maintained a rate of egg production of over 10 eggs per

bird per two-week period for 28 consecutive weeks while the April-hatched females laid at this rate for only eight weeks.

The egg size distribution in percentages for the February and April-hatched females are presented in Tables 28-34, inclusive. The egg size distribution data are graphically presented in Figures 13 through 20. Figures 13-18, inclusive, show the percentages of comparable individual egg weights by hatching date per two-week period, whereas Figures 19 and 20 illustrate the complete egg weight distributions for the February and April hatching dates. The egg size distribution of the large, medium and small egg weight classes was affected by the season of production. The production of medium-sized eggs was especially affected, as represented by a substantial percentage increase, during the spring and summer months.

Comparisons between the February and April hatching dates show that the February-hatched birds produced a higher percentage of jumbo, extra-large and large eggs than did the April-hatched birds. On the other hand, the April-hatched birds produced a higher percentage of small and peewee eggs than did the February-hatched birds. However, there was no consistent advantage of one hatching date over another date in the numbers of medium-sized eggs produced by the birds.

Haugh unit scores of the eggs produced by the birds, in the extended laying period, are indicated in Tables 41 and 42. These tables are represented graphically in Figures 25 and 26. The Haugh unit scores of the eggs laid by the birds hatched in February were observed to be lower than the scores of the eggs laid by the April-hatched birds. The differences of Haugh unit scores between hatching dates were not consistent when comparable aged birds were plotted and shown in Figure 25. There was no marked season of production influence on Haugh unit scores between the hatching dates.

Shell thickness data of the eggs laid by the February and April-hatched hens are given in Tables 43 and 44. These data are graphically presented in Figures 27 and 28. There was no significant advantage of one hatching date over another hatching date in the egg shell thickness quality factor. The shell thickness of the eggs laid by the birds hatched in February and in April declined slightly during the period of the test. The average shell thickness decline, measured in thousandths of an inch, was only 0.0005 of an inch.

Detectable blood spot incidence data are presented in Tables 45, 46 and 47 for the eggs produced by females of the various seasons of hatch. Insignificant numbers of detectable blood spots occurred in the eggs produced by the hens representing both the February and the April

hatching dates. However, a greater number of blood spots were found in the eggs produced during the late summer, fall and early winter months. Females of both hatching dates were affected in a similar manner. No difference between the two hatching dates (February and April) was noted in respect to the pinpoint blood spots observed in the broken-out eggs.

Tables 49 and 50 indicate the cumulative dozens of eggs, by size, produced by hens hatched in February and in April. Table 48 gives the monthly egg production data in cumulative dozens of eggs produced. All data of the three tables are calculated per 1000 birds housed (hen-housed basis). The February-hatched birds produced a larger total number of eggs (8231 dozen) and larger number of eggs of the various egg weights (jumbo, 620 dozen; extra-large, 2870 dozen; large, 2480 dozen; medium, 1721 dozen; and small, 237 dozen) except for the production of the eggs of the peewee egg weight classification (101 dozen).

<u>Season A (February hatch) versus Season C (June hatch)</u>

The numbers of eggs laid by the birds of hatching Seasons A and C (February and June, respectively) are presented in Table 1. The numbers in the tables represent the average numbers of eggs laid per bird per two-week period. The data are graphically plotted in Figures 6 and 8. These two hatches are compared on the same basis of the length of lay and the period of lay. All of the hatches of Strain I are compared in the same manner.

It was noted in the discussion relative to the egg production of the birds of hatching Seasons A and B that the pen egg production data were pooled due to the non-significance of the differences in total egg production of the different pens. Pen differences in total egg production were highly significant from the birds of hatching Season C (Tables 16, 17 and 18). However, this pen difference in total egg production was the only significant pen difference of the five hatches analyzed involving the divisions of similar strains into different pens. Therefore, the egg production data of these pens were pooled also.

The females hatched in February laid at the rate of 4.9 eggs per bird during Period 12 in comparison with the rate of 1.0 egg per bird for the comparable period by the females hatched in June. As we pointed out in the earlier comparison, the February-hatched birds continued the high rate of production throughout the 34 two-week periods. In this comparison, the rate of lay per bird was higher for the February-hatched birds than for the June-hatched birds. The differences of the production means of the two hatches (9.27 eggs per bird for the February hatching season; 7.67 eggs per bird for the June hatching season) reflected this higher rate of lay of the February-hatched birds. The

difference of 1.6 eggs per bird per two-week period favoring the February-hatched females was highly significant ($P < 0.01$).

Data from Table 1 indicated that the February-hatched birds peaked in egg production at 11.9 eggs per bird per two-week period, while the birds of the June hatching date peaked in egg production at 12.2 eggs. The June-hatched birds laid at a rate of 10 eggs per bird per two-week period for 12 consecutive weeks, while the February-hatched birds maintained the same production for 28 consecutive weeks.

The data of the egg size distribution of the February and June-hatched birds are presented in Tables 28 through 34. The complete egg size distributions of the total egg production by hatching dates are given in Tables 35 and 37 (February and June hatching dates, respectively).

Figures 13 through 18, inclusive, graphically represent the data presented in Tables 28 through 34, inclusive. These tables and figures compare percentages of individual egg sizes by hatching date. Whereas the Figures 19 and 21 represent, by hatching date, the complete egg size distribution data of Tables 35 and 37 (hatching dates February and June, respectively).

The birds of the February hatching season produced a higher percentage of jumbo and extra-large eggs throughout the laying season than did the June-hatched birds.

o
p
h
i
o
su

in
42
25

the
On
mea
age
hat
proc
Peri
the
Haug

quali
ison.

However, the June-hatched birds, at comparable ages produced a higher percentage of large, medium, small and peewee eggs. Again, the large, medium and small sized egg production was affected by the season of lay for both hatching seasons, with the percentage of medium eggs showing the most fluctuation. The increases, in percentage, of these sized eggs came during the periods of spring and summer months.

Haugh unit scores of the eggs produced by the hens in the extended laying period are given in Tables 41 and 42. These tables are represented graphically by Figures 25 and 26.

The average Haugh unit score of the eggs produced by the birds of the February-hatching season was 73.55 units. On the other hand, the June-hatched birds laid eggs that measured slightly higher or 74.77 Haugh units. The average Haugh unit score of the eggs produced by the February-hatched birds represented fewer periods and these eggs were produced only during the later periods of the test, or Periods 46 through 65. The interior egg quality scores of the eggs of the June-hatched birds were averaged from Haugh scores recorded during Periods 37 through 66.

There were no consistent advantages of interior egg quality of one season of hatch over another in this comparison. Comparable age of the bird and the season of egg

production were observed per season of hatch as indicated in Figures 25 and 26, respectively.

The shell thickness data per season of hatch are given in Tables 43 and 44. These data are graphically presented in Figures 27 and 28. There was no significant advantage of one hatching date over another in the egg shell thickness quality factor. The shell thickness of the eggs produced by the hens of both seasons of hatch declined only slightly during the period of the test. This decline in shell thickness was only 0.0005 of an inch.

The detectable blood spot incidence data of these hatching dates are presented in Tables 45, 46 and 47. Insignificant numbers of blood spots occurred in most periods of lay. However, larger numbers of blood spots occurred in the eggs produced by both groups of birds (February and June hatching dates) during the late summer, fall and early winter months (Table 45). Age of the birds did not affect the incidence of blood spots in the extended laying period.

Data of the total egg production calculated in cumulative dozens of sized eggs per 1000 birds (hen-housed basis) are given in Tables 48, 49 and 52. The egg production data presented are the same as the data presented earlier under the total egg production and egg size distribution. When this basis of comparison was utilized, the differences in dozens of the various sized eggs favored

the February-hatched birds. However, the June-hatched birds did produce less undergrade eggs and more peewee eggs (Tables 58 through 64).

<u>Season A (February hatch) versus Season D (August hatch)</u>

The total egg production data per female hatched in February and August (Seasons A and D, respectively) are presented in Table 1. The data represent the average numbers of eggs produced per female per two-week period. The data are graphically shown in Figures 6 and 9. All egg production data per season of hatch are shown graphically, for comparative purposes, in Figure 12.

The production rate of 4.9 eggs per February-hatched female at the beginning of the record period has been presented previously. The August-hatched birds laid at the comparable rate of 3.4 eggs per female during the first period of lay.

The production mean of the February-hatched females was 9.27 eggs per bird and the mean production of the August-hatched birds was 8.15 eggs per bird. The higher rate of lay of the February-hatched birds was reflected in a sustained rate of lay of over 10 eggs per bird for 14 two-week periods. The August-hatched birds maintained the rate of lay of over 10 eggs per bird for only seven two-week periods.

a

r

e

i

p

ha

th

to

ha

of

re

a

Au

ma

eg

te

pro

in

Analysis of variance testing indicated that the difference in the production means of 1.12 eggs per bird was highly significant (Tables 5 and 6) ($P < 0.01$).

The February-hatched birds peaked, in egg production, at 11.9 eggs per bird; whereas, the August-hatched birds reached a peak production of 12.0 eggs per bird.

The individual egg size distribution data of the eggs laid by the females per hatching date are presented in Tables 28 through 34, inclusive, and graphically represented in Figures 13 through 18, inclusive. Every hatching season was compared by separate egg weights in these tables and figures.

On the other hand, Tables 35 and 38 present the total egg size distribution of the eggs produced by females hatched in February and August. The same egg weight data of the two hatching dates under comparison are graphically represented in Figures 19 and 22.

The females of the February hatching season produced a higher percentage of jumbo and extra-large eggs than the August-hatched females. However, the August-hatched females produced a higher percentage of small and peewee eggs. Due to the season of egg production during the latter stages of the test, the August-hatched females also produced a higher percentage of large and medium eggs.

Haugh unit scores of the eggs produced by the females in the extended laying period are given in Tables 41 and

4.

2!

bj
th
Ha
no
eg
th
ha
wer
of
sea

are
ica
qua
egg
ary
zat

egg
are
num
fal
sent

42 and these tables are represented graphically by Figures 25 and 26.

The average Haugh unit score of the eggs produced by the February-hatched females was 73.55 units. Whereas, the August-hatched females produced eggs averaging 74.07 Haugh units during the extended laying period. It must be noted that fewer laying periods were represented in the eggs measured from the February-hatched females and that the February-hatched females were older than the August-hatched females. Even with these discrepancies, there were no significant differences in the Haugh unit scores of the eggs produced by the females of either hatching season.

Shell thickness data of the extended laying period are presented in Tables 43 and 44, and represented graphically in Figures 27 and 28. The shell thickness egg quality factor was not significantly different between the egg production of females of either hatching date (February and August). The shell thickness declined approximately 0.0005 of an inch during the extended laying period.

The detectable blood spot incidence data of the eggs produced by the August and February-hatched females are presented in Tables 45, 46 and 47. Insignificant numbers of blood spots occurred during the late summer, fall and early winter months (Table 45). Females, representing both hatching dates (February and August), showed o

a

h

in

da

ma

(1

Fe

exc

egg

540

Sea

Febr

pres

grap

of ha

at si

Figur

male c

hand,

during

the same characteristic of producing higher numbers of eggs with blood spots during these seasons.

The total egg production data, calculated in dozens of sized eggs per 1000 females, are given in Tables 48, 49 and 53. These data give the egg size distribution by hatching date (February and August). Tables 58 through 64, inclusive, give the egg size distribution of the hatching dates by individual egg weights. The August-hatched females produced more dozens of small (512 dozen), peewee (155 dozen) and undergrade (207 dozen) eggs than the February-hatched females. The February-hatched females excelled in the production of the other weight classes of eggs (jumbo, 551 dozen; extra-large, 1637 dozen; large, 840 dozen; and medium, 260 dozen).

Season A (February hatch) versus Season E (October hatch)

The total egg production data of females hatched in February and October (Season A and E, respectively) are presented in Table 1. The total egg production data are graphically represented by Figures 6 and 10. All seasons of hatch (the total egg production of the females hatched at six different seasons) are represented graphically by Figure 12.

February-hatched females produced 4.9 eggs per female during the initial record period (12). On the other hand, October-hatched females produced 0.9 eggs per female during this first period.

The production mean of the February-hatched females was 9.27 eggs per female per two-week period, while the October-hatched females averaged 8.53 eggs per female per two-week period for the total record period. The higher rate of lay of the February-hatched females was reflected in a sustained rate of lay of over 10 eggs per bird for 14 two-week periods. Compared to the above rate of lay, the October-hatched females maintained their egg production of over 10 eggs per bird for 10 two-week periods.

Statistically analyzed, the difference in the production means of 0.74 eggs per female was significant ($P < 0.05$, Tables 5 and 6).

The February-hatched females peaked in egg production at 11.9 eggs per bird; whereas, the October-hatched females reached a peak production of 12.2 eggs per bird per two-week period.

Individual egg size data of the females by hatching date are presented in Tables 28 through 34 and these tables are graphically represented in Figures 13 through 18. All hatching dates were compared by individual egg weights in these tables and figures.

Tables 35 and 39 present the total egg size distribution of the females hatched in February and October while the same egg size distribution data are graphically represented in Figures 19 and 23.

t

i

o

t

a

d

fe

41

Fi

Fe

ha

74

eg

hat

Oct

duc

of

wher

the

cont

perio

are r

The egg size distribution patterns, in Figures 13 through 18, inclusive, showed no consistent hatching date influences on the egg size distribution. There were season of production influences on the egg size distribution in the spring and summer months. Larger numbers of medium and large eggs were produced by the October-hatched females during those warmer months.

The Haugh unit scores of the eggs produced by the females in the extended laying period are given in Tables 41 and 42 and these tables are represented graphically by Figures 25 and 26.

The average Haugh units of the eggs produced by the February-hatched females was 73.55 units. On the other hand, the October-hatched females produced eggs averaging 74.73 Haugh units during the extended laying period. The eggs that were measured were produced by the February-hatched females when the birds were 92 weeks old. The October-hatched birds, when they were 58 weeks old, produced the eggs that were measured. The Haugh unit records of the eggs of the February-hatched females terminated when the layers were 130 weeks old. On the other hand, the Haugh unit study of the October-hatched birds was discontinued when the layers were 116 weeks old.

The shell thickness data of the extended laying period are presented in Tables 43 and 44 and these data are represented graphically in Figures 27 and 28. The

shell thickness was not significantly different between the two hatching dates (February and October) during the extended laying period. The eggs produced by the October and February-hatched females declined 0.0005 of an inch in shell thickness during the extended period of lay.

The detectable blood spot incidence data are presented in Tables 45, 46 and 47 for all hatching dates. No significant differences were noted in the incidence of candled blood spots, when the egg production of the females of the two hatching dates was compared. The seasonal effect of larger numbers of blood spots found in eggs laid during the late summer, fall and early winter months was noted in the production of the females of both hatching dates (February and October).

Total egg production data, calculated in dozens of sized eggs per 1000 females (hen-housed basis) are given in Tables 48, 49 and 55. These tables give the egg size distribution by hatching date. On the other hand, Tables 58 through 64, inclusive, give the egg size distribution data of the hatching dates by individual egg weights. Fewer dozens of eggs (3523 dozen) of all weight classes were produced by the October-hatched females than by the February-hatched females (jumbo, 273 dozen; extra large, 1201 dozen; large, 1343 dozen; and medium, 347 dozen). However, the production of undergrade and peewee eggs by females hatched on both dates were approximately the same.

Season A (February hatch) versus Season F (December hatch)

The total egg production data of females hatched in February and December (Seasons A and F, respectively) are presented in Table 1. The total egg production data for the comparison are graphically represented in Figures 6 and 11. All of the egg production data per hatching season of the study are graphically represented in Figure 12.

February-hatched females produced 4.9 eggs per female during the first record period (Period 12) while the December-hatched females laid 9.0 eggs per female during this first two-week period.

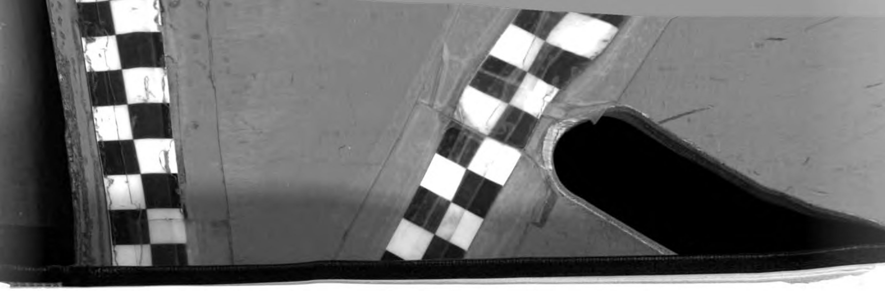
The production means of the hatching dates under consideration (February and December) were 9.27 and 8.01 eggs, respectively, per female for the complete record period. The February-hatched females peaked in egg production at 11.9 eggs per bird; whereas the December-hatched females reached a peak of 10.8 eggs per bird per two-week period. The high rates of lay (10 or more eggs per bird) for the February and December-hatched females were reflected in 14 two-week periods and seven two-week periods, respectively.

The difference between the production means of the females hatched during these seasons was 1.26 eggs per female. Statistically analyzed, this difference was highly significant (Tables 5 and 6, $P < 0.01$).

Individual egg size data per hatching date are presented in Tables 28 through 34, inclusive, and these tables are graphically represented by Figures 13 through 18, inclusive. All hatching dates (compared by separate egg weights) were represented in these figures.

Tables 35 and 40 present the complete egg size distribution of the egg production of the females hatched in February and December, respectively. The same egg size distribution data are graphically shown in Figures 19 and 24. It should be noted that the jumbo egg size distribution percentage was higher for the February-hatched females than for the December-hatched females for comparable periods of lay. The same observation was made of the extra-large sized eggs which was in favor of the production of the February-hatched females. The December-hatched females started with a lower percentage in the production of large eggs per comparable period of lay, but these birds peaked higher than the February-hatched females. Season of production influences were again evident in the egg size distribution of the egg production of the females hatched on these two dates. The production of large and medium-sized eggs was affected more by the season of production than were the other egg weights.

The Haugh unit scores of the eggs produced by the females in the extended laying period are given in Tables 41 and 42 and these tables are represented graphically by



Figures 25 and 26. The average Haugh unit score of the eggs produced by the February-hatched females in the extended lay period was 73.55 units and the December-hatched females produced eggs averaging 74.10 Haugh units. The Haugh unit scores of the eggs of the February-hatched females were recorded when the females were from 92 to 130 weeks of age, while the eggs of the December-hatched birds were measured when the females were from 48 to 106 weeks of age.

The shell thickness data of the laying period are presented in Tables 43 and 44 and are graphically represented by Figures 27 and 28. The shell thickness of the eggs produced by the females of the February and December hatching dates was not significantly different. Females of same age were involved in this measurement of egg quality.

The detectable blood spot incidence data are presented in Tables 45, 46 and 47 for all hatching dates. No significant differences were noted in the numbers of candled blood spots in the eggs produced by the females of these hatching dates. The seasonal effects of larger numbers of blood spots occurring during the late summer, fall and early winter months were noted in the eggs produced by females of both hatching dates. However, during these seasons of lay the following year, larger numbers of blood

spots were not noted and not explained in the eggs produced by the December-hatched females.

Total egg production data, calculated in dozens of eggs per 1000 females (hen-housed basis) are presented in Tables 48, 49 and 56. These tables of data give the egg size distribution by hatching date. On the other hand, Tables 58 through 64 give the egg size distribution data per hatching date by individual egg weights. The February-hatched females produced more dozens of jumbo (381 dozen), extra-large (2612 dozen), and medium (1413 dozen) eggs than the December-hatched females.

Season B (April hatch) versus Season C (June hatch)

The date of the total egg production per female hatched in April and in June are presented in Table 1. The data indicate the average number of eggs produced per female per two-week period and are graphically represented in Figures 7 and 8. All egg production data per season are shown graphically, for comparative purposes, by Figure 12.

The females hatched in April laid at the rate of 1.9 eggs per bird during Period 12 in comparison with a rate of 1.0 egg per bird for the same period by the females hatched in June.

The April-hatched birds peaked in egg production per period at 10.6 eggs per bird; whereas, the June-hatched

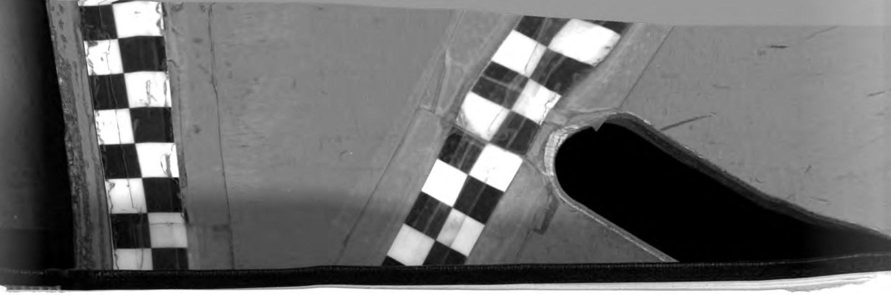
birds reached a peak production of 12.2 eggs per bird. The persistency of egg production over 10 eggs per bird was four two-week periods for the April-hatched females and six two-week periods for the June-hatched birds.

The total egg production mean of the April-hatched females was 7.47 eggs per bird and the production mean of the June-hatched females was 7.67 eggs per bird. Analysis of variance and Duncan's Multiple Range testing indicated that the difference in the egg production means of 0.20 eggs per bird was not significant (Table 6).

The individual egg size distribution data of the females by hatching date are presented in Tables 28 through 34, and these tables are graphically represented in Figures 13 through 18. Each hatching season was compared by separate egg weights in these tables and figures.

On the other hand, Tables 36 and 37 present the total egg distribution of the females hatched in April and June. The same egg weight data of the females hatched at these two dates are graphically represented by Figures 20 and 21.

The females of both hatching seasons produced eggs that were distributed according to identical weights during the laying periods (Tables 36 and 37). However, during the extended lay periods the females of both hatching dates produced larger numbers of medium and large eggs in



in the spring and summer months. The increase in percentage of these egg sizes was offset by decreases in the percentage of the jumbo and extra-large eggs during these months.

The Haugh unit scores of the eggs produced by the females in the extended lay periods are given in Tables 41 and 42 and these tables are represented graphically by Figures 25 and 26. The average Haugh unit score of the eggs produced by the April-hatched females measured 76.46 units, while the June-hatched females produced eggs averaging 74.77 Haugh units during the extended lay period. There were no important differences in the Haugh units of the eggs produced by the females of either hatching season shown in Table 41.

Shell thickness data of the eggs produced during the extended lay periods are presented in Tables 43 and 44 and are represented graphically by Figures 27 and 28. The shell thickness egg quality factor was not noticeably different between the egg production of the females of either hatching date. The shell thickness declined approximately 0.0005 of an inch during the extended lay periods (Figure 28).

The detectable blood spot incidence data of the eggs produced by the April-hatched and June-hatched females are presented in Tables 45, 46 and 47. Small numbers (expressed in percentages) of blood spots were noted in most

periods of lay. However, a higher percentage of blood spots occurred during the later summer, fall and early winter months (Table 45). Females, representing both hatching dates showed the same characteristics of producing a higher percentage of eggs with blood spots during these seasons.

Total egg production data calculated in cumulative dozens of sized eggs per 1000 females (hen-housed basis) are given in Tables 48, 50 and 52. These data give the egg size distribution in cumulative dozens produced by females of the comparative hatching dates (April and June). On the other hand, Tables 58 through 64 give the cumulative egg size distribution data by individual egg weights.

The April hatched females produced a larger number of dozens of jumbo (66 dozen) and extra-large eggs (318 dozen) at the beginning of the record periods than the June-hatched females. The differences were not evident toward the close of the record periods. More dozens of large eggs (1374 dozen) were produced in the later periods of lay by the June-hatched females than by the April-hatched females. The production of large eggs started at essentially the same time for these two groups of females. The June-hatched females produced significantly larger numbers of medium (1936 dozen) eggs than the April-hatched females. No differences in egg production by hatching date were

observed in the small and peewee weight classifications as shown in Tables 62 and 63.

Season B (April hatch) versus Season D (August hatch)

The total egg production data per female hatched in April and August are presented in Table 1. The data presented indicate the average numbers of eggs produced per female (hen-day basis) per two-week period and are graphically represented by Figures 7 and 9 and for comparative purposes by Figure 12.

The April-hatched females laid at the rate of 1.9 eggs per bird during the initial record Period 12. Whereas, the August-hatched females laid at the rate of 3.4 eggs per bird during the comparable period.

The April-hatched females peaked in egg production at 10.6 eggs per bird; whereas, the August-hatched birds reached a peak egg production of 12.0 eggs per bird. Over 10 eggs per period were produced for four two-week periods by the April-hatched birds; however, the August-hatched birds produced over 10 eggs per period for seven two-week periods.

The total egg production mean of the April-hatched females was 7.47 eggs per bird. On the other hand, the production mean of the August-hatched birds was 8.15 eggs per bird. Analysis of variance and Duncan's Multiple Range testing indicated that the difference in the egg production means of 0.68 eggs was not significant (Table 6).

The individual egg size distribution data of the seasonally-hatched females are presented in Tables 28 through 34 and are graphically represented in Figures 13 through 18. On the other hand, Tables 36 and 38 present the complete egg size distribution of the females by hatching date. The same egg weight data of these seasonally hatched females are graphically represented by Figures 20 and 22.

The females of the April and the August hatching season produced a size distribution of eggs that, when the data were plotted, indicated a similar pattern of egg size distribution as shown in Figures 13 through 18. However, during the extended lay periods the females of both hatching dates produced a pattern of egg size distribution that was affected by season of production. Higher percentages of large and medium eggs were produced and lower percentages of jumbo and extra-large eggs produced during the spring and summer months.

The Haugh unit scores of the eggs produced by the females in the extended lay periods are presented in Tables 41 and 42 and are represented graphically by Figures 25 and 26. The average Haugh unit score of the eggs produced by the April-hatched females measured 76.46 units and the August-hatched females produced eggs averaging 74.07 Haugh units during the extended lay period. The season of production did not affect the Haugh units of the eggs produced

by the seasonally-hatched birds, illustrated by Table 41.

Shell thickness data of the eggs produced by the hens in the extended lay periods are presented in Tables 43 and 44 and are graphically represented in Figures 27 and 28. There were no seasonal differences in the shell thickness of the eggs produced by the females of either hatching season and the shell thickness of these eggs did decline (0.0005 of an inch) over time during the extended lay periods, as shown in Table 43 and Figure 28.

Detectable blood spot incidence data of the eggs produced by the April-hatched and August-hatched females are presented in Tables 45, 46 and 47. Insignificant numbers of blood spots were noted in most periods of lay. However, a higher percentage of blood spots occurred during the late summer, fall and early winter months. Both groups of seasonally-hatched hens showed the same characteristic of producing a higher percentage of eggs with blood spots during these seasons.

Total egg production data, calculated in cumulative dozens of sized eggs per 1000 (hen-housed basis) are presented in Tables 48, 50 and 53. These tables show the egg size distribution of monthly cumulative dozens of eggs produced by females of the comparative hatching dates. Whereas, Tables 58 through 64 show the cumulative egg size distribution data by separate egg weights and per season of hatch.

The August-hatched females produced larger numbers of dozens of eggs (5534 dozen) than the April-hatched females. This Table 48 also indicated that the rate of increase in egg production was higher for the August-hatched birds. The tables of individual egg weights, Tables 58 through 64, inclusive, indicated that the April-hatched females had produced comparable or more dozens of eggs (jumbo, 54 dozen; extra-large, 255 dozen; and large, 338 dozen) at 10 months of cumulate egg production. However, the August-hatched females had excelled the April-hatched females in the weight classifications of jumbo (22 dozen), extra-large (1041 dozen) and large (1536 dozen) eggs by the end of the test. The August-hatched females also produced more dozens of medium (1493 dozen), small (749 dozen) and peewee (54 dozen) eggs.

<u>Season B (April hatch) versus Season E (October hatch)</u>

The total egg production data per female hatched in April and October are presented in Table 1. The data presented indicate the average numbers of eggs produced per female (hen-day basis) per two-week period. These data are graphically represented by Figures 7 and 10 and for comparative purposes in Figure 12.

The April-hatched females laid at the rate of 1.9 eggs per bird during the initial record Period 12. On the other hand, the October-hatched females laid at the rate of 0.9 eggs per bird during the similar period.

birds reached a peak production of 12.2 eggs per bird. The persistency of egg production over 10 eggs per bird was four two-week periods for the April-hatched females and six two-week periods for the June-hatched birds.

The total egg production mean of the April-hatched females was 7.47 eggs per bird and the production mean of the June-hatched females was 7.67 eggs per bird. Analysis of variance and Duncan's Multiple Range testing indicated that the difference in the egg production means of 0.20 eggs per bird was not significant (Table 6).

The individual egg size distribution data of the females by hatching date are presented in Tables 28 through 34, and these tables are graphically represented in Figures 13 through 18. Each hatching season was compared by separate egg weights in these tables and figures.

On the other hand, Tables 36 and 37 present the total egg distribution of the females hatched in April and June. The same egg weight data of the females hatched at these two dates are graphically represented by Figures 20 and 21.

The females of both hatching seasons produced eggs that were distributed according to identical weights during the laying periods (Tables 36 and 37). However, during the extended lay periods the females of both hatching dates produced larger numbers of medium and large eggs in in the spring and summer months. The increase in percentage of these egg sizes was offset by decreases in the percentage of the jumbo and extra-large eggs during these months.

The Haugh unit scores of the eggs produced by the females in the extended lay periods are given in Tables 41 and 42 and these tables are represented graphically by Figures 25 and 26. The average Haugh unit score of the eggs produced by the April-hatched females measured 76.46 units, while the June-hatched females produced eggs averaging 74.77 Haugh units during the extended lay period. There were no important differences in the Haugh units of the eggs produced by the females of either hatching season shown in Table 41.

Shell thickness data of the eggs produced during the extended lay periods are presented in Tables 43 and 44 and are represented graphically by Figures 27 and 28. The shell thickness egg quality factor was not noticeably different between the egg production of the females of either hatching date. The shell thickness declined approximately 0.0005 of an inch during the extended lay periods (Figure 28).

The detectable blood spot incidence data of the eggs produced by the April-hatched and June-hatched females are presented in Tables 45, 46 and 47. Small numbers (expressed in percentages) of blood spots were noted in most in the spr [illegible]

age of th [illegible]

centage of [illegible]

months.

Th [illegible]

females [illegible]

41 pro [illegible]

Figures [illegible]

eggs p [illegible]

units, [illegible]

aging [illegible]

There [illegible]

the [illegible]

shown [illegible]

the extr [illegible]

and are [illegible]

shell [illegible]

ferent [illegible]

hatching [illegible]

0.0005 of [illegible]

23).

Th [illegible]

eggs produ [illegible]

are presente [illegible]

pressed in [illegible]

periods of lay. However, a higher percentage of blood spots occurred during the later summer, fall and early winter months (Table 45). Females, representing both hatching dates showed the same characteristics of producing a higher percentage of eggs with blood spots during these seasons.

Total egg production data calculated in cumulative dozens of sized eggs per 1000 females (hen-housed basis) are given in Tables 48, 50 and 52. These data give the egg size distribution in cumulative dozens produced by females of the comparative hatching dates (April and June). On the other hand, Tables 58 through 64 give the cumulative egg size distribution data by individual egg weights.

The April hatched females produced a larger number of dozens of jumbo (66 dozen) and extra-large eggs (318 dozen) at the beginning of the record periods than the June-hatched females. The differences were not evident toward the close of the record periods. More dozens of large eggs (1374 dozen) were produced in the later periods of lay by the June-hatched females than by the April-hatched females. The production of large eggs started at essentially the same time for these two groups of females. The June-hatched females produced significantly larger numbers of medium (1936 dozen) eggs than the April-hatched females. No differences in egg production by hatching date were observed in the small and peewee weight classifications as shown in Tables 62 and 63.

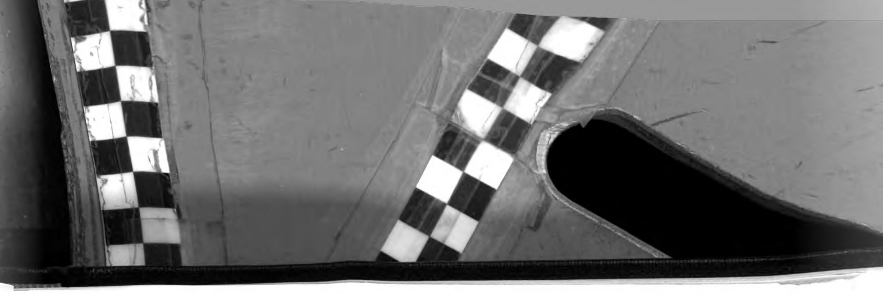
Season B (April hatch) versus Season D (August hatch)

The total egg production data per female hatched in April and August are presented in Table 1. The data presented indicate the average numbers of eggs produced per female (hen-day basis) per two-week period and are graphically represented by Figures 7 and 9 and for comparative purposes by Figure 12.

The April-hatched females laid at the rate of 1.9 eggs per bird during the initial record Period 12. Whereas, the August-hatched females laid at the rate of 3.4 eggs per bird during the comparable period.

The April-hatched females peaked in egg production at 10.6 eggs per bird; whereas, the August-hatched birds reached a peak egg production of 12.0 eggs per bird. Over 10 eggs per period were produced for four two-week periods by the April-hatched birds; however, the August-hatched birds produced over 10 eggs per period for seven two-week periods.

The total egg production mean of the April-hatched females was 7.47 eggs per bird. On the other hand, the production mean of the August-hatched birds was 8.15 eggs per bird. Analysis of variance and Duncan's Multiple Range testing indicated that the difference in the egg production means of 0.68 eggs was not significant (Table 6).



The individual egg size distribution data of the seasonally-hatched females are presented in Tables 28 through 34 and are graphically represented in Figures 13 through 18. On the other hand, Tables 36 and 38 present the complete egg size distribution of the females by hatching date. The same egg weight data of these seasonally hatched females are graphically represented by Figures 20 and 22.

The females of the April and the August hatching season produced a size distribution of eggs that, when the data were plotted, indicated a similar pattern of egg size distribution as shown in Figures 13 through 18. However, during the extended lay periods the females of both hatching dates produced a pattern of egg size distribution that was affected by season of production. Higher percentages of large and medium eggs were produced and lower percentages of jumbo and extra-large eggs produced during the spring and summer months.

The Haugh unit scores of the eggs produced by the females in the extended lay periods are presented in Tables 41 and 42 and are represented graphically by Figures 25 and 26. The average Haugh unit score of the eggs produced by the April-hatched females measured 76.46 units and the August-hatched females produced eggs averaging 74.07 Haugh units during the extended lay period. The season of production did not affect the Haugh units of the eggs produced by the seasonally-hatched birds, illustrated by Table 41.

Shell thickness data of the eggs produced by the hens in the extended lay periods are presented in Tables 43 and 44 and are graphically represented in Figures 27 and 28. There were no seasonal differences in the shell thickness of the eggs produced by the females of either hatching season and the shell thickness of these eggs did decline (0.0005 of an inch) over time during the extended lay periods, as shown in Table 43 and Figure 28.

Detectable blood spot incidence data of the eggs produced by the April-hatched and August-hatched females are presented in Tables 45, 46 and 47. Insignificant numbers of blood spots were noted in most periods of lay. However, a higher percentage of blood spots occurred during the late summer, fall and early winter months. Both groups of seasonally-hatched hens showed the same characteristic of producing a higher percentage of eggs with blood spots during these seasons.

Total egg production data, calculated in cumulative dozens of sized eggs per 1000 (hen-housed basis) are presented in Tables 48, 50 and 53. These tables show the egg size distribution of monthly cumulative dozens of eggs produced by females of the comparative hatching dates. Whereas, Tables 58 through 64 show the cumulative egg size distribution data by separate egg weights and per season of hatch.

The August-hatched females produced larger numbers of dozens of eggs (5534 dozen) than the April-hatched females. This Table 48 also indicated that the rate of increase in egg production was higher for the August-hatched birds. The tables of individual egg weights, Tables 58 through 64, inclusive, indicated that the April-hatched females had produced comparable or more dozens of eggs (jumbo, 54 dozen; extra-large, 255 dozen; and large, 338 dozen) at 10 months of cumulate egg production. However, the August-hatched females had excelled the April-hatched females in the weight classifications of jumbo (22 dozen), extra-large (1041 dozen) and large (1536 dozen) eggs by the end of the test. The August-hatched females also produced more dozens of medium (1493 dozen), small (749 dozen) and peewee (54 dozen) eggs.

Season B (April hatch) versus Season E (October hatch)

The total egg production data per female hatched in April and October are presented in Table 1. The data presented indicate the average numbers of eggs produced per female (hen-day basis) per two-week period. These data are graphically represented by Figures 7 and 10 and for comparative purposes in Figure 12.

The April-hatched females laid at the rate of 1.9 eggs per bird during the initial record Period 12. On the other hand, the October-hatched females laid at the rate of 0.9 eggs per bird during the similar period.

The April-hatched females peaked in egg production per layer per period at 10.6 eggs; whereas, the October-hatched birds reached a peak egg production of 12.2 eggs per bird. Over 10 eggs per bird were produced for four two-week periods by the April-hatched birds; whereas, the October-hatched birds produced over 10 eggs per period for 10 consecutive periods.

The total egg production means were 7.47 and 8.53 eggs per bird hatched in April and October. Analysis of variance and Duncan's Multiple Range Tests indicated that the difference in means of 1.06 eggs per bird per period was highly significant, ($P < 0.01$, Tables 5 and 6).

The individual egg size distribution data of the females hatched at different times (April and October) are presented in Tables 28 through 34, inclusive, and are graphically represented by Figures 13 through 18, inclusive. Tables 36 and 39 tabulate the complete egg size distribution data of the females hatched in April and October and the same egg weight data are graphically shown by Figures 20 and 23.

The females of both hatching seasons (April and October) produced a size distribution of eggs that, when the data were graphically represented, the figures appeared to be essentially similar as shown in Figures 13 through 18, inclusive. The differences in level of the percentage lines on the representative graphs indicate

Th

per layer

hatched

per bird

two-week

October

10 consec

eggs

ratio

the d

was

female

presen

graph

sive.

distri

October

by Fig.

October

the data

peared

through

percentage

that a higher percentage of extra-large eggs were produced by the October-hatched females. The level of the large egg percentage line of the egg production of the October-hatched birds was only slightly higher than the April-hatched birds. Differences, in the balance of the weight classifications, were not significant between the egg production of the two seasonally-hatched females.

However, during the extended lay periods, the females of both hatching dates produced eggs that were affected by the season of production. There were higher percentages of large and medium eggs and lower percentages of jumbo and extra-large eggs produced during the spring and summer months.

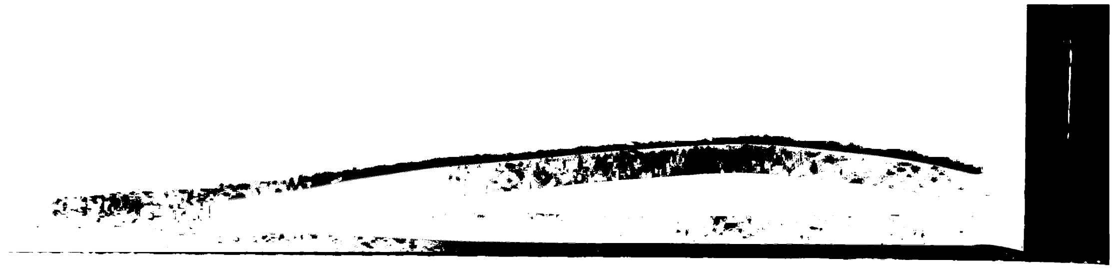
Haugh unit scores of the eggs produced by the females in the extended lay periods are presented in Tables 41 and 42 and are represented graphically by Figures 25 and 26. The average Haugh unit score of the eggs produced by the April-hatched females measured 76.46 units. On the other hand, the October-hatched females produced eggs averaging 74.73 Haugh units during the extended lay period. There were no season of production effects in the Haugh units of the eggs produced by the seasonally-hatched birds.

The shell thickness data of the eggs produced by the hens in the extended lay periods are presented in Tables 43 and 44 and are represented graphically in Figures 27 and 28. Season of production did not affect the shell thickness of the eggs produced by the females of either hatching date, illustrated in Table 43. The shell thickness of the eggs laid during the extended lay period declined approximately 0.0005 of an inch.

The detectable blood spot incidence data of the eggs produced by the April and October-hatched females are given in Tables 45, 46 and 47. Insignificant numbers of blood spots were observed in most periods of lay. However, a higher percentage of blood spots occurred during the late summer, fall and early winter months shown in Table 45. Both groups of seasonally-hatched birds produced a higher percentage of blood spots during these seasons of lay.

Total egg production data, calculated in cumulative dozens of sized eggs per 1000 females (hen-housed basis) are presented in Tables 48, 50 and 55. These tables give the egg size distribution in monthly cumulative dozens of eggs produced by females of the hatching dates being compared. Differently presented, Tables 58 through 64 give the cumulative separate egg size distribution data season of hatch.

The October-hatched females produced 3523 more dozens of eggs than the April-hatched females. Of the various egg size classifications, the October-hatched females produced more dozens of eggs than the April-hatched females with the following egg sizes: jumbo (153 dozen); extra-large (1288 dozen); large (990 dozen); and medium (1519



dozen). More dozens of small eggs (120 dozen) and of peewee eggs (86 dozen) were produced by the April-hatched females than by the October-hatched females in comparable months.

Season B (April hatch) versus Season F (December hatch)

The total egg production data per female hatched in April and December are presented in Table 1. The data presented indicate the average numbers of eggs produced per female (hen-day basis) per two-week period. These data are graphically represented by Figures 7 and 11, and for comparative purposes by Figure 12.

The April-hatched females laid at the rate of 1.9 eggs per bird during Period 12. During the same initial record period, the December-hatched females laid 9.0 eggs per bird.

The April-hatched females peaked in egg production per layer per period at 10.6 eggs; whereas, the December-hatched birds reached a peak egg production of 10.8 eggs per bird. Over 10 eggs per bird were produced for four two-week periods by the April-hatched birds. On the other hand, the December-hatched females produced over 10 eggs per period for seven consecutive two-week periods.

The total egg production means were 7.47 and 8.01 eggs per bird hatched in April and December. Analysis of variance and Duncan's Multiple Range tests indicated that

the difference in means of 0.54 eggs per bird was not significant (Tables 5 and 6).

The individual egg size distribution data of the females hatched at different times are presented in Tables 28 through 34, inclusive, and are graphically represented by Figures 13 through 18, inclusive. Whereas, Tables 36 and 40 list the complete egg size distribution data of the females. The same egg weight data of these April and December-hatched females are graphically shown by Figures 20 and 24.

The April-hatched females produced a higher percentage of jumbo, extra-large and large eggs at the beginning of the record periods than did the December-hatched females. However, the December-hatched females peaked at a higher percentage of extra-large and large eggs than the April-hatched females. These peaks were achieved at an older age also. The medium egg size distribution pattern of both the April and December-hatched females were essentially the same. Seasonal production effects on the medium egg size distribution in the extended lay periods were again evident for both seasons of hatch, and shown in Figure 16. Small egg percentages were lower for the December-hatched females and these birds persisted longer in producing small eggs as represented in Figure 17.

The Haugh unit scores of the eggs produced by the females in the extended lay periods are presented in

Tables 41 and 42 and are represented graphically by Figures 25 and 26. The average Haugh unit score of the eggs produced by the April-hatched females measured 76.46 units. Whereas, the December-hatched females produced eggs averaging 74.10 Haugh units during the extended lay period. There were no seasonal production effects in the Haugh units of the eggs produced by the seasonally-hatched birds (Table 41).

Shell thickness data of the eggs produced by the hens and in the extended lay periods are presented in Tables 43 and 44 and are graphically represented by Figures 27 and 28. Season of production did not affect the shell thickness of the eggs produced by the April and December-hatched birds, illustrated by Table 43. The shell thickness of the eggs laid during the extended lay periods declined approximately 0.0005 of an inch.

The detectable blood spot incidence data of the eggs produced by the April and December-hatched females are given in Tables 45, 46 and 47. A low percentage (1-2%) of blood spots was detected in most periods of lay representing both hatching dates. However, a higher percentage (2-3%) of blood spots was noted in Table 45 for the late summer, fall and early winter months.

Total egg production data (hen-housed basis), calculated in cumulative dozens of sized eggs per 1000 females, are presented in Tables 48, 50 and 56. Tables 58 through

64 give the cumulative individual egg weight distribution data per season of hatch.

More dozens of eggs of all weight classifications (2187 dozen) were produced by the December-hatched females than by the April-hatched birds. The egg production of the females of both seasons of hatch was relatively similar in the egg weights of jumbo, extra-large, large and medium. However, the December-hatched females produced 1304 more dozens of small eggs and 818 more dozens of peewee eggs than the April-hatched birds.

<u>Season C (June hatch) versus Season D (August hatch)</u>

The total egg production data per female hatched in June and August are presented in Table 1. The data presented indicate the average numbers of eggs (hen-day basis) produced per female per two-week period. These data are graphically represented by Figures 8 and 9 and for comparative purposes by Figure 12.

The June-hatched females laid at the rate of 1.0 eggs per bird during Period 12. During the same initial record period, the August-hatched females laid 3.4 eggs per bird.

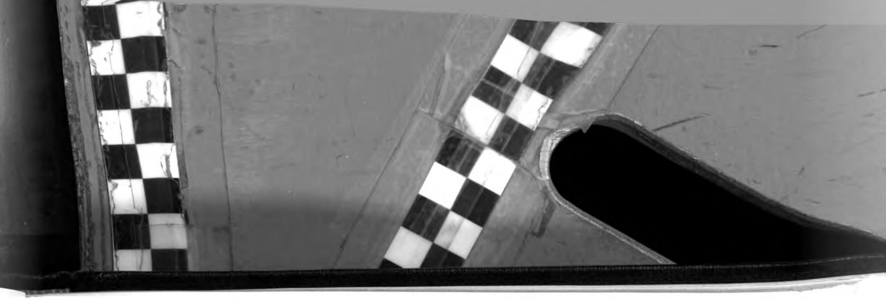
The June-hatched females peaked in egg production per layer per period at 12.2 eggs, whereas, the August-hatched females reached a peak egg production of 12.0 eggs per bird. The June-hatched birds persisted in the production of over 10 eggs per bird per period for six two-week periods. On the other hand, the August-hatched birds produced over 10 eggs per period for seven consecutive two-week periods.

The total egg production means were 7.67 and 8.15 eggs per bird hatched in June and August, respectively. Analysis of variance and Duncan's Multiple Range Tests indicated that the difference in means of 0.48 eggs per bird was not significant (Tables 5 and 6).

The individual egg size distribution data of the June and August-hatched females are presented in Tables 28 through 34, inclusive, and are graphically represented in Figures 13 through 18. Tables 37 and 38 present the complete egg size distribution data of the June and August-hatched females and these data are graphically represented by Figures 21 and 22.

The June and August-hatched females produced egg sizes that, when these data were plotted on Figures 13 through 18, represented essentially a similar pattern of egg size distribution. Season of production influences on the production of medium eggs were evident in the extended lay periods.

Haugh unit scores of the eggs produced by the females in the extended lay periods are presented in Tables 41 and 42 and are represented graphically by Figures 25 and 26. The average Haugh unit score of the eggs produced by the June-hatched females measured 74.77 units and the



eggs of the August-hatched birds measured an average of 74.07 Haugh units during the extended lay period. There were no seasonal production effects on the Haugh units of the eggs produced by the June and August-hatched birds.

Shell thickness data of the eggs produced by the hens in the extended lay periods are presented in Tables 43 and 44 and are represented graphically by Figures 27 and 28. Season of production did not affect the shell thickness of the eggs produced by the June and August-hatched birds shown in Table 43. The shell thickness of the eggs laid during the extended lay periods did decline approximately 0.0005 of an inch.

Detectable blood spot incidence data of the eggs produced by the June and August-hatched females are given in Tables 45, 46 and 47. A low percentage (1%) of blood spots was detected in most periods of lay of the June and August-hatched birds. However, a higher percentage (3-4%) of blood spots was noted during the late summer, fall and early winter months and shown in Table 45. The June and August-hatched females both showed this characteristic during these seasons.

Total egg production data (hen-housed basis), calculated in cumulative dozens of egg sizes per 1000 females, are presented in Tables 48, 52 and 53. Tables 58 through 64 give the cumulative individual egg weight distribution data per hatching season.

More dozens of eggs (1996 dozen) of all weights were produced by the August-hatched females than the June-hatched females. The egg production of the August-hatched females yielded more dozens of jumbo (91), extra-large (687), large (244), small (802), peewee (94) and undergrade (508) eggs than the June-hatched birds. The June-hatched birds did produce 430 dozen eggs more than the August-hatched birds.

Season C (June hatch) versus Season E (October hatch)

The total egg production data per female hatched in June and October are presented in Table 1. The data presented indicate the average numbers of eggs (hen-day basis) produced per female per two-week period. These data are graphically represented by Figures 8 and 10 and for comparative purposes by Figure 12.

The June-hatched females laid at the rate of 1.0 eggs per bird during Period 12. Whereas, the October-hatched females laid 0.9 eggs per bird during the same period.

Both the June-hatched and October-hatched females peaked in egg production per layer per period at 12.2 eggs. The June-hatched birds persisted in egg production of over 10 eggs per bird per period for six periods. On the other hand, the October-hatched birds produced over 10 eggs per period for 10 consecutive periods.

The total egg production means were 7.67 and 8.53 eggs per bird hatched in June and October, respectively. Analysis of variance and Duncan's Multiple Range tests indicated that the difference in means of 0.86 eggs per bird was significant ($P < 0.05$, Tables 5 and 6).

The individual egg size distribution data of the June and October-hatched females are presented in Tables 28 through 34, inclusive, and are graphically represented in Figures 13 through 18, inclusive. Similarly, Tables 37 and 39 present the complete egg size distribution data of the June and October-hatched females and these data are graphically represented by Figures 21 and 23.

The June and October-hatched females produced an egg size distribution pattern that was essentially the same shape, illustrated in Figures 13 through 18. However, the level of the egg size distribution curve of the jumbo and extra-large eggs produced by the October-hatched birds was higher. The large-egg curves produced by females of both hatching dates were essentially similar. Whereas, the data indicated that the June-hatched females produced a higher percentage of medium and small eggs. Season of production influences on the production of medium eggs in the extended lay periods were again evident in the curves of Figure 16.

The Haugh unit scores of the eggs produced by the females in the extended lay periods are presented in Tables

41 and 42 and are represented graphically in Figures 25 and 26. The average Haugh unit score of the eggs produced by the June-hatched females measured 74.77 units while the eggs of the October-hatched females measured an average of 74.73 Haugh units during the extended lay periods. There were no seasonal production effects on the Haugh units of the eggs produced by the June and October-hatched birds.

The shell thickness data of the eggs produced by the hens in the extended lay periods are presented in Tables 43 and 44 and are represented graphically by Figures 27 and 28. Season of production did not affect the shell thickness of the eggs produced by the June and October-hatched birds, shown in Table 43. The shell thickness of the eggs laid during the extended lay periods declined approximately 0.0005 of an inch.

The detectable blood spot incidence data of the eggs produced by the June and October-hatched females are given in Tables 45, 46 and 47. Low percentages (1%) of blood spots were detected in most periods of lay of the June and October-hatched birds. However, a higher percentage (3-4%) was produced by the June-hatched birds and a slightly lower percent (2-3%) by the October-hatched birds during the late summer, fall and early winter months as shown in Table 45.

Total egg production data (hen-housed basis), calculated in cumulative dozens of egg sizes per 1000 birds,

are presented in Tables 48, 52 and 55. Tables 58 through 64 give the cumulative individual egg weight distribution data per hatching season.

The October-hatched birds produced 585 more dozens of eggs than the June-hatched birds. The October-hatched females produced more dozens of jumbo and extra-large eggs but fewer dozens of large, medium, small and peewee eggs than did the June-hatched birds as listed in Tables 52 and 55.

Season C (June hatch) versus Season F (December hatch)

The total egg production data per female hatched in June and December are presented in Table 1. The data presented indicate the average numbers of eggs (hen-day basis) produced per female per two-week period. These data are graphically represented by Figures 8 and 11 and for comparative purposes by Figure 12.

The June-hatched females laid at the rate of 1.0 eggs per bird during Period 12, whereas, the December-hatched females laid 9.0 eggs per bird during the same period.

The June-hatched females peaked in egg production per layer per two-week period at 12.2 eggs, and the December-hatched females reached a peak egg production of 10.8 eggs. The June-hatched birds maintained a level of egg production of over 10 eggs per bird per period for six

periods. On the other hand, the December-hatched birds laid at this level for seven consecutive periods.

The total egg production means were 7.67 and 8.01 eggs per bird hatched in June and December, respectively. Analysis of variance and Duncan's Multiple Range tests indicated that the difference in means of 0.34 eggs per bird was not significant (Tables 5 and 6).

The individual egg size distribution data of the June and December-hatched females are presented in Tables 28 through 34 and are graphically represented in Figures 13 through 18. Similarly, Tables 37 and 40 present the complete egg size distribution data of the June and December-hatched females and are graphically represented by Figures 21 and 24.

The jumbo egg size distribution patterns of eggs laid by females of both seasons of hatch were essentially alike. However, the extra-large and large egg size distribution patterns were not similar. The December-hatched females laid a lower percentage of extra-large and large eggs than the June-hatched females. Season of production effects influenced the production of the eggs of both weights, however, as the production of large and extra-large eggs was depressed in the spring and summer months. During the same months, more medium eggs were produced by both the June-hatched and December-hatched females. There were differences between hatching dates in the small egg

percentage curves. The December-hatched females produced a lower percentage of small eggs during the early periods and these layers persisted for a longer period of time in the production of small eggs (Figure 17).

The Haugh unit scores of the eggs produced by the females in the extended lay periods are presented in Tables 41 and 42 and are represented graphically by Figures 25 and 26. The average Haugh unit score of the eggs produced by the June-hatched females measured 74.77 units while the December-hatched females produced eggs averaging 74.10 Haugh units during the extended lay periods.

The shell thickness data of the eggs produced by the hens in the extended lay periods are presented in Tables 43 and 44 and are graphically represented by Figures 27 and 28. Season of production did not affect the shell thickness of the eggs produced by the June and December-hatched females, shown in Table 43. The shell thickness of the eggs laid during the extended lay periods declined approximately 0.0005 of an inch.

The blood spot incidence data of the eggs produced by the June and December-hatched females are given in Tables 45, 46 and 47. A low percentage (1%) of blood spots was detected in most periods of lay. However, a higher percentage (3-4%) was produced by the June-hatched birds and a lower percentage (2-3%) was produced by the December-hatched birds during the late summer, fall and

early winter which is illustrated in Table 45.

Total egg production data (hen-housed basis), calculated in cumulative dozens of egg sizes per 1000 birds, are presented in Tables 48, 52, and 56. Tables 58 through 64 present the cumulative individual egg weight distribution data per hatching season.

The June-hatched females produced 446 more dozens of eggs than the December-hatched birds. The June-hatched females produced more dozens of jumbo eggs (74 dozen), extra-large eggs (676 dozen), large eggs (1185 dozen) and medium eggs (1271 dozen) than the December-hatched females. On the other hand, the December-hatched females produced more small eggs (1372 dozen), peewee eggs (958 dozen) and undergrade eggs (430 dozen) than the June-hatched birds.

Season D (August hatch) versus Season E (October hatch)

The total egg production data per female hatched in August and October are presented in Table 1. The data presented indicate the average numbers of eggs (hen-day basis) produced per female per two-week period. These data are graphically represented by Figures 9 and 10 and for comparative purposes by Figure 12.

The August-hatched females laid at the rate of 3.4 eggs per bird during the initial record period (12), while the October-hatched females laid 0.9 eggs per bird during the same period.

The August-hatched females peaked in egg production per layer per two-week period at 12.0 eggs, and the October-hatched females reached a peak egg production of 12.2 eggs per bird. The August-hatched birds maintained a level of egg production of over 10 eggs per bird per period for seven periods while the October-hatched birds produced over 10 eggs per period for 10 consecutive periods.

The total egg production means were 8.15 and 8.53 eggs per bird hatched in August and October, respectively. Analysis of variance and Duncan's Multiple Range tests indicated that the mean difference of 0.38 eggs per bird was not significant (Tables 5 and 6).

The individual egg size distribution data of the August and October-hatched females are presented in Tables 28 through 34, inclusive, and are graphically represented by Figures 13-18, inclusive. Similarly, Tables 38 and 39 present the complete egg size distribution data of the August and October-hatched females and are graphically represented by Figures 22 and 23.

The percentage of jumbo and extra-large eggs was higher for the eggs laid by the October-hatched females than by the August-hatched females. The egg size distribution patterns of the large, medium and small egg weights were essentially similar except for the influences of the season of production. Higher percentages of eggs of these

egg weights were laid during the spring and summer months by the females of both the August and October-hatched females, as shown in Figures 15, 16 and 17.

The Haugh unit scores of the eggs produced by the females in the extended lay period are presented in Tables 41 and 42 and are graphically represented by Figures 25 and 26. The average Haugh unit score of the eggs produced by the August-hatched females measured 74.07 units while the October-hatched females produced eggs averaging 74.73 Haugh units during the extended lay periods.

The shell thickness data of the eggs produced by the hens in the extended lay periods are presented in Tables 43 and 44 and are graphically represented by Figures 27 and 28. Season of egg production did not affect the shell thickness of the eggs produced by the August and October-hatched females, as shown in Table 43. The shell thickness of the eggs laid during the extended lay periods did decline approximately 0.0005 of an inch.

The detectable blood spot incidence data of the eggs produced by the August and October-hatched females are given in Tables 45, 46 and 47. A low percentage (1%) of blood spots was detected in most periods of lay. However, a higher percentage (2-3%) of blood spots was produced by the August and October-hatched females during the late summer, fall and early winter months, as recorded in Table 45.

The total egg production data, calculated in cumulative dozens of egg sizes per 1000 layers, (hen-housed basis) are presented in Tables 48, 53 and 55. Tables 58 through 64 present the cumulative individual egg weight distribution data per hatching season.

The August-hatched females produced 1281 more dozens of eggs than the October-hatched birds as shown in Table 48. The August-hatched females produced more dozens of large eggs (509 dozen), medium eggs (69 dozen), small eggs (869 dozen), peewee eggs (140 dozen) and undergrade eggs (334 dozen) than the October-hatched females. On the other hand, the October-hatched females produced more dozens of jumbo eggs (192 dozen) and extra-large eggs (448 dozen) than the August-hatched females.

Season D (August hatch) versus Season F (December hatch)

The total egg production data per female hatched in August and December are presented in Table 1. The data presented indicate the average numbers of eggs (hen-day basis) produced per female per two-week period. These data are graphically represented by Figures 9 and 11 and for comparative purposes by Figure 12.

The August-hatched females laid at the rate of 3.4 eggs per bird during the initial record period (12). Whereas, the December-hatched females laid 9.0 eggs per bird during the same period.

The August-hatched females peaked in egg production per layer per period at 12.0 eggs, and the December-hatched females reached a peak egg production of 10.8 eggs per bird. Both the August-hatched and the December-hatched birds maintained a level of egg production of over 10 eggs per bird per period for seven two-week periods.

The total egg production means were 8.15 and 8.01 eggs per bird hatched in August and December, respectively. Analysis of variance and Duncan's Multiple Range tests indicated the mean difference of 0.14 eggs per bird was not significant (Tables 5 and 6).

The individual egg size distribution data of the August and December-hatched females are presented in Tables 28 through 34 and are graphically represented by Figures 13 through 18. Similarly, Tables 38 and 40 present the complete egg size distribution data of the August and December-hatched females and these data are graphically represented by Figures 22 and 24.

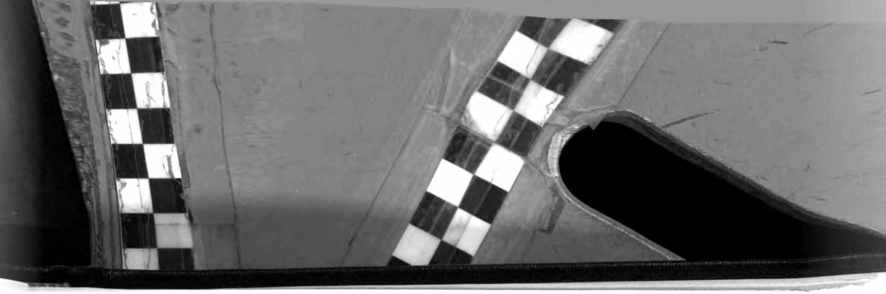
A higher percentage of jumbo, extra-large and large eggs were laid by the August-hatched birds than by the December-hatched birds. The August-hatched females laid a higher percentage of medium eggs in the initial periods, but at one year of age the December-hatched females produced a higher percentage of medium eggs. More small and peewee eggs were laid earlier in the production periods by the August-hatched females than by the December-hatched

females.

The Haugh unit scores of the eggs produced by the females in the extended lay periods are presented in Tables 41 and 42. These data are graphically represented by Figures 25 and 26. The average Haugh unit score of the eggs produced by the August-hatched females was 74.07 units. On the other hand, the December-hatched females produced eggs averaging 74.10 Haugh units during the extended lay periods.

The shell thickness data of the eggs produced by the hens in the extended lay periods are presented in Tables 43 and 44 and are graphically represented by Figures 27 and 28. Season of egg production did not affect the shell thickness of the eggs produced by the August and December-hatched females shown in Table 43. The shell thickness of the eggs laid during the extended lay periods declined approximately 0.0005 of an inch.

The detectable blood spot incidence data of the eggs produced by the August and December-hatched females are given in Tables 45, 46 and 47. Low percentages (1%) of blood spots were detected in most periods of lay. However, higher percentages (2-3%) of blood spots were produced by the August and December-hatched females during the late summer, fall and early winter months shown in Table 45.



Total egg production data, calculated in cumulative dozens of egg sizes per 1000 layers (hen-housed basis), are presented in Tables 48, 53 and 56. Tables 58-64, inclusive, present the cumulative individual egg weight distribution data per hatching season.

The August-hatched females produced 2500 more dozens of eggs than the December-hatched females. The August-hatched females produced more dozens of jumbo eggs (64 dozen), extra-large eggs (1171 dozen), large eggs (1505 dozen), medium eggs (1112 dozen) and undergrade eggs (68 dozen) than the December-hatched females. The December-hatched females produced more dozens of small eggs (556 dozen) and peewee eggs (864 dozen) than the August-hatched females.

Season E (October hatch) versus Season F (December hatch)

The total egg production data per female hatched in October and December are presented in Table 1. The data presented indicate the average numbers of eggs (hen-day basis) produced per female per two-week period. These data are graphically represented by Figures 10 and 11 and for comparative purposes by Figure 12.

The October-hatched females laid at the rate of 0.9 eggs per bird during the initial record period (12), and the December-hatched females laid 9.0 eggs per female during the same period.

The October-hatched females peaked in egg production per layer per period at 12.2 eggs, and the December-hatched females reached a peak egg production of 10.8 eggs per bird. The October-hatched females maintained a level of egg production of over 10 eggs per bird per period for 10 periods. On the other hand, the December-hatched females produced over 10 eggs per period for seven months.

The total egg production means were 8.53 and 8.01 eggs per bird hatched in October and December. Analysis of variance and Duncan's Multiple Range tests indicated the mean difference of 0.52 eggs per bird was not significant (Tables 5 and 6).

The individual egg size distribution data of the October and December-hatched females are presented in Tables 28-34, inclusive, and are graphically represented by Figures 13-18, inclusive. Similarly, Tables 39 and 40 present the complete egg size distribution data of the October and December-hatched females, and these data are graphically portrayed by Figures 23 and 24.

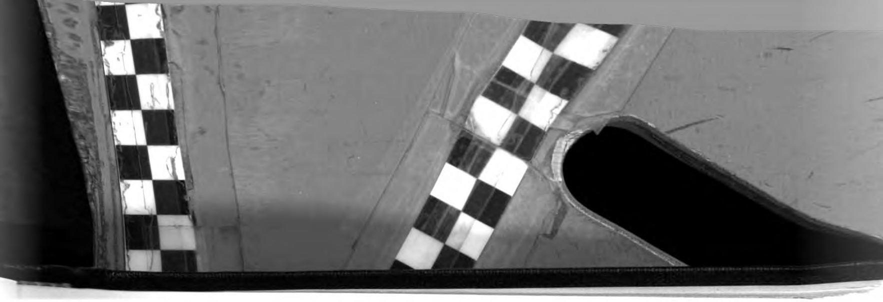
Higher percentages of jumbo, extra-large, large and medium eggs were laid by the October-hatched females than by the December-hatched females. However, more small eggs were laid earlier in the record period by the October-hatched females than by the December-hatched females. Haugh unit scores of the eggs produced by the females in the extended lay periods are presented in Tables 41 and 42

and are graphically represented by Figures 25 and 26. The average Haugh unit score of the eggs produced by the October-hatched females was 74.73 units, while the December-hatched females produced eggs measuring an average of 74.10 Haugh units during the extended lay periods.

The shell thickness data of the eggs produced by the hens in the extended lay periods are presented in Tables 43 and 44 and are graphically represented by Figures 27 and 28. Season of egg production did not affect the shell thickness of the eggs produced by the October and December-hatched females shown in Table 43. The shell thickness of the eggs laid during the extended lay periods declined approximately 0.0005 of an inch.

The detectable blood spot incidence data of the eggs produced by the October and December-hatched females are given in Tables 45, 46 and 47. Low percentages (1%) of blood spots were detected in most periods of lay. However, seasonally higher percentages (2-3%) of blood spots were produced by the October and December-hatched females during the late summer, fall and early winter months.

The total egg production data, calculated in cumulative dozens of egg sizes per 1000 layers (hen-housed basis), are presented in Tables 48, 55 and 56. Tables 58 through 64 present the cumulative individual egg weight distribution data per hatching season.



The October-hatched females produced 1742 more dozens of eggs than the December-hatched females. The October-hatched females produced more dozens of jumbo (255 dozen), extra-large (1659 dozen), large (1305 dozen) and medium eggs (1131 dozen) than the December-hatched females. However, the December-hatched females produced more dozens of small (1421 dozen), peewee (1004 dozen) and undergrade eggs (183 dozen) than the October-hatched females.

STRAIN II COMPARISONS

Season B (April hatch) versus Season D (August hatch)

The total egg production data per female hatched in April and August are presented in Table 2. The data presented indicate the average numbers of eggs (hen-day basis) produced per female per two-week period.

The April-hatched females laid eggs at the rate of 2.3 eggs per bird during the initial record period (12). Whereas, the August-hatched females laid 3.8 eggs per female during the same period. The April-hatched females peaked in egg production per layer per period at 11.5 eggs, and the August-hatched females reached this peak egg production of 12.2 eggs per bird. The April-hatched birds maintained a level of egg production of over 10 eggs per bird per period for three periods, while the August-hatched females produced at this level for 10 consecutive

periods.

The total egg production means were 7.88 and 9.68 eggs per bird, respectively. Analysis of variance and Duncan's Multiple Range tests indicated the mean difference of 1.80 eggs per bird was highly significant ($P < 0.01$, Tables 7 and 8).

The total egg production data, calculated in cumulative dozens of sized eggs per 1000 layers (hen-housed basis), are presented in Tables 48, 51 and 54. Tables 58 through 64 present the cumulative individual egg weight distribution data per hatching season.

The August-hatched females produced 3329 more dozens of eggs than the April-hatched females recorded in Table 48. The April-hatched females produced more dozens of jumbo (74 dozen) and extra-large eggs (666 dozen), but the August-hatched females excelled in the production of large (483 dozen), medium (2349 dozen), small (745 dozen), peewee (89 dozen) and undergrade (303 dozen) eggs (Tables 51 and 54).

Season B (April hatch) versus Season F (December hatch)

The total egg production data per female hatched in April and December are presented in Table 2. The data presented indicate the average numbers of eggs (hen-day basis) produced per female per two-week period.

The April-hatched females laid eggs at the rate of 2.3 eggs per bird during the initial record period (12), while the December-hatched females laid 9.1 eggs per female during the same period. The April-hatched females peaked in egg production per layer per period at 11.5 eggs and the December-hatched females reached a peak egg production of 10.8 eggs per bird. The April-hatched birds maintained a level of egg production of over 10 eggs per bird per period for three periods while the December-hatched females produced at this level for only two periods.

The total egg production means were 7.88 and 8.48 eggs per bird hatched in April and December, respectively. Analysis of variance and Duncan's Multiple Range tests indicated the mean difference of 0.60 eggs per bird was not significant (Tables 7 and 8).

Total egg production data, calculated in cumulative dozens of sized eggs per 1000 layers (hen-housed basis), are presented in Tables 48, 51 and 57. Tables 58 through 64 present the cumulative individual egg weight distribution data per hatching season.

The December-hatched females produced 441 more dozens of eggs than the April-hatched females (Table 48). The April-hatched females produced more dozens of jumbo (140 dozen), extra-large (1482 dozen) and large (1486 dozen) eggs, but the December-hatched females produced

The Ap [illegible]

2.5 eggs per [illegible]
while the De[illegible]
[illegible] during [illegible]
peaked in [illegible]
eggs and th[illegible]
production [illegible]
maintained [illegible]
bird per [illegible]
hatched [illegible]

Th[illegible]
eggs per [illegible]
analysis o[illegible]
dicated th[illegible]
significan[illegible]

A [illegible]
dozens of [illegible]
are presen[illegible]
be present[illegible]
tion data p[illegible]

The Dece[illegible]
dozens of eggs [illegible]
The April-hatc[illegible]
(240 dozen), [illegible]
dozen) eggs, [illegible]

more dozens of medium (494 dozen), small (1910 dozen), peewee (1027 dozen) and undergrade (118 dozen) eggs.

Season D (August hatch) versus Season F (December hatch)

The total egg production data per female hatched in August and December are presented in Table 2. The data presented indicate the average numbers of eggs (hen-day basis) produced per female per two-week period.

The August-hatched females laid eggs at the rate of 3.8 eggs per bird during the initial record period (12), while the December-hatched females laid 9.1 eggs per female during the same period. The August-hatched females peaked in egg production at 12.2 eggs per bird per period and the December-hatched females reached a peak egg production of 10.8 eggs per bird. The August-hatched birds maintained a level of egg production of over 10 eggs per bird per period for 10 consecutive periods and the December-hatched females produced at this rate for only two periods.

The total egg production means were 9.68 and 8.48 eggs per bird hatched in August and December, respectively. Analysis of variance and Duncan's Multiple Range tests indicated the mean difference of 1.20 eggs per bird was significant ($P < 0.005$, Tables 7 and 8).

Total egg production data, calculated in cumulative dozens of sized eggs per 1000 layers (hen-housed basis),

are presented in Tables 48, 54 and 57. Tables 58 through 64 present the cumulative individual egg weight distribution data per hatching season.

The August-hatched females produced 2854 more dozens of eggs than the December-hatched females. The August-hatched females produced more dozens of jumbo (88 dozen), extra-large (663 dozen), large (2133 dozen), medium (2034 dozen) and undergrade (29 dozen) eggs than the December-hatched females. The December-hatched birds produced more dozens of small (1155 dozen) and peewee (938 dozen) eggs than the August-hatched birds.

Strain III Comparisons

Season A (February hatch) versus Season B (April hatch) versus Season C (June hatch) versus Season D (August hatch)

The total egg production data per female hatched in February, April, June and August are presented in Table 3. The data presented indicate the average numbers of eggs (hen-day basis) produced per female per two-week period.

The total egg production means were 9.31, 9.31, 10.28 and 10.11 eggs per bird hatched in February, April, June and August, respectively. Analysis of variance and Duncan's Multiple Range tests indicated that there were no significant differences between the egg production means of the females hatched at the various dates (Tables 3, 9 and 10; F ratio - 2.47).

Strain IV Comparisons

Season A (February hatch) versus Season B (April hatch)

The total egg production data per female hatched in February and April are presented in Table 4. The data presented indicate the average numbers of eggs (hen-day basis) produced per female per two-week period.

The total egg production means were 8.50 and 8.34 eggs per bird hatched in February and April, respectively. Analysis of variance and Duncan's Multiple Range tests indicate the mean difference of 0.16 eggs per bird was not significant (F ratio - 0.09, Tables 4, 11 and 12).

Table 1. The Average Hen-day Egg Production of Chickens Hatched at Bimonthly Intervals.

Strain I

Age of Birds in Two-week Period: Prod. Period	Approx. Age of Birds	Season of Hatching[1]: A	B	C	D	E	F
		Number of Eggs per Two-week Period					
12	24	4.9	1.9	1.0	3.4	.9	9.0
13	26	10.0	4.6	3.8	9.2	6.3	10.8
14	28	11.5	7.0	6.2	11.9	11.2	10.6
15	30	11.8	9.0	11.3	12.0	12.2	10.5
16	32	11.9	10.4	12.2	11.5	12.0	10.8
17	34	11.7	10.6	11.6	11.1	11.9	10.6
18	36	11.2	10.3	11.2	10.4	11.1	10.3
19	38	11.3	10.0	10.7	10.3	11.1	10.0
20	40	11.3	9.8	10.3	10.1	10.9	9.7
21	42	10.7	9.6	9.7	9.7	10.6	9.3
22	44	10.8	9.2	9.7	9.8	10.3	9.2
23	46	11.2	9.0	9.7	9.3	10.2	8.9
24	48	10.6	8.9	9.5	9.3	9.5	8.5
25	50	10.5	8.3	9.4	9.1	9.5	8.3
26	52	10.4	8.2	8.8	9.0	9.3	8.0
27	54	9.6	8.5	9.0	8.7	9.4	8.1
28	56	9.9	8.2	8.3	8.6	9.0	8.4
29	58	10.0	8.1	7.9	8.2	9.2	8.2
30	60	9.7	7.8	7.4	8.0	9.4	7.9
31	62	9.4	7.8	7.3	7.9	9.0	7.7
32	64	9.5	7.0	7.1	7.8	8.7	7.5
33	66	9.1	6.9	7.1	7.6	8.6	7.4
34	68	9.1	6.4	6.8	7.7	8.3	7.0
35	70	8.8	6.8	6.8	7.5	8.0	6.9
36	72	8.6	6.7	6.8	7.2	7.8	6.6
37	74	8.2	7.0	6.8	7.0	7.4	6.8
38	76	7.9	6.4	6.7	6.8	7.3	6.8
39	78	7.6	6.4	6.4	6.6	6.8	6.6
40	80	7.3	6.5	6.0	6.1	6.9	6.4
41	82	7.2	6.1	6.0	5.7	6.3	6.2
42	84	6.8	6.0	5.6	5.3	6.1	5.9
43	86	6.6	5.6	5.4	5.3	5.8	5.7
44	88	6.5	5.5	5.4	5.5	5.7	5.6
45	90	6.4	5.4	5.3	5.7	5.8	5.2
46	92	6.3	5.5	5.2	5.9	5.9	5.1
Egg Production Means		9.266	7.469	7.669	8.149	8.526	8.014

[1] A. February 1, 1958; B. April 1, 1958; C. June 1, 1958; D. August 1, 1958; E. October 1, 1958; F. December 1, 1958.

Table 2. The Average Hen-day Egg Production of Chickens Hatched at Bimonthly Intervals.

Strain II

Age of Birds in Two-week Period: Prod. Period	Approx. Age of Birds	Season of Hatching[1]: B	D	F
12	24	2.3	3.8	9.1
13	26	5.0	9.4	10.8
14	28	7.1	12.0	10.4
15	30	9.9	12.2	9.9
16	32	11.5	11.8	9.7
17	34	10.3	11.7	9.4
18	36	10.0	11.4	9.6
19	38	9.5	11.3	9.1
20	40	9.1	11.2	8.7
21	42	8.6	10.7	8.4
22	44	8.0	10.5	8.4
23	46	8.1	10.3	8.0
24	48	8.0	9.9	7.8
25	50	7.8	9.2	7.8
26	52	7.5	8.8	7.3
27	54	7.5	8.4	7.5
28	56	7.3	8.4	7.9
29	58	7.4	8.1	7.3
30	60	7.2	8.1	7.4
31	62	7.0	8.1	7.0
32	64	6.3	8.0	6.5
Egg Production Means		7.88	9.68	8.48

[1]B. April 1, 1958; D. August 1, 1958; F. December 1, 1958.

Table 2. The ...
Hatch...

Age of Birds in Two-week Period...	
Prod. Period	Approx. Age in Months
12	[illegible]
13	[illegible]
14	[illegible]
15	[illegible]
16	[illegible]
17	[illegible]
18	[illegible]
19	[illegible]
20	[illegible]
21	[illegible]
22	[illegible]
23	[illegible]
24	[illegible]
25	[illegible]
26	[illegible]
27	[illegible]
28	[illegible]
29	[illegible]
30	[illegible]
31	[illegible]
32	[illegible]
Egg production Means	

[1] S. April 1, ...

Table 3. The Average Hen-day Egg Production of Chickens Hatched at Bimonthly Intervals.

Strain III

Age of Birds in Two-week Periods		Season of Hatching[1]			
Prod. Period	Approx. Age of Birds	A	B	C	D
13	26	10.0	8.4	2.6	5.7
14	28	10.5	10.9	8.3	11.1
15	30	10.5	11.0	11.6	12.4
16	32	10.6	10.5	12.1	12.1
17	34	10.5	10.4	11.9	11.8
18	36	10.6	10.6	11.3	11.6
19	38	10.7	10.4	11.2	11.1
20	40	10.1	10.3	11.4	11.1
21	42	10.0	10.1	11.3	10.8
22	44	9.4	9.7	11.2	10.6
23	46	9.4	9.5	11.0	10.1
24	48	9.3	8.9	10.9	9.8
25	50	8.8	8.4	10.7	9.8
26	52	7.9	8.2	10.5	9.5
27	54	7.7	7.9	10.2	9.1
28	56	7.5	7.7	9.9	8.8
29	58	7.0	7.5	9.6	8.6
30	60	7.1	7.2	9.4	8.1
Egg Production Means		9.31	9.31	10.28	10.11

[1] A. February 1, 1959; B. April 1, 1959; C. June 1, 1959; D. August 1, 1959.

Table 5. The [illegible]
[illegible]

Age of Birds [illegible] Two-week Peri[illegible]	
Prod. Period	Appr[illegible] Age [illegible] Bir[illegible]
13	[illegible]
14	[illegible]
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
Egg Produc[illegible] Means	

1. Februar[illegible]
2. August [illegible]

Table 4. The Average Hen-day Egg Production of Chickens Hatched at Bimonthly Intervals.

Strain IV

Age of Birds in Two-week Periods		Season of Hatching[1]	
Prod. Period	Approx. Age of Birds	A	B
12	24	4.8	3.0
13	26	8.3	7.3
14	28	9.8	9.9
15	30	10.0	10.8
16	32	10.3	10.6
17	34	10.3	10.1
18	36	10.2	9.8
19	38	10.1	10.4
20	40	9.7	10.2
21	42	9.3	10.1
22	44	9.4	9.8
23	46	9.3	9.6
24	48	9.3	9.4
25	50	8.8	8.9
26	52	8.1	8.4
27	54	7.8	8.1
28	56	7.6	8.2
29	58	7.9	8.0
30	60	8.0	7.9
31	62	8.1	7.9
32	64	8.3	7.9
33	66	8.2	7.7
34	68	8.0	7.3
35	70	7.7	7.2
36	72	7.4	6.7
37	74	7.3	6.6
38	76	7.0	6.3
39	78	6.9	5.5
Egg Production Means		8.496	8.343

[1] A. February 1, 1959; B. April, 1959.

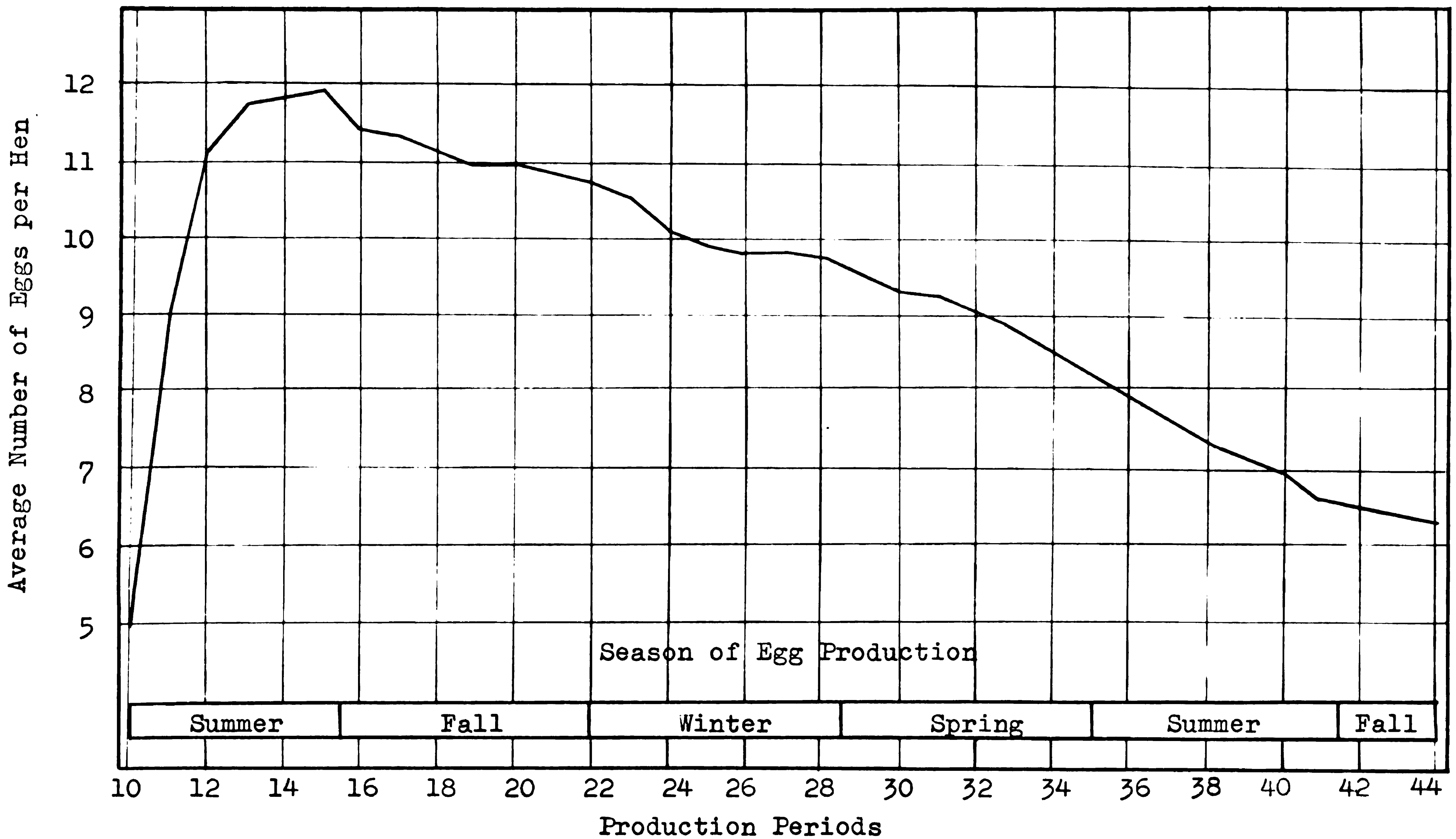


Figure 6. The Average Hen-Day Egg Production of Chickens Hatched on February 1, 1958.

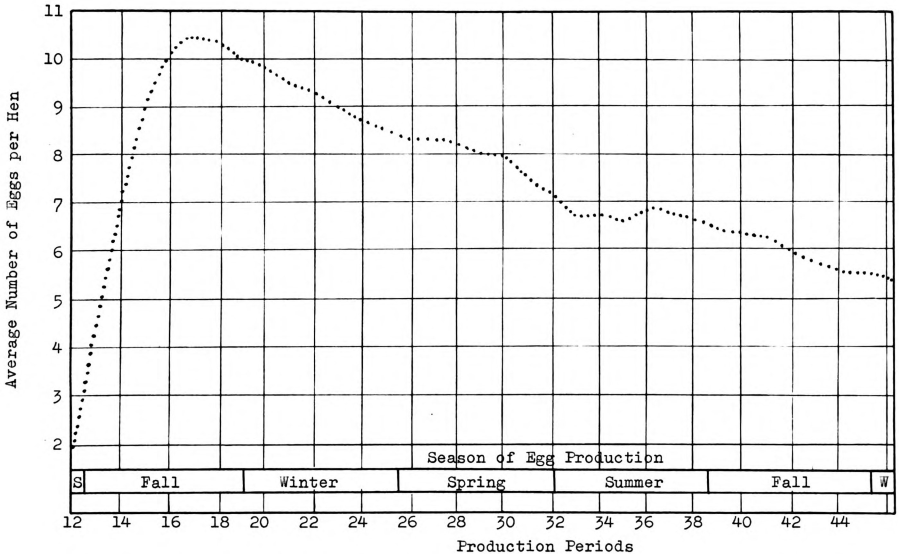


Figure 7. The Average Hen-day Egg Production of Chickens Hatched on April 1, 1958.

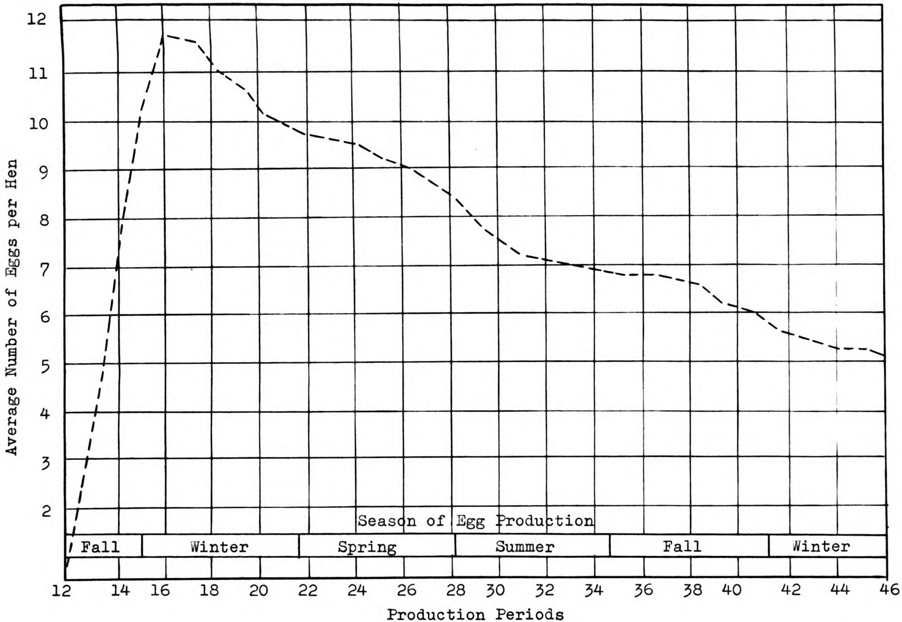
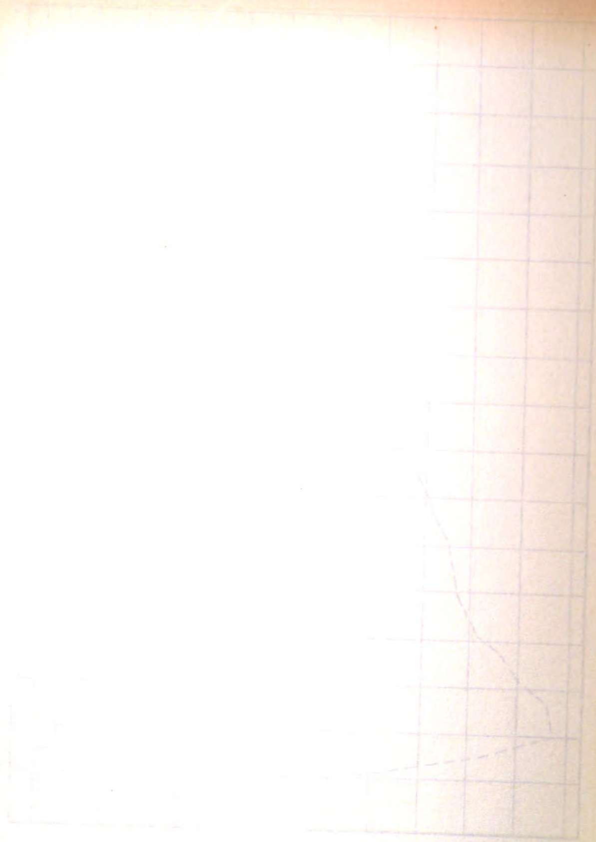


Figure 8. The Average Hen-day Egg Production of Chickens Hatched on June 1, 1958.



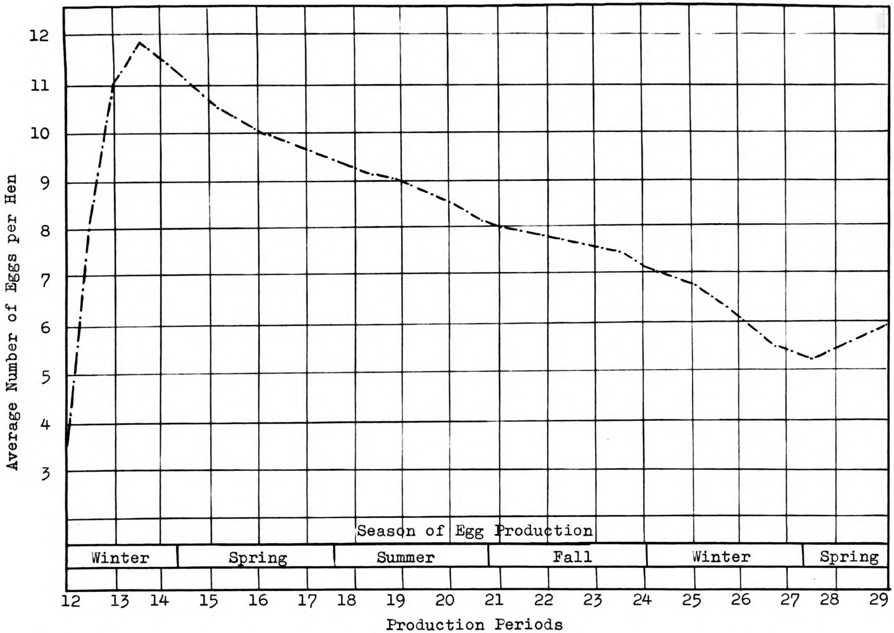


Figure 9. The Average Hen-day Production of Chickens Hatched on August 1, 1958.

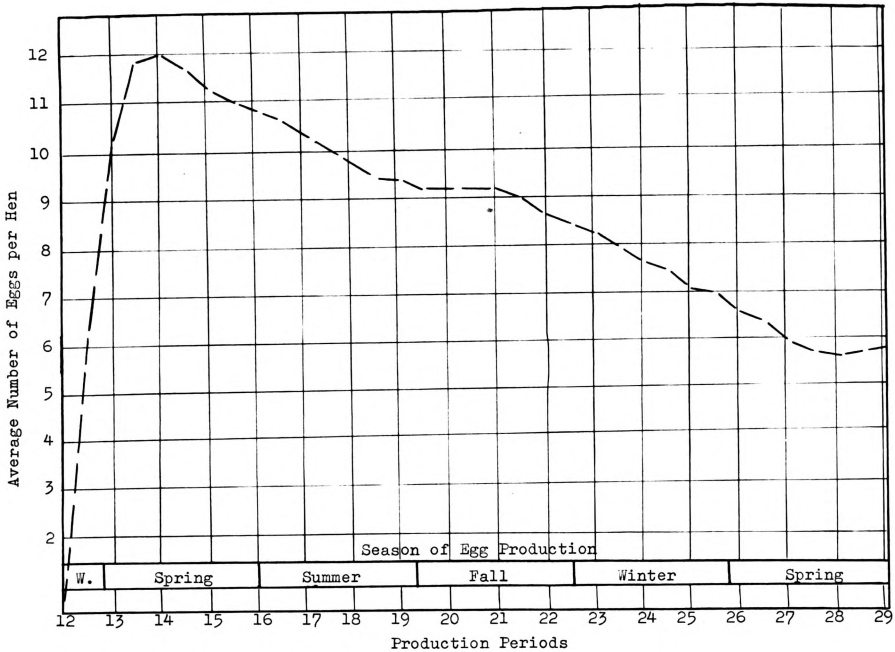
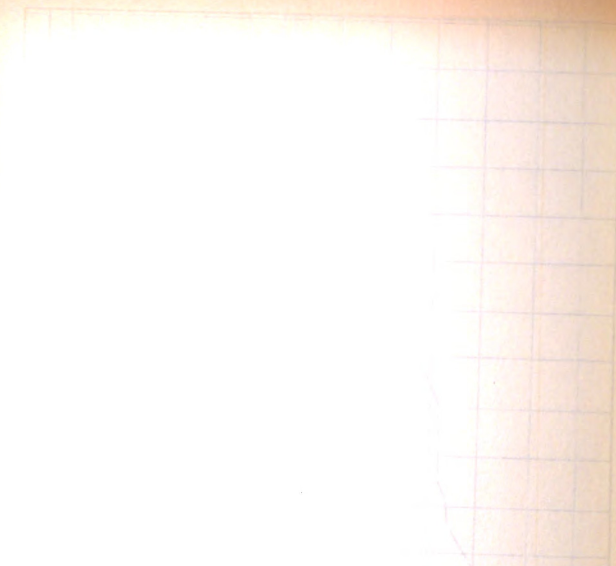


Figure 10. The Average Hen-day Egg Production of Chickens Hatched on October 1, 1958.



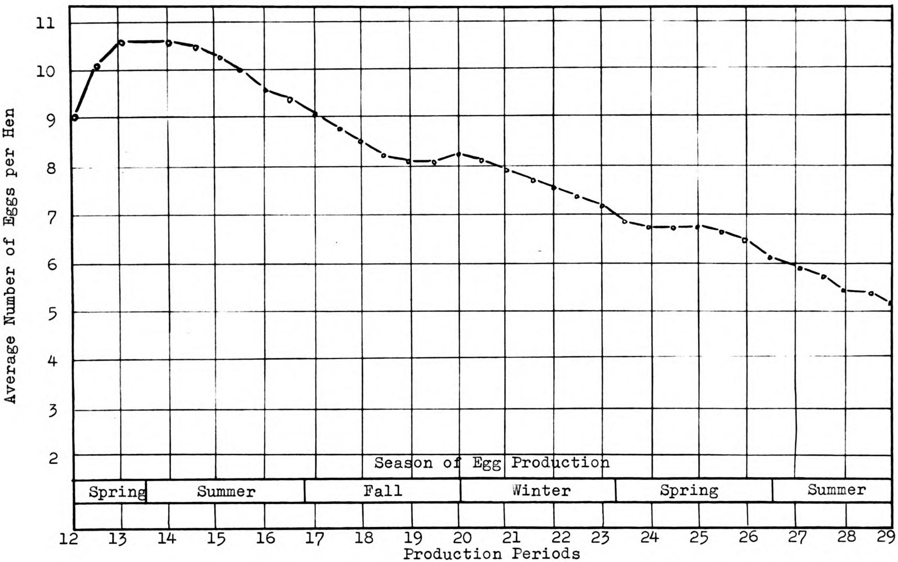


Figure 11. The Average Hen-day Egg Production of Chickens Hatched on December 1, 1958.

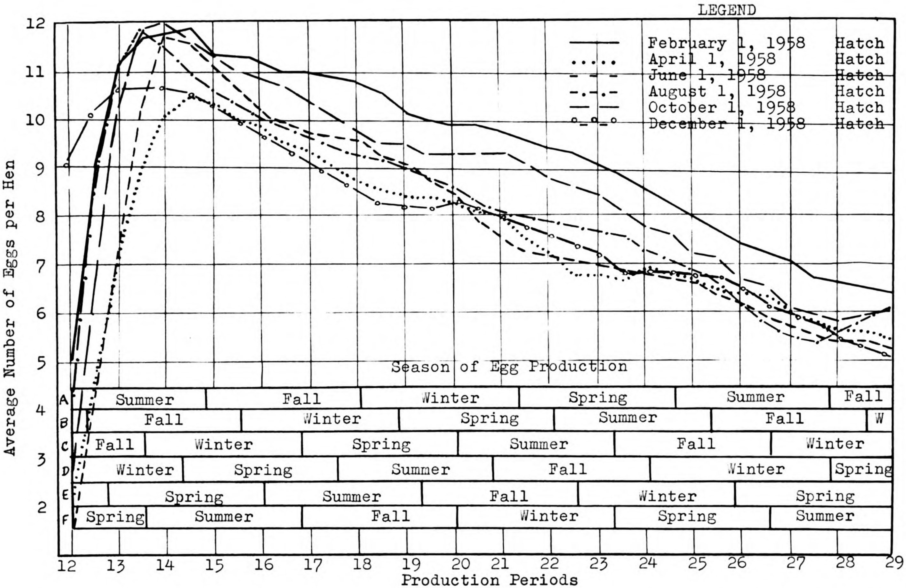


Figure 12. The Average Hen-day Egg Production of Strain I Chickens Hatched at Bimonthly Intervals.

Table 5. Analysis of Variance of Average Hen-day Egg Production for Chickens Hatched at Different Seasons.

Strain I

Source of Variation	D.F.	S.S.	M.S.	F Ratio
Periods	4	425.6	106.400	
Seasons	5	73.3	14.660	6.40[1]
P x S	20	33.6	1.68	
Error	180	423.7	2.35	
New Error	200	457.3	2.29	
Total	209	956.2		

[1]Significant P < .01.

Table 6. The Results of Statistical Analyses of Egg Production Means[1] for Chickens Hatched at Different Seasons.

Strain I

Production Means Ranked from Low to High					
7.469	7.669	8.014	8.149	8.526	9.266

[1]Any two means not underscored by the same line are significantly different, and any two lots underscored by the same line are not significantly different.

Table 7. Analysis of Variance of Average Hen-day Egg Production for Chickens Hatched at Different Seasons.

Strain II

Source of Variation	D.F.	S.S.	M.S.	F Ratio
Periods	2	39.690	19.845	
Seasons	2	35.480	17.740	7.10[1]
P x S	4	4.210	1.052	
Error	54	140.59	2.603	
New Error	58	144.80	2.50	
Total	62	219.97		

[1]Significant $P < .01$.

Table 8. The Results of Statistical Analyses of Egg Production Means[1] for Chickens Hatched at Different Seasons.

Strain II

Production Means Ranked from Low to High		
7.88	8.48	9.68

[1]Any two means not underscored by the same line are significantly different, and any two lots underscored by the same line are not significantly different.

Table 9. Analysis of Variance of Average Hen-day Egg Production for Chickens Hatched at Different Seasons.

Strain III

Source of Variation	D.F.	S.S.	M.S.	F Ratio
Periods	2	45.71	22.86	
Seasons	3	14.47	4.82	2.47 N.S.
P x S	6	19.86	3.31	
Error	60	117.00	1.95	
Total	71	197.04		

Table 10. The Results of Statistical Analyses of Egg Production Means[1] for Chickens Hatched at Different Seasons.

Strain III

Production Means Ranked from Low to High			
9.31	9.31	10.11	10.28

[1]Any two means not underscored by the same line are significantly different, and any two lots underscored by the same line are not significantly different.

Table 11. Analysis of Variance of Average Hen-day Egg Production for Chickens Hatched at Different Seasons.

Strain IV

Source of Variation	D.F.	S.S.	M.S.	F Ratio
Periods	3	48.74	20.140	
Seasons	1	.33	.136	.085 N.S.
P x S	3	2.42	.807	
Error	48	79.30	1.652	
New Error	51	81.72	1.602	
Total	55	130.79		

Table 12. The Results of Statistical Analyses of Egg Production Means[1] for Chickens Hatched at Different Seasons.

Strain IV

Production Means Ranked from Low to High	
8.343	8.496

[1]Any two means not underscored by the same line are significantly different, and any two lots underscored by the same line are not significantly different.

Table 13. The Average Hen-day Egg Production of Strain I Females Hatched on April 1, 1958 and Housed in Different Pens.

Age of Birds in Two-week Periods: Prod. Period	Approx. Age of Birds	Pen[1] a	Pen[1] b	Pen[1] c
14	28	6.3	5.9	7.6
15	30	7.8	8.6	9.5
16	32	10.9	9.7	10.5
17	34	11.2	9.9	11.0
18	36	11.0	9.5	10.1
19	38	10.6	9.2	10.2
20	40	10.4	8.8	10.3
21	42	10.2	8.6	9.8
22	44	9.7	8.5	9.8
23	46	9.6	8.5	9.1
24	48	9.1	8.7	9.2
25	50	8.8	8.5	8.8
26	52	8.2	8.3	8.9
27	54	8.4	8.9	9.0
28	56	8.1	8.5	8.4
29	58	8.4	8.5	8.5
30	60	8.6	7.9	8.1
31	62	7.7	7.9	8.0
32	64	6.7	7.1	7.4
33	66	6.7	7.1	7.0
34	68	5.8	6.8	6.7
35	70	6.3	7.3	6.7
36	72	6.4	7.1	6.7
37	74	6.4	7.0	7.1
38	76	6.4	6.6	6.3
39	78	6.4	6.8	6.1
40	80	6.3	6.9	6.3
41	82	6.1	6.1	6.2
42	84	6.0	5.9	6.1
43	86	5.8	5.0	6.1
44	88	5.8	4.9	6.0
45	90	5.6	5.3	5.5
46	92	5.8	5.3	5.5
47	94	5.6	4.9	5.4
48	96	5.0	5.0	4.8
Egg Production Means		7.63	7.41	7.79

[1]See Appendix Table 7.

Table 14. Analysis of Variance of Average Hen-day Egg Production for Strain I Females Hatched on April 1, 1958 and Housed in Different Pens.

Source of Variation	D.F.	S.S.	M.S.	F Ratio
Periods	4	229.568	57.390	
Pens	2	2.608	1.300	1.87 N.S.
Interaction	8	6.118	.765	
Error	90	61.871	.687	
New Error	98	67.989	.694	
Total	104	300.165		

Table 15. The Results of Statistical Analyses of Egg Production Means[1] for Strain I Females Hatched on April 1, 1958 and Housed in Different Pens.

Production Means Ranked from Low to High		
7.41	7.69	7.79

[1] Any two means not underscored by the same line are significantly different, and any two lots underscored by the same line are not significantly different.

Table 16. The Average Hen-day Egg Production of Strain I Females Hatched on June 1, 1958 and Housed in Different Pens.

Age of Birds in Two-week Periods: Prod. Period	Approx. Age of Birds	Pen[1] d	Pen[1] e
15	30	11.4	11.2
16	32	12.4	12.0
17	34	11.9	11.4
18	36	11.5	11.0
19	38	11.3	10.3
20	40	11.0	9.9
21	42	10.3	9.3
22	44	10.0	9.5
23	46	10.0	9.5
24	48	9.9	9.3
25	50	9.6	9.2
26	52	9.2	8.6
27	54	9.1	8.9
28	56	8.3	8.2
29	58	8.0	7.9
30	60	7.4	7.4
31	62	7.2	7.4
32	64	7.0	7.1
33	66	7.1	7.1
34	68	6.9	6.7
35	70	7.0	6.6
36	72	7.1	6.7
37	74	7.2	6.6
38	76	7.0	6.5
39	78	6.7	6.3
40	80	6.2	5.9
41	82	6.4	5.8
42	84	5.5	5.6
43	86	5.6	5.2
44	88	5.9	5.1
45	90	5.8	5.0
46	92	5.9	4.7
47	94	5.8	4.7
48	96	5.8	4.4
49	98	5.8	3.7
Egg Production Means		8.09	7.56

[1]See Appendix Table 7.

Table 17. Analysis of Variance of Average Hen-day Egg Production for Strain I Females Hatched on June 1, 1958 and Housed in Different Pens.

Source of Variation	D.F.	S.S.	M.S.	F Ratio
Periods	4	302.29	75.57	
Pens	1	4.89	4.89	15.05[1]
Interaction	4	2.17	.54	
Error	60	18.69	.31	
New Error	64	20.86	.325	
Total	69	328.04		

[1]Significant $P < .01$.

Table 18. The Results of Statistical Analyses of Egg Production Means[1] for Strain I Females Hatched on June 1, 1958 and Housed in Different Pens.

Production Means Ranked from Low to High	
7.56	8.09

[1]Any two means not underscored by the same line are significantly different, and any two lots underscored by the same line are not significantly different.

Table 19. The Average Hen-day Egg Production of Strain I Females Hatched on October 1, 1958 and Housed in Different Pens.

Age of Birds in Two-week Periods: Prod. Period	Approx. Age of Birds	Pen[1] f	Pen[1] g
13	26	7.1	5.7
14	28	11.5	11.0
15	30	12.1	12.2
16	32	12.0	12.0
17	34	11.6	12.1
18	36	11.1	11.0
19	38	11.1	11.1
20	40	10.5	11.0
21	42	10.5	10.7
22	44	10.0	10.5
23	46	10.2	10.2
24	48	9.6	9.4
25	50	9.3	9.6
26	52	9.1	9.4
27	54	9.1	9.5
28	56	8.2	9.4
29	58	9.2	9.3
30	60	10.2	8.9
31	62	8.8	9.1
32	64	8.6	8.7
33	66	8.5	8.7
34	68	8.0	8.5
35	70	8.0	8.1
36	72	7.8	7.8
37	74	7.4	7.5
38	76	7.6	7.2
39	78	7.0	6.8
40	80	6.9	6.8
41	82	6.6	6.1
42	84	6.6	5.8
43	86	5.7	5.9
44	88	5.6	5.8
45	90	5.7	5.9
46	92	6.0	5.8
47	94	6.0	5.9
Egg Production Means		8.66	6.66

[1]See Appendix Table 7.

Table 20. Analysis of Variance of Average Hen-day Egg Production for Strain I Females Hatched on October 1, 1958 and Housed in Different Pens.

Source of Variation	D.F.	S.S.	M.S.	F Ratio
Periods	4	212.93	53.23	
Pens	1	0.001	0	0.0 N.S.
Interaction	4	0.470	.12	.117 N.S.
Error	60	61.780	1.03	
Total	69	275.18		

Table 21. The Results of Statistical Analyses of Egg Production Means[1] for Strain I Females Hatched on October 1, 1958 and Housed in Different Pens.

Production Ranked from Low to High	
8.66	8.66

[1] Any two means not underscored by the same line are significantly different, and any two lots underscored by the same line are not significantly different.

Table 22. The Average Hen-day Egg Production of Strain III Females Hatched on June 1, 1959 and Housed in Different Pens.

Age of Birds in Two-week Periods: Prod. Period	Approx. Age of Birds	Pen[1] h	Pen[1] i
13	26	3.1	3.3
14	28	9.4	9.2
15	30	12.1	12.1
16	32	12.4	12.4
17	34	12.2	12.3
18	36	12.1	11.6
19	38	11.9	11.5
20	40	12.1	11.7
21	42	11.7	11.8
22	44	11.6	11.8
23	46	11.4	11.5
24	48	11.1	11.5
25	50	11.0	11.1
26	52	10.8	10.7
27	54	10.4	10.5
28	56	10.1	10.2
29	58	9.9	9.6
30	60	9.7	9.6
31	62	9.2	9.4
32	64	9.2	8.8
33	66	9.0	7.7
Egg Production Means		10.50	10.40

[1] See Appendix Table 7.

Table 23. Analysis of Variance of Average Hen-day Egg Production for Strain III Females Hatched on June 1, 1959 and Housed in Different Pens.

Source of Variation	D.F.	S.S.	M.S.	F Ratio
Periods	2	25.12	12.56	
Pens	1	0.10	0.10	0.025 N.S.
Interaction	2	0.16	0.08	
Error	36	143.58	3.99	
Total	41	168.96		

Table 24. The Results of Statistical Analyses of Egg Production Means[1] for Strain III Females Hatched on June 1, 1959 and Housed in Different Pens.

Productions Means Ranked from Low to High	
10.40	10.50

[1] Any two means not underscored by the same line are significantly different, and any two lots underscored by the same line are not significantly different.

Table 25. The Average Hen-day Egg Production of Strain IV Hatched on February 1, 1959 and Housed in Different Pens.

Age of Birds in Two-week Periods: Prod. Period	Approx. Age of Birds	Pen[1] j	Pen[1] k
11	22	1.3	1.1
12	24	5.0	4.3
13	26	8.4	7.9
14	28	9.8	9.7
15	30	10.1	9.7
16	32	10.3	10.1
17	34	10.3	10.2
18	36	10.2	10.0
19	38	10.2	9.6
20	40	10.0	8.9
21	42	9.5	8.6
22	44	9.7	8.6
23	46	9.8	7.9
24	48	9.7	7.9
25	50	9.2	7.7
26	52	8.2	7.7
27	54	8.0	7.2
28	56	7.7	7.5
29	58	7.9	7.8
30	60	8.1	7.6
31	62	8.2	7.8
32	64	8.5	7.7
33	66	8.4	7.6
34	68	8.1	7.6
35	70	7.9	7.5
36	72	7.5	7.2
37	74	7.4	6.9
38	76	7.2	6.5
39	78	7.1	6.4
40	80	6.7	6.0
Egg Production Means		8.347	7.707

[1]See Appendix Table 7.

Table 25. The

Age of
Two-

Prod.
Fert.

40
Egg Pro
Mean

See Appendix

Table 26. Analysis of Variance of Average Hen-day Egg Production for Strain IV Females Hatched on February 1, 1959 and Housed in Different Pens.

Source of Variation	D.F.	S.S.	M.S.	F Ratio
Periods	2	11.43	5.71	
Pens	1	6.18	6.18	1.835 N.S.
Interaction	2	0.66	0.33	
Error	54	181.81	3.367	
Total	59	200.08		

Table 27. The Results of Statistical Analyses of Egg Production Means[1] for Strain IV Females Hatched on February 1, 1959 and Housed in Different Pens.

Production Means Ranked from Low to High	
7.707	8.347

[1] Any two means not underscored by the same line are significantly different, and any two lots underscored by the same line are not significantly different.

Table 28. The Percentage of Jumbo Eggs Produced by Females Hatched at Different Seasons[1] of the Year.

Period	Seasons A	B	C	D	E	F	Period	Seasons A	B	C	D	E	F
11	1					3	39	3	2	3	3	4	2
12	2	3	2			3	40	3	3	2	2	4	1
13	1	2	2	1	3	2	41	3	4	3	4	4	2
14	1	2	1	1	2	1	42	4	6	4	4	4	1
15	1	1	1	1	2	1	43	5	6	5	4	4	1
16		1	1		1		44	6	5	5	3	4	3
17		1			1		45	7	6	5	3	5	4
18		1					46	11	7	6	3	5	6
19		1					47	12	10	6	3	5	6
20							48	14	9	6	3	6	2
21							49	12	6	4	3	6	
22							50	13	9	5	3	9	
23							51	12	9	4	3	11	
24							52	15	9	4	3	11	
25							53	14	6	3	6	9	
26							54	11	5	4	6		
27							55	11	6	3	8		
28							56	12	6	3	7		
29	1	1	1		2	1	57	13	6	2			
30		1			2		58	12	5	5			
31	2	1			1	1	59	12	4	6			
32	1	1		1	1		60	11	5	7			
33	1	1		2	1	1	61	10	6	5			
34	2	1	1	1	3	1	62	9	8				
35	3	1	1	1	3		63	8	9				
36	3	1	2	2	3		64	7	8				
37	3	1	3	2	3	1	65	6	7				
38	3	2	4	3	3	2							

[1] A. February 1, 1958; B. April 1, 1958; C. June 1, 1958; D. August 1, 1958; E. October 1, 1958; F. December 1, 1958.

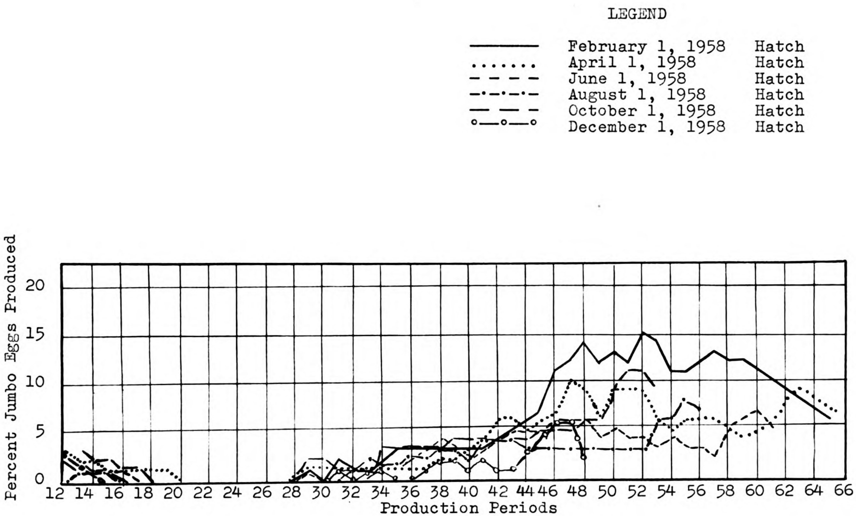


Figure 13. The Percentage of Jumbo Eggs Produced by Females Hatched at Different Seasons of the Year.

Table 29. The Percentage of Extra-large Eggs Produced by Females Hatched at Different Seasons[1] of the Year.

Period	Seasons A	B	C	D	E	F	Period	Seasons A	B	C	D	E	F
11							39	30	25	30	28	32	19
12							40	32	26	33	26	34	19
13							41	33	32	35	28	36	20
14							42	36	34	35	29	35	21
15							43	38	34	33	31	34	23
16	1						44	41	34	31	32	33	25
17							45	42	35	29	32	35	29
18	2	1					46	41	35	29	30	36	33
19	2	1	1		1		47	42	34	30	29	35	37
20	2	2	1	1	1		48	42	34	30	28	34	39
21	2	3	2	2	1		49	45	31	31	30	35	
22	4	4	3	3	2	2	50	46	32	32	30	38	
23	7	7	4	3	3	3	51	45	31	31	30	39	
24	10	9	5	3	4	5	52	40	32	30	30	42	
25	13	11	6	5	5	6	53	40	34	29	32	34	
26	14	12	8	6	7	7	54	38	35	27	35		
27	16	13	9	6	11	8	55	37	33	29	35		
28	19	14	8	6	15	11	56	37	33	29	35		
29	22	14	7	8	18	13	57	37	33	32			
30	25	16	8	12	21	13	58	42	34	33			
31	26	16	12	18	24	12	59	41	35	35			
32	27	16	14	21	26	12	60	42	34	37			
33	27	17	15	23	30	13	61	39	33	36			
34	27	17	17	25	34	15	62	38	31				
35	28	21	21	27	33	18	63	36	33				
36	28	22	25	29	33	20	64	38	36				
37	29	21	26	30	30	20	65	38	38				
38	29	22	26	29	31	19							

[1]A. February 1, 1958; B. April 1, 1958; C. June 1, 1958; D. August 1, 1958; E. October 1, 1958; F. December 1, 1958.

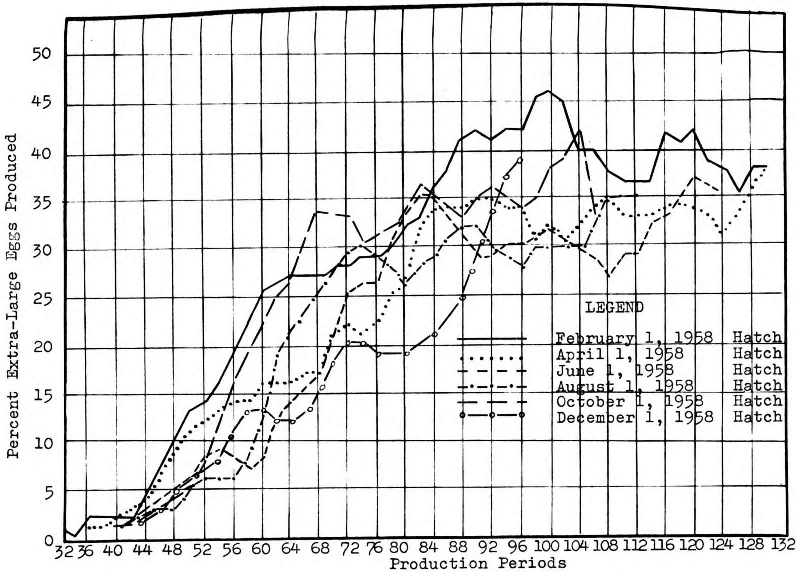


Figure 14. The Percentage of Extra-Large Eggs Produced by Females Hatched at Different Seasons of the Year.

Table 30. The Percentage of Large Eggs Produced by Females Hatched at Different Seasons[1] of the Year.

Period	A	B	C	D	E	F	Period	A	B	C	D	E	F
11							39	44	42	44	43	46	49
12					3	2	40	43	41	42	46	45	48
13	1						41	41	39	40	47	42	48
14	2			1			42	40	38	39	45	42	46
15	4	2	4	1	2	1	43	39	38	38	45	41	43
16	7	3	5	2	4		44	37	37	41	45	42	41
17	11	6	7	4	8	1	45	35	37	42	44	40	41
18	13	11	10	8	13	4	46	32	35	45	44	39	41
19	17	16	15	13	18	5	47	31	33	44	45	38	41
20	21	23	21	18	20	6	48	32	33	45	46	38	40
21	25	27	26	23	24	9	49	27	39	45	45	37	
22	27	32	30	28	28	17	50	27	38	44	43	34	
23	34	35	34	29	32	25	51	27	40	43	42	34	
24	40	39	37	31	33	31	52	29	39	42	42	33	
25	47	40	39	33	34	33	53	28	40	42	41	34	
26	47	43	41	37	38	38	54	31	39	42	38		
27	49	45	43	37	44	41	55	33	39	41	37		
28	49	47	42	37	50	43	56	34	39	40	38		
29	50	47	42	40	49	46	57	34	39	40			
30	49	47	43	45	49	45	58	33	40	35			
31	49	48	45	48	49	47	59	34	38	37			
32	48	47	45	48	49	48	60	33	37	35			
33	47	47	45	47	46	54	61	35	35	39			
34	47	46	44	47	41	56	62	35	37				
35	47	45	46	46	38	53	63	39	36				
36	47	43	46	45	39	51	64	38	36				
37	45	42	46	44	43	50	65	36	33				
38	45	41	45	41	46	50							

(Columns A–F are grouped under the heading "Seasons" on both halves of the table.)

[1] A. February 1, 1958; B. April 1, 1958; C. June 1, 1958; D. August 1, 1958; E. October 1, 1958; F. December 1, 1958.

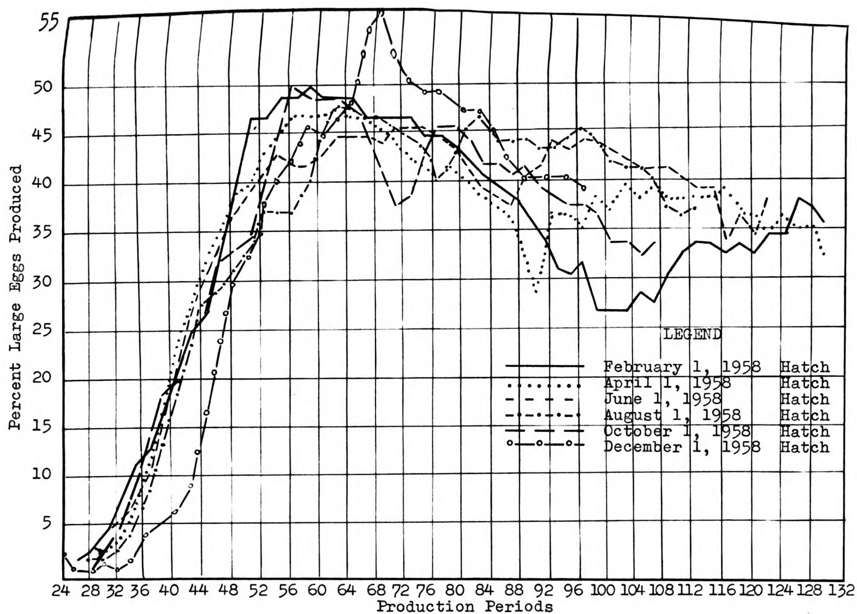


Figure 15. The Percentage of Large Eggs Produced by Females Hatched at Different Seasons of the Year.

Table 31. The Percentage of Medium Eggs Produced by Females Hatched at Different Seasons[1] of the Year.

Period	A	B	C	D	E	F	Period	A	B	C	D	E	F
11	7					4	39	14	21	16	14	9	22
12	15	6	5		5	4	40	13	16	15	13	10	23
13	30	12	11	23	13	6	41	13	14	13	8	10	23
14	45	23	26	29	30	14	42	11	12	12	9	11	22
15	56	36	44	40	45	24	43	10	13	14	9	12	22
16	62	48	48	50	64	36	44	7	14	13	11	13	19
17	66	56	64	59	70	49	45	6	13	12	11	13	15
18	67	61	66	66	70	61	46	5	13	10	12	13	12
19	67	61	65	67	68	64	47	4	13	10	14	13	9
20	65	59	64	66	67	65	48	4	13	11	15	13	9
21	63	58	61	61	65	65	49	4	11	12	15	12	
22	60	54	57	59	62	65	50	5	9	13	16	9	
23	53	49	54	57	57	61	51	5	9	16	17	7	
24	43	45	50	56	54	54	52	6	10	17	15	6	
25	35	41	48	53	52	51	53	7	12	18	10	6	
26	34	37	44	48	46	47	54	8	18	9			
27	31	34	42	47	38	43	55	6	15	18	8		
28	28	32	43	47	28	38	56	5	14	19	9		
29	24	30	42	42	25	33	57	4	14	17			
30	21	29	40	34	22	33	58	5	13	15			
31	20	29	35	25	20	30	59	5	15	12			
32	17	29	32	21	18	28	60	6	16	11			
33	17	28	30	20	16	21	61	7	16	11			
34	16	26	28	18	15	15	62	8	14				
35	16	23	23	17	17	19	63	8	12				
36	15	24	18	15	15	20	64	8	11				
37	15	24	17	14	13	20	65	8	11				
38	15	24	17	15	9	21							

[1] A. February 1, 1958; B. April 1, 1958; C. June 1, 1958; D. August 1, 1958; E. October 1, 1958; F. December 1, 1958.

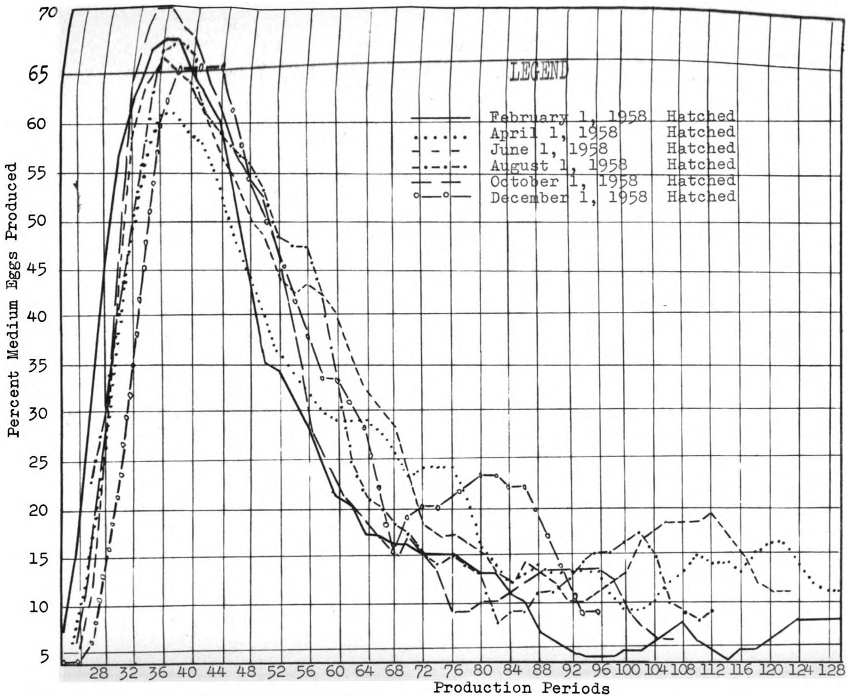


Figure 16. The Percentage of Medium Eggs Produced by Females Hatched at Different Seasons of the Year.

Table 32. The Percentage of Small Eggs Produced by Females Hatched at Different Seasons[1] of the Year.

Pe-riod	A	B	C	D	E	F	Pe-riod	A	B	C	D	E	F
			Seasons							Seasons			
11	51					11	39		1	1			1
12	54	59	49		50	30	40		1	1			1
13	57	52	62	65	53	50	41		1	1			
14	48	60	56	60	55	60	42		1	1			
15	36	53	44	52	42	60	43						
16	28	42	32	42	24	53	44					1	
17	20	33	32	32	16	42	45		1				
18	17	24	20	31	12	30	46						
19	12	17	16	15	9	25	47						
20	10	11	11	11	8	23	48						
21	7	9	8	8	7	20	49						
22	6	7	6	5	5	12	50		1				
23	3	5	3	5	4	5	51						
24	2	4	4	4	4	3	52			1			
25	1	3	3	4	4	2	53						
26	1	3	2	3	4	2	54						
27	1	2	2	3	2	2	55		1		1		
28	1	2	3	3	1	1	56						
29		1	4	3		1	57						
30	1	1	3	2			58			1			
31		1	2	1		2	59						
32		1	2	1		1	60						
33		2	2				61						
34		2	2				62						
35		1	1	1			63		1				
36		1	1				64						
37		1					65		1				
38		1	1			1							

[1]A. February 1, 1958; B. April 1, 1958; C. June 1, 1958; D. August 1, 1958; E. October 1, 1958; F. December 1, 1958.

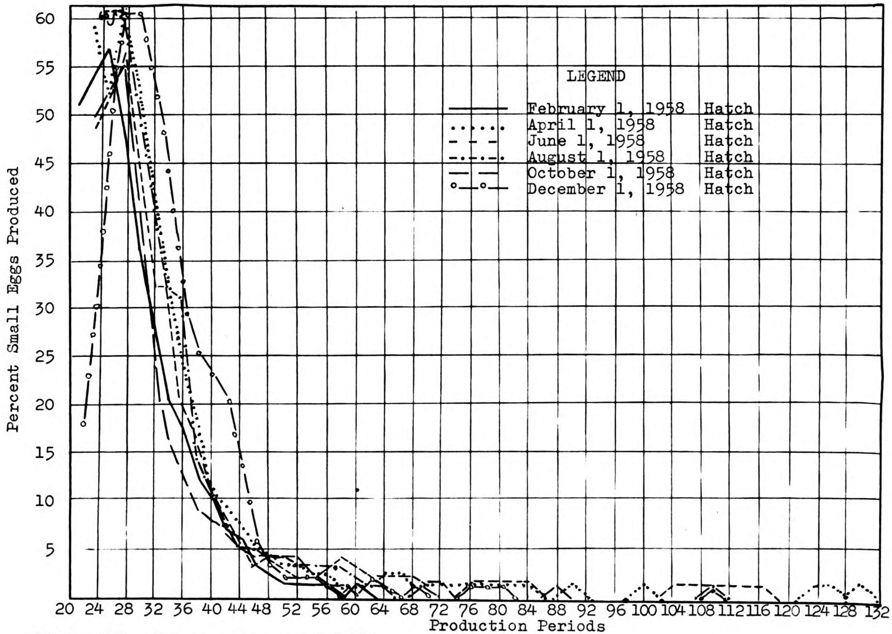


Figure 17. The Percentage of Small Eggs Produced by Females Hatched at Different Seasons of the Year.

Table 33. The Percentage of Peewee Eggs Produced by Females Hatched at Different Seasons[1] of the Year.

Age Period in Two-week Intervals	Hatching Season A	B	C	D	E	F
11	38					68
12	27	32	42		40	56
13	9	24	32	7	28	34
14	3	13	14	6	10	19
15	1	7	5	3	3	10
16	1	5	2	2		6
17		3	1	1		3
18		2	1			
19		1				
20		1				

[1]A. February 1, 1958; B. April 1, 1958; C. June 1, 1958; D. August 1, 1958; E. October 1, 1958; F. December 1, 1958.

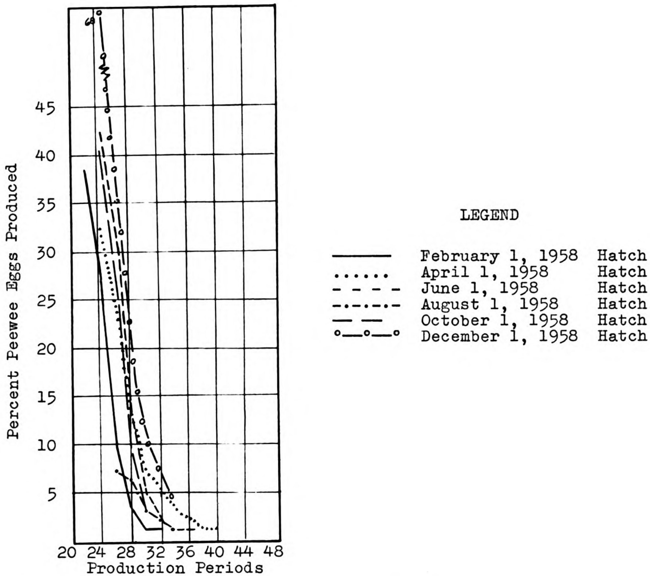


Figure 18. The Percentage of Peewee Eggs Produced by Females Hatched at Different Seasons of the Year.

Table 34. The Percentage of Undergrade Eggs Produced by Females Hatched at Different Seasons[1] of the Year.

Period	Seasons A	B	C	D	E	F	Period	Seasons A	B	C	D	E	F
11							39	8	10	6	11	9	7
12	2		2		2	6	40	8	10	6	12	7	7
13	2	2	3	2	2	7	41	9	10	7	13	7	8
14	2	2	2	3	3	5	42	8	11	8	12	8	9
15	1	2	2	2	4	4	43	8	10	9	10	7	10
16	2	2	2	2	4	4	44	9	10	9	9	7	11
17	2	2	2	2	4	4	45	9	9	10	9	7	10
18	2	2	2	2	2	4	46	10	9	10	9	7	9
19	2	2	2	3	2	5	47	10	10	10	9	9	8
20	2	2	2	4	2	5	48	11	10	8	8	10	7
21	1	2	2	4	2	5	49	11	8	6	8	10	
22	2	2	2	4	3	5	50	9	12	6	7	9	
23	3	3	2	5	4	5	51	9	11	6	8	9	
24	3	4	3	4	4	6	52	9	9	8	8	8	
25	3	5	4	6	4	7	53	11	8	8	10	8	
26	3	5	4	5	5	6	54	12	7	8	11		
27	3	5	4	7	5	6	55	13	7	8	10		
28	3	5	4	7	5	6	56	12	7	8	9		
29	3	6	4	8	5	7	57	10	7	8			
30	3	6	5	7	6	8	58	8	7	10			
31	4	6	6	8	6	9	59	9	7	10			
32	6	6	8	7	7	10	60	9	8	10			
33	6	6	8	8	7	10	61	9	10	8			
34	6	7	9	8	8	9	62	8	10				
35	6	8	8	9	9	8	63	8	9				
36	7	10	8	9	9	8	64	8	9				
37	8	10	7	10	11	8	65	8	9				
38	8	11	7	11	10	7							

[1] A. February 1, 1958; B. April 1, 1958; C. June 1, 1958; D. August 1, 1958; E. October 1, 1958; F. December 1, 1958.

Table 35. The Distribution, in Percentage,[1] of Egg Weights Recorded in Two-week Intervals for Females Hatched on February 1, 1958.

Period	J	XL	L	M	S	PW	UG	Period	J	XL	L	M	S	PW	UG
			Egg Weights[2]								Egg Weights[2]				
11	1			7	51	38	2	39	3	30	44	14			8
12	2			15	54	27	2	40	3	32	43	13			8
13	1		1	30	57	9	2	41	3	33	41	13			9
14	1		2	45	48	3	2	42	4	36	40	11			8
15	1		4	56	36	1	1	43	5	38	39	10			8
16		1	7	62	28	1	2	44	6	41	37	7			9
17			11	66	20		2	45	7	42	35	6			9
18		2	13	67	17		2	46	11	41	32	5			10
19		2	17	67	12		2	47	12	42	31	4			10
20		2	21	65	10		2	48	14	42	32	4			11
21		2	25	63	7		1	49	12	45	27	4			11
22		4	27	60	6		2	50	13	46	27	5			9
23		7	34	53	3		3	51	12	45	27	5			9
24		10	40	43	2		3	52	15	40	29	6			9
25		13	47	35	1		3	53	14	40	28	7			11
26		14	47	34	1		3	54	11	38	31	8			12
27		16	49	31	1		3	55	11	37	33	6			13
28		19	49	28	1		3	56	12	37	34	5			12
29	1	22	50	24			3	57	13	37	34	4			10
30		25	49	21	1		3	58	12	42	33	5			8
31	2	26	49	20			4	59	12	41	34	5			9
32	1	27	48	17			6	60	11	42	33	6			9
33	1	27	47	17			6	61	10	39	35	7			9
34	2	27	47	16			6	62	9	38	35	8			8
35	3	28	47	16			6	63	8	36	39	8			8
36	3	28	47	15			7	64	7	38	38	8			8
37	3	29	45	15			8	65	6	38	36	8			8
38	3	29	45	15			8								

[1]Percentage calculated as a moving average of three two-week periods, Haugh (1943).

[2]J-Jumbo; XL-Extra Large; L-Large; M-Medium; S-Small; PW-PeeWee; UG-Under Grade.

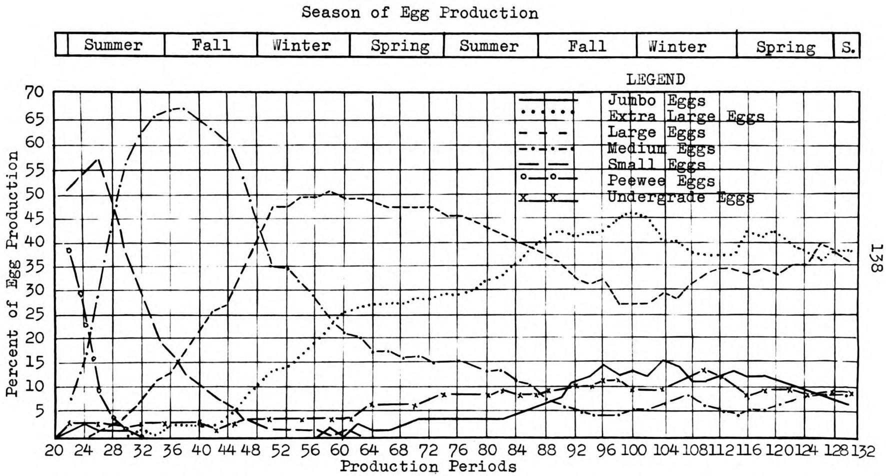


Figure 19. The Distribution, in Percentage, of Egg Weights Recorded in Two-week Intervals for Females Hatched on February 1, 1958.

Table 36. The Distribution, in Percentage,[1] of Egg Weights Recorded in Two-week Intervals for Females Hatched on April 1, 1958.

Period	Egg Weights[2]							Period	Egg Weights[2]						
	J	XL	L	M	S	PW	UG		J	XL	L	M	S	PW	UG
11								39	2	25	42	21	1		10
12	3			6	59	32		40	3	26	41	16	1		10
13	2			11	62	24	1	41	4	32	39	14	1		10
14	2			23	60	13	2	42	6	34	38	12	1		11
15	1		2	36	53	7	2	43	6	34	38	13			10
16	1		3	48	42	5	2	44	5	34	37	14			10
17	1		6	56	33	3	2	45	6	35	37	13	1		9
18	1	1	11	61	24	2	2	46	7	35	35	13			9
19	1	1	16	61	17	1	2	47	10	34	33	13			10
20		2	23	59	11	1	2	48	9	34	33	13			10
21		3	27	58	9		2	49	6	31	39	11			8
22		4	32	54	7		2	50	9	32	38	9	1		12
23		7	35	49	5		3	51	9	31	40	9			11
24		9	39	45	4		4	52	9	32	39	10			9
25		11	40	41	3		5	53	6	34	40	12			8
26		12	43	37	3		5	54	5	35	39	13			7
27		13	45	34	2		5	55	6	33	39	15	1		7
28		14	47	32	2		5	56	6	33	39	14			7
29	1	14	47	30	1		6	57	6	33	39	14			7
30	1	16	47	29	1		6	58	5	34	40	13			7
31	1	16	48	29	1		6	59	4	35	38	15			7
32	1	16	47	29	1		6	60	5	34	37	16			8
33	1	17	47	28	2		6	61	6	33	35	16			10
34	1	17	46	26	2		7	62	8	31	37	14	1		10
35	1	21	45	23	1		8	63	9	33	36	12	1		9
36	1	22	43	24	1		10	64	8	36	36	11			9
37	1	21	42	24	1		10	65	7	38	33	11	1		9
38	2	22	41	24	1		11								

[1]Percentage calculated as a moving average of three two-week periods, Haugh (1943).

[2]J-Jumbo; XL-Extra Large; L-Large; M-Medium; S-Small; PW-PeeWee; UG-Under Grade.

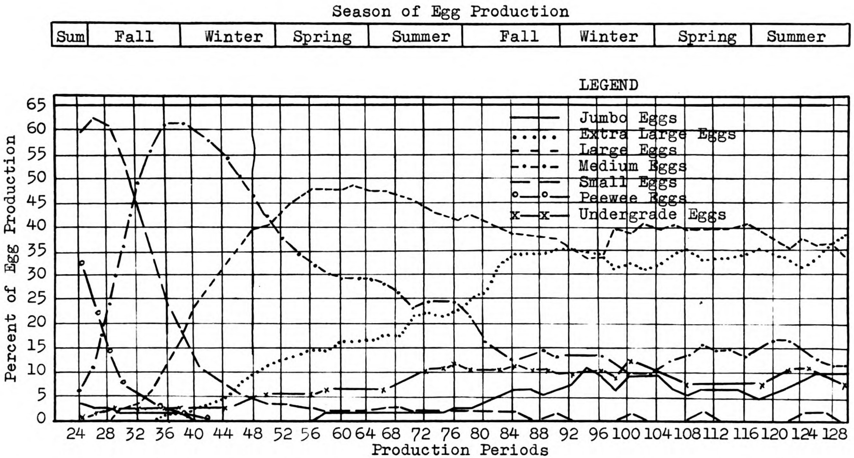


Figure 20. The Distribution, in Percentage, of Egg Weights Recorded in Two-week Intervals for Females Hatched on April 1, 1958.

Table 37. The Distribution, in Percentage,[1] of Egg Weights Recorded in Two-week Intervals for Females Hatched on June 1, 1958.

Pe-			Egg	Weights[2]				Pe-			Egg	Weights[2]			
riod	J	XL	L	M	S	PW	UG	riod	J	XL	L	M	S	PW	UG
11								39	3	30	44	16	1		6
12	2			5	49	42	2	40	2	33	42	15	1		6
13	2			11	52	32	3	41	3	35	40	13	1		7
14	1			26	56	14	2	42	4	35	39	12	1		8
15	1		4	44	44	5	2	43	5	33	38	14			9
16	1		5	58	32	2	2	44	5	31	41	13			9
17			7	62	29	1	2	45	5	29	42	12			10
18			10	66	20	1	2	46	6	29	45	10			10
19		1	15	65	16		2	47	6	30	44	10			10
20		1	21	64	11		2	48	6	30	45	11			8
21		2	26	61	8		2	49	4	31	45	12			6
22		3	30	57	6		2	50	5	32	44	13			6
23		4	34	54	3		2	51	4	31	43	16			6
24		5	37	50	4		3	52	4	30	42	17	1		8
25		6	39	48	3		4	53	3	29	42	18			8
26		8	41	44	2		4	54	4	27	42	18			8
27		9	43	42	2		4	55	3	29	41	18			8
28		8	42	43	3		4	56	3	29	40	19			8
29	1	7	42	42	4		4	57	3	32	40	17			8
30		8	43	40	3		5	58	5	33	35	15	1		10
31		12	45	35	2		6	59	6	35	37	12			10
32		14	45	32	2		8	60	7	37	35	11			10
33		15	45	30	2		8	61	5	36	39	11			8
34	1	17	44	28	2		9	62							
35	1	21	46	23	1		8	63							
36	2	25	46	18	1		8	64							
37	3	26	46	17			7	65							
38	4	26	45	17	1		7								

[1] Percentage calculated as a moving average of three two-week periods, Haugh (1943).

[2] J—Jumbo; XL-Extra Large; L-Large; M-Medium; S-Small; PW-Peewee; UG-Under Grade.

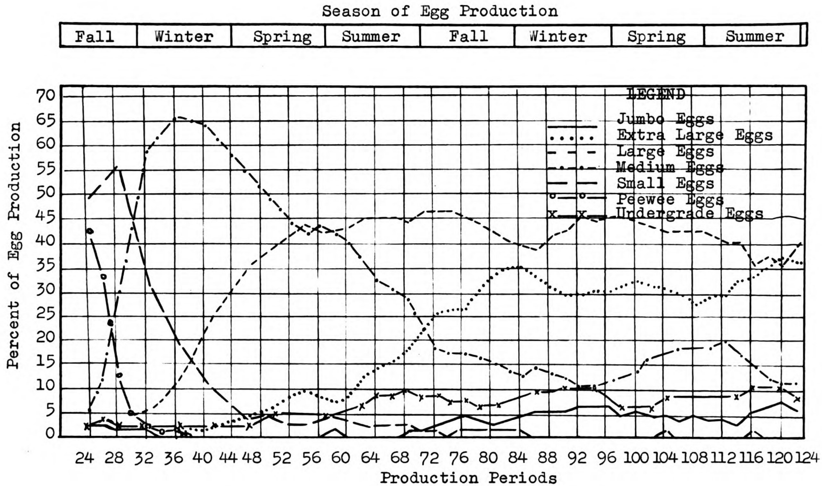


Figure 21. The Distribution, in Percentage, of Egg Weights Recorded in Two-week Intervals for Females Hatched on June 1, 1958.

Table 38. The Distribution, in Percentage,[1] of Egg Weights Recorded in Two-week Intervals for Females Hatched on August 1, 1958.

Pe-			Egg Weights[2]					Pe-			Egg Weights[2]				
riod	J	XL	L	M	S	PW	UG	riod	J	XL	L	M	S	PW	UG
11								39	3	28	43	14			11
12								40	2	26	46	13			12
13	1			23	65	7	3	41	4	28	47	8			13
14	1		1	29	60	6	3	42	4	29	45	9			12
15	1		1	40	52	3	2	43	4	31	45	9			10
16			2	50	42	2	2	44	3	32	45	11			9
17			4	59	33	1	2	45	3	32	44	11			9
18			8	66	31		2	46	3	30	44	12			9
19			13	67	15		3	47	3	29	45	14			9
20		1	18	66	11		4	48	3	28	46	15			8
21		2	23	61	8		4	49	3	30	45	15			8
22		3	28	59	5		4	50	3	30	43	16			7
23		3	29	57	5		5	51	3	30	42	17			8
24		3	31	56	4		4	52	3	30	42	15			8
25		5	33	53	4		6	53	6	32	41	10			10
26		6	37	48	3		5	54	6	35	38	9			11
27		6	37	47	3		7	55	8	35	37	8	1		10
28		6	37	47	3		7	56	7	35	38	9			9
29		8	40	42	3		8	57							
30		12	45	34	2		7	58							
31		18	48	25	1		8	59							
32	1	21	48	21	1		7	60							
33	2	23	47	20			8	61							
34	1	25	47	18			8	62							
35	1	27	46	17	1		9	63							
36	2	29	45	15			9	64							
37	2	30	44	14			10	65							
38	3	29	41	15			11								

[1] Percentage calculated as a moving average of three two-week periods, Haugh (1943).

[2] J—Jumbo; XL-Extra Large; L-Large; M-Medium; S-Small; PW-Peewee; UG-Under Grade.

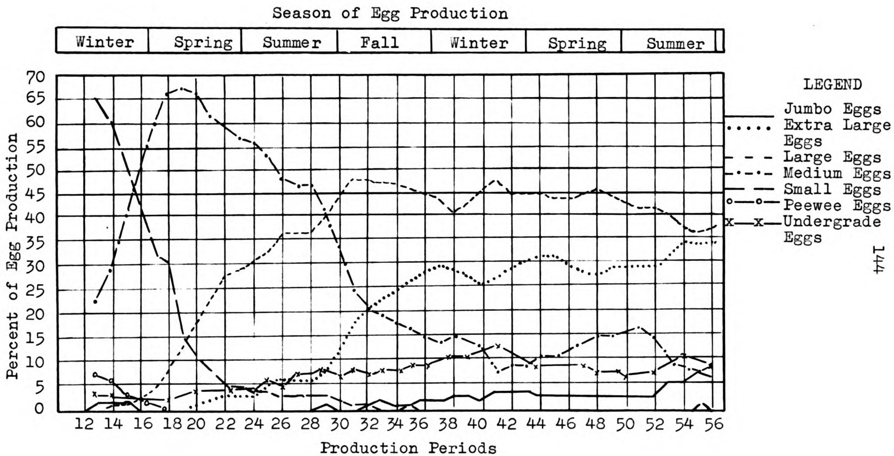


Figure 22. The Distribution, in Percentage, of Egg Weights Recorded in Two-week Intervals for Females Hatched on August 1, 1958.

Table 39. The Distribution, in Percentage,[1] of Egg Weights Recorded in Two-week Intervals for Females Hatched on October 1, 1958.

Age of Birds	J	XL	Egg Weights[2] L	M	S	PW	UG	Age of Birds	J	XL	Egg Weights[2] L	M	S	PW	UG
22								78	4	32	46	9			9
24			3	5	50	40	2	80	4	34	45	10			7
26	3			13	53	28	2	82	4	36	42	10			7
28	2			30	55	10	3	84	4	35	42	11			8
30	2		2	45	42	3	4	86	4	34	41	12			7
32	1		4	64	24		4	88	4	33	42	13	1		7
34	1		8	70	16		4	90	5	35	40	13			7
36			13	70	12		2	92	5	36	39	13			7
38		1	18	68	9		2	94	5	35	38	13			9
40		1	20	67	8		2	96	6	34	38	13			10
42		1	24	65	7		2	98	6	35	37	12			10
44		2	28	62	5		3	100	9	38	34	9			9
46		3	32	57	4		4	102	11	39	34	7			9
48		4	33	54	4		4	104	11	42	33	6			8
50		5	34	52	4		4	106	9	43	34	6			8
52		7	38	46	4		5								
54		11	44	38	2		5								
56		15	50	28	1		5								
58	2	18	49	25			5								
60	2	21	49	22			6								
62	1	24	49	20			6								
64	1	26	49	18			7								
66	1	30	46	16			7								
68	3	34	41	15			8								
70	3	33	38	17			9								
72	3	33	39	15			9								
74	3	30	43	13			11								
76	3	31	46	9			10								

1 Percentage calculated as a moving average of three two-week periods, Haugh (1943).

2 J–Jumbo; XL–Extra Large; L–Large; M–Medium; S–Small; PW–Peewee; UG–Under Grade.

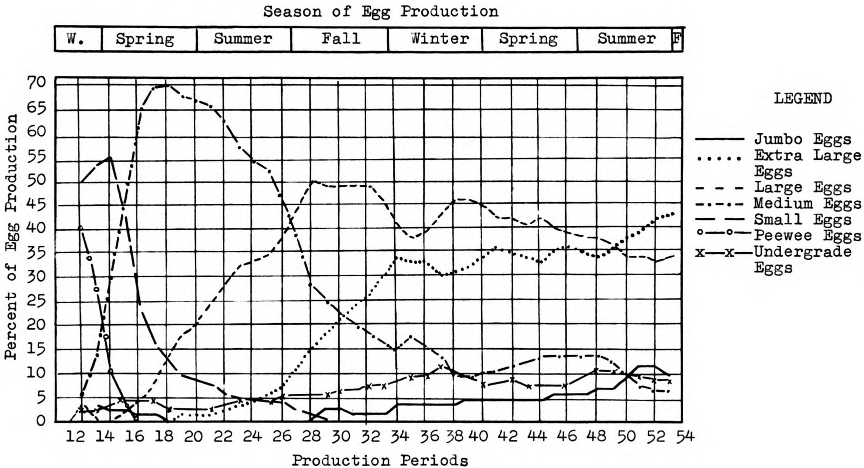


Figure 23. The Distribution, in Percentage, of Egg Weights Recorded in Two-week Intervals for Females Hatched on October 1, 1958.

Table 40. The Distribution, in Percentage,[1] of Egg Weights Recorded in Two-week Intervals for Females Hatched on December 1, 1958

Age of Birds	J	XL	L	M	S	PW	UG	Age of Birds	J	XL	L	M	S	PW	UG
22	3			4	18	68	6	78	2	19	49	22	1		7
24	3		2	4	30	56	6	80	1	19	48	23	1		7
26	2			6	50	34	7	82	2	20	48	23			8
28	1			14	60	19	5	84	1	21	46	22			9
30	1		1	24	60	10	4	86	1	23	43	22			10
32				36	53	6	4	88	3	25	41	19			11
34			1	49	42	3	4	90	4	29	41	15			10
36			4	61	30		4	92	6	33	41	12			9
38			5	64	25		5	94	6	37	41	9			8
40			6	65	23		5	96	2	39	40	9			7
42			9	65	20		5								
44		2	17	65	12		5								
46		3	25	61	5		5								
48		5	31	54	3		6								
50		6	33	51	2		7								
52		7	38	47	2		6								
54		8	41	43	2		6								
56		11	43	38	1		6								
58	1	13	46	33	1		7								
60		13	45	33			8								
62	1	12	47	30	2		9								
64		12	48	28	1		10								
66	1	13	54	21			10								
68	1	15	56	15			9								
70		18	53	19			8								
72		20	51	20			8								
74	1	20	50	20			8								
76	2	19	50	21	1		7								

[1] Percentage calculated as a moving average of three two-week periods, Haugh (1943).

[2] J—Jumbo; XL-Extra Large; L-Large; M-Medium; S-Small; PW-Peewee; UG-Under Grade.

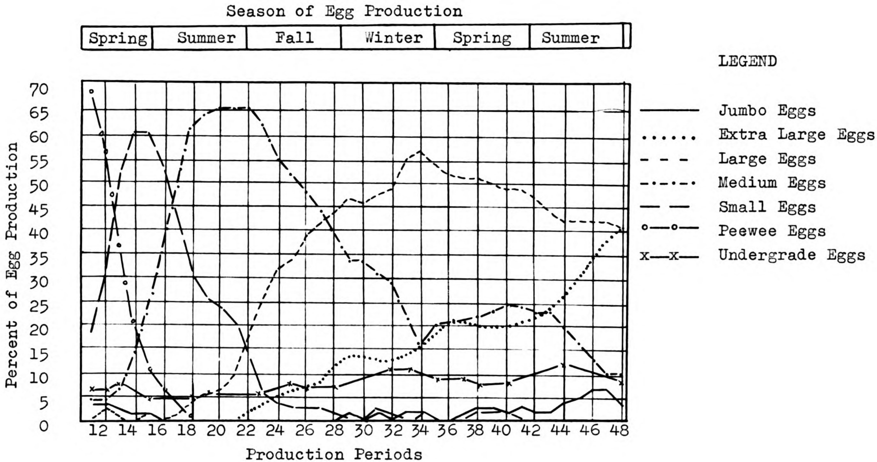


Figure 24. The Distribution, in Percentage, of Egg Weights Recorded in Two-week Intervals for Females Hatched on December 1, 1958.

Table 41. The Haugh Unit Scores[1] for Eggs Laid by Chickens Hatched at Different Seasons of the Year. (By Age of Birds).

	Hatching Season					
Period	A	B	C	D	E	F
24						79
25						81
26						81
27						80
28						79
29					77	74
30					78	72
31					79	73
32				76	80	72
33				78	81	73
34				79	75	76
35				78	72	74
36				77	73	70
37			77	71	76	73
38			79	71	75	76
39			80	75	74	70
40			79	76	77	65
41		79	78	75	74	66
42		81	71	73	72	72
43		81	74	71	73	77
44		79	75	68	69	72
45		78	74	70	63	70
46	75	75	74	69	65	75
47	75	75	73	65	75	75
48	75	73	77	66	79	77
49	77	71	73	68	76	75
50	77	76	71	74	75	71
51	72	78	69	80	75	74
52	71	81	68	76	74	76
53	75	80	71	74	74	75
54	78	76	72	76	72	
55	75	75	75	75	75	
56	76	74	81	76	78	
57	80	67	71	76	80	
58	77	66	71	75	76	
59	76	75	75	77		
60	67	82	75	79		
61	64	77	76	78		
62	63	75	74			
63	64	80	75			
64	74	80	78			
65	80	79	80			
66		75	77			
Average	73.55	76.46	74.77	74.07	74.73	74.10

[1] Two two-week moving averages, Waugh (1943).

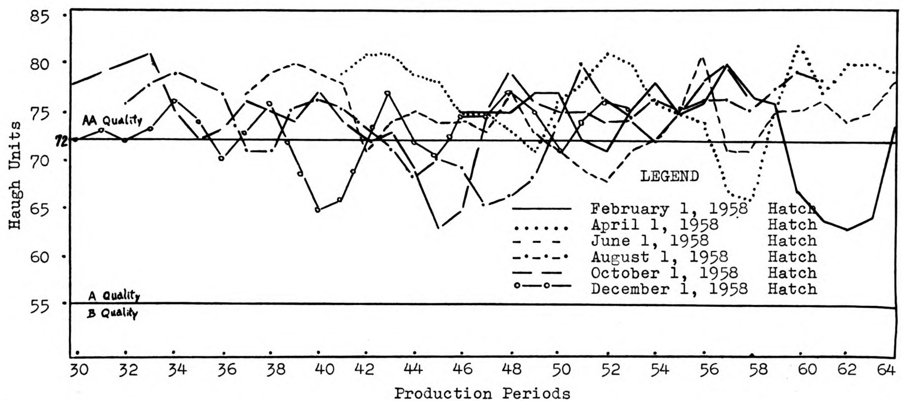


Figure 25. The Haugh Unit Scores for Eggs Laid by Chickens Hatched at Different Seasons of the Year. (By Age of Birds).

Table 42. The Haugh Unit Scores[1] for Eggs Laid by Chickens Hatched at Different Seasons of the Year. (By Similar Date of Sample).

	Hatching Season					
Sample	A	B	C	D	E	F
1	75	79	77	76	77	79
2	75	81	79	78	78	81
3	75	81	80	79	79	81
4	77	79	79	78	80	80
5	77	78	78	77	81	79
6	72	75	71	71	75	74
7	71	75	74	71	72	72
8	75	73	75	75	73	73
9	78	71	74	76	76	72
10	75	76	74	75	75	73
11	76	78	73	73	74	76
12	80	81	77	71	77	74
13	77	80	73	68	74	70
14	76	76	71	70	72	73
15	67	75	69	69	73	76
16	64	74	68	65	69	70
17	63	67	71	66	63	65
18	64	66	72	68	65	66
19	74	75	75	74	75	72
20	80	82	81	80	79	77
21		77	71	76	76	72
22		75	71	74	75	70
23		80	75	76	75	75
24		80	75	75	74	75
25		79	76	76	74	77
26		75	74	76	72	75
27			75	75	75	71
28			78	77	78	74
29			80	79	80	76
30			77	78	76	75
Average	73.55	76.46	74.77	74.07	74.73	74.10

[1] Two two-week moving averages, Waugh (1943).

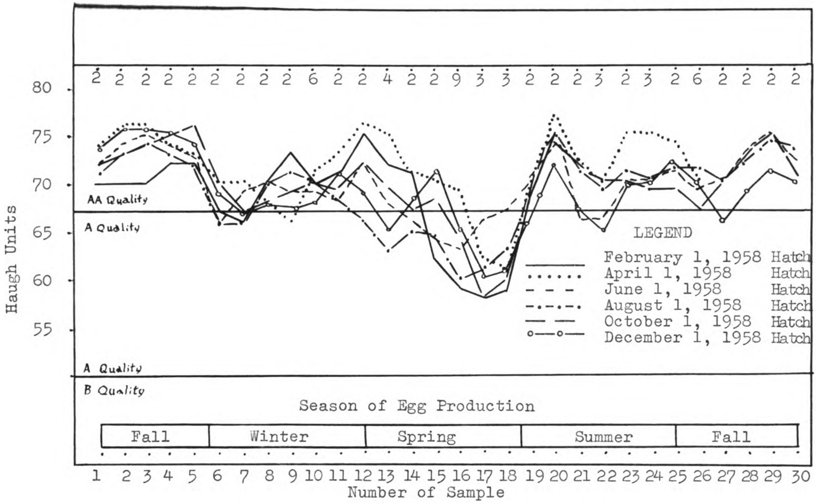


Figure 26. The Haugh Unit Scores for Eggs Laid by Chickens Hatched at Different Seasons of the Year. (By Similar Date of Sample).

Table 43. The Shell Thickness of Eggs Laid by Chickens Hatched at Different Seasons of the Year. (By Age of Birds).

	Hatching Season					
Period	A	B	C	D	E	F
24						13.3
25						12.8
26						13.6
27						13.7
28						13.1
29					13.1	13.3
30					13.2	13.5
31					13.6	13.6
32				13.8	13.5	13.1
33				12.9	13.5	13.5
34				13.8	13.6	13.4
35				13.5	13.9	13.6
36				13.8	13.6	13.2
37			13.0	13.7	13.2	14.0
38			13.0	13.7	13.6	13.2
39			13.5	13.8	13.0	13.5
40			13.7	13.4	13.8	13.6
41		13.3	13.0	13.4	13.6	13.7
42		13.0	13.4	13.8	13.5	13.0
43		13.0	13.7	13.5	13.5	12.7
44		13.3	13.2	14.0	13.9	12.9
45		13.1	13.4	13.8	13.4	13.3
46	13.4	13.3	14.0	13.5	13.3	13.3
47	13.7	13.6	13.5	13.1	13.3	13.3
48	13.7	13.8	13.1	13.9	12.4	12.9
49	13.1	13.2	13.7	13.3	13.5	13.4
50	13.6	12.7	13.8	13.1	13.4	12.8
51	13.5	13.6	13.4	12.8	13.1	13.3
52	13.8	13.1	12.9	13.2	13.2	12.9
53		13.5	13.3	13.2	13.0	12.3
54	13.5	13.7	13.0	13.5	12.2	
55	12.7	12.8	13.0	13.6	13.3	
56	13.5	12.8	12.5	13.2	12.8	
57	13.4	13.4	12.7	13.4	13.0	
58	13.3	13.4	13.3	13.2	12.4	
59	13.6	12.9	13.4	13.4		
60	13.0	12.5	13.7	12.8		
61	14.0	13.1	12.8	13.2		
62	13.2	13.1	12.9			
63	13.3	13.2	12.8			
64	13.1	13.4	13.5			
65	12.6	13.0	12.8			
66		14.0	12.2			

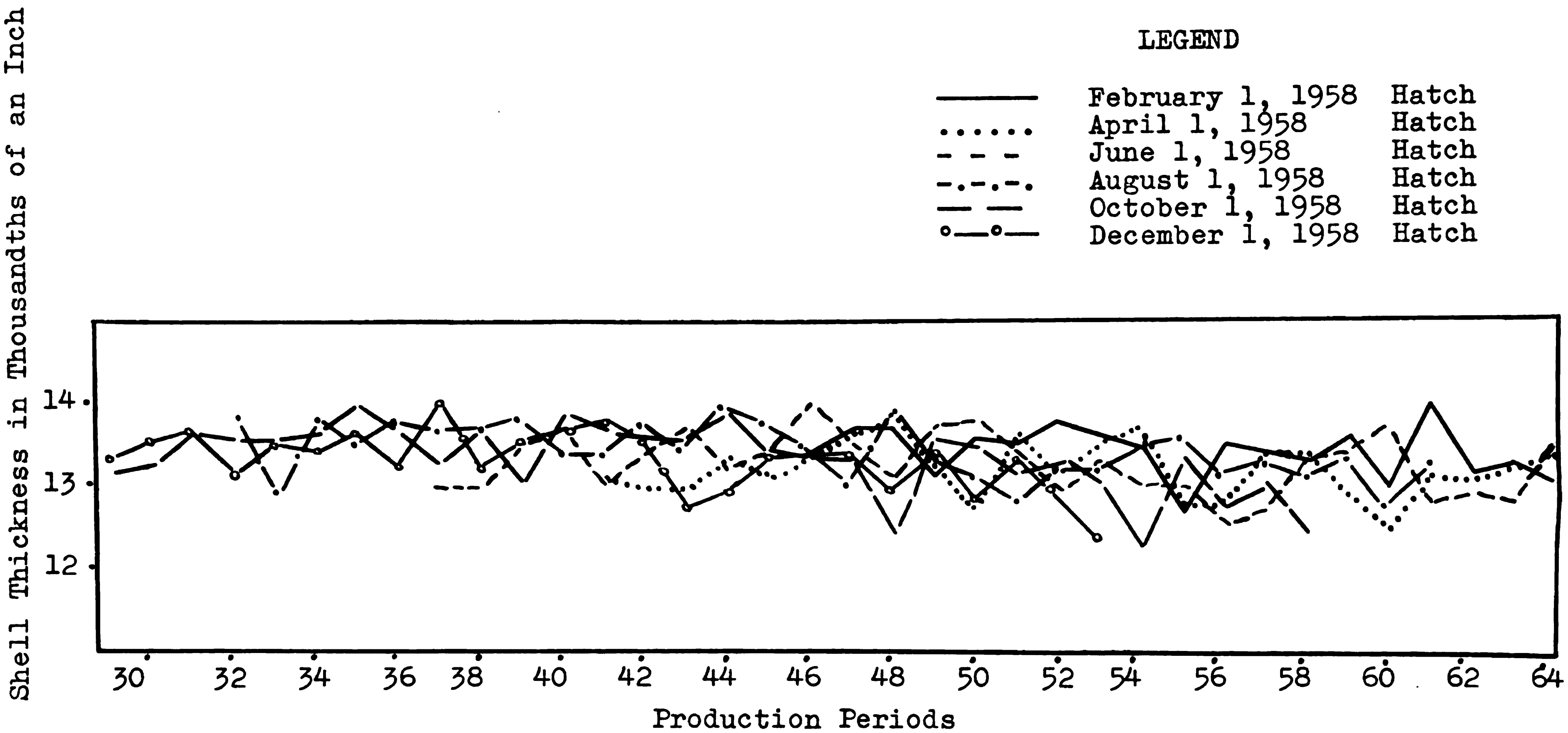


Figure 27. The Shell Thickness of Eggs Laid by Chickens Hatched at Different Seasons of the Year. (By Age of Birds).

Table 44. The Shell Thickness of Eggs Laid by Chickens Hatched at Different Seasons of the Year. (By Similar Date of Sample).

	Hatching Season					
Sample	A	B	C	D	E	F
1	13.4	13.3	13.0	13.8	13.1	13.3
2	13.7	13.0	13.0	12.9	13.2	12.8
3	13.7	13.0	13.5	13.8	13.6	13.6
4	13.1	13.3	13.7	13.5	13.5	13.7
5	13.6	13.1	13.0	13.8	13.5	13.1
6	13.5	13.3	13.4	13.7	13.6	13.3
7	13.8	13.6	13.7	13.7	13.9	13.5
8		13.8	13.2	13.8	13.6	13.6
9	13.5	13.2	13.4	13.4	13.2	13.1
10	12.7	12.7	14.0	13.4	13.6	13.5
11	13.5	13.6	13.5	13.8	13.0	13.4
12	13.4	13.1	13.1	13.5	13.8	13.6
13	13.3	13.5	13.7	14.0	13.6	13.2
14	13.6	13.7	13.8	13.8	13.5	14.0
15	13.0	12.8	13.4	13.5	13.5	13.2
16	14.0	12.8	12.9	13.1	13.9	13.5
17	13.2	13.4	13.3	13.9	13.4	13.6
18	13.3	13.4	13.0	13.3	13.3	13.7
19	13.1	12.9	13.0	13.1	13.3	13.0
20	12.6	12.5	12.5	12.8	12.4	12.7
21		13.1	12.7	13.2	13.5	12.9
22		13.1	13.3	13.2	13.4	13.3
23		13.2	13.4	13.5	13.1	13.3
24		13.4	13.7	13.6	13.2	13.3
25		13.0	12.8	13.2	13.0	12.9
26		14.0	12.9	13.4	12.2	13.4
27			12.8	13.2	13.3	12.8
28			13.5	13.4	12.8	13.3
29			12.8	12.8	13.0	12.9
30			12.2	13.2	12.4	12.3

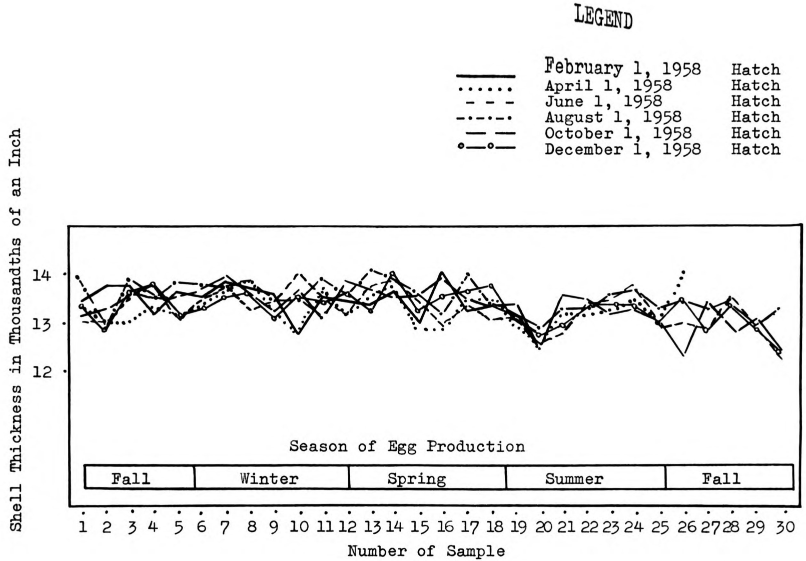


Figure 28. The Shell Thickness of Eggs Laid by Chickens Hatched at Different Seasons of the Year. (By Similar Date of Sample).

Table 45. The Percentage of Blood Spots Found in Candled Eggs Laid by Females Hatched at Different Seasons of the Year.

Period	Hatching Season A	B	C	D	E	F
11						
12			1			
13						
14		1				
15						
16		1				
17						
18						
19						2
20						1
21						1
22		1				1
23		1				2
24		1				2[1]
25					1	2
26		1			2	3
27		1		2	2	1
28		1		4	1	2
29	1	1		2	1[1]	2
30	1	1		3	2	2
31	1	1		2	1	3
32	1	1		2[1]	1	4
33			3	2	3	3
34		1	3	2	2	1
35		1	3	2	2	2
36	1	1	3	2	3	1
37	1	4	3[1]	4	3	2
38		2	2	3	3	1
39		3	2	3	2	1
40		3	2	4	1	3
41		4[1]	4	2	1	1
42	2	3	4	2	1	1
43	2	4	3	1	1	1
44	3	4	3	1	1	1
45	4	3	3	2	1	2
46	3[1]	3	1	1	1	2
47	4	3	2	1	1	1
48	3	5	2	0	1	0
49	6	5	1	1	1	1
50	4	2	0	2	1	1
51	3	0	1	1	0	2
52	3	1	1	0	2	0
53	5	1	0	1	0	1
54	5	2	1	2	0	

Table 45. Continued.

Period	Hatching Season A	B	C	D	E	F
55	4	1	1	1	1	
56	1	2	0	1	1	
57	1	1	0	1	0	
58	2	1	1	1	1	
59	1	1	4	1		
60	2	0	2	1		
61	3	1	1	0		
62	1	1	1			
63	0	1	0			
64	2	1	0			
65	1	1				
66						

[1]The starting period of the extended lay observations as reported in the Experimental Design.

Table 46. The Blood Spots Found in Broken-out Eggs[1] Laid by Females Hatched at Different Seasons of the Year. (By Age of Birds).

	Hatching Season					
Period	A	B	C	D	E	F
24						1
25						2
26						3
27						0
28					2	1
29					2	2
30					0	1
31				0	1	3
32				4	1	1
33				4	3	1
34				4	3	1
35				3	1	0
36				3	3	1
37			2	2	1	0
38			6	1	2	4
39			2	2	2	0
40			1	3	5	1
41		3	4	1	3	1
42		3	2	2	4	3
43		4	2	2	4	4
44		2	1	3	1	1
45		2	7	1	2	1
46	3	4	1	2	1	0
47	5	4	4	1	5	2
48	1	2	2	0	3	3
49	0	3	3	0	4	1
50	0	2	1	1	3	1
51	3	0	4	0	2	1
52	1	2	1	0	2	2
53		1	0	0	3	2
54	4	1	4	0	1	
55	1	1	3	2	3	
56	0	1	2	3	4	
57	0	1	1	2	1	
58	1	4	2	1	1	
59	1	1	1	0		
60	2	1	0	0		
61	1	1	4	1		
62	2	0	1			
63	0	2	2			
64	1	3	0			
65	0	3	2			
66		0	0			

[1] Observations made of two dozen samples after candling entire pen production.

Table 47. The Blood Spots Found in Broken-out Eggs[1] Laid by Females Hatched at Different Seasons of the Year. (By Date of Sample).

	Hatching Season					
Sample	A	B	C	D	E	F
1	3	3	2	0	2	1
2	5	3	6	4	2	2
3	1	4	2	4	0	3
4	0	2	1	3	1	0
5	0	2	4	3	1	2
6	3	4	2	2	3	1
7	1	4	2	1	1	2
8		2	1	2	3	1
9	4	3	7	3	1	3
10	1	2	1	1	2	1
11	0	0	4	2	2	1
12	0	2	2	2	5	0
13	1	1	3	3	3	1
14	1	1	1	1	4	0
15	2	1	4	2	4	4
16	1	1	1	1	1	0
17	2	1	0	0	2	1
18	0	4	4	0	1	1
19	1	1	3	1	5	3
20	0	1	2	0	3	4
21		1	1	0	4	1
22		0	2	0	3	1
23		2	1	0	2	0
24		3	0	2	2	2
25		3	4	3	3	3
26		0	1	2	1	1
27			2	1	3	1
28			0	0	4	1
29			2	0	1	2
30			0	1	1	2

[1] Observations made of two dozen samples after candling of entire pen production.

Table 48. The Monthly Cumulative Egg Production[1] of Two Commercial Strains of Females Hatched at Different Seasons of the Year.

Mo. of Lay	Season of Hatch A	B		C	D		E	F	
	St. I	St. I	St. II	St. I	St. I	St. II	St. I	St. I	St. II
10	17503	14004	13622	15247	15902	16917	16531	15406	14063
12	20259	15944	15740	17344	17798	18856	18890	17449	
13	21488	16805	16714	18566	18990	20087	19926	18412	
14	22609	17713	17702	19654	20017	20883	20867	19321	
15	23649	18493	18616	20446	20989	21624	21714	20362	
16	24260	19201	19397	21192	22018	22441	22739	21286	
17	25542	20051	19947	21992	23120	23276	23784	21958	
18	26467	20670		22634	24522	24626	24368	22620	
19	27678	21058		23691	25745		24987	23245	
20	28842	21570		24773	26618		25585		
21	29700	22141		25592	27458		26177		
22	30483	22810		26307	28223				
23	31303	23436		26974	28970				
24	32117	23886		27644					

[1]Calculated in dozens of eggs per 1000 birds housed.

Table 49. The Monthly Cumulative Egg Size Distribution[1] of Strain I Females Hatched on February 1, 1958.

Mo. of Lay	Cumulative Dozens of Eggs per 1000 Layers: Jumbo	X-Lg	Lg.	Med.	Sm.	Pee-wee	Under Grade
10	67	1498	4817	7926	2573	200	422
12	128	2260	6103	8374	2573	200	621
13	165	2612	6659	8559	2573	200	720
14	204	2956	7156	8117	2578	200	798
15	235	3314	7581	8848	2578	200	893
16	289	3709	7952	8921	2578	200	971
17	359	4105	8269	8972	2578	200	1059
18	491	4486	8549	9005	2578	200	1158
19	650	5039	8867	9065	2578	200	1279
20	837	5497	9199	9143	2578	200	1388
21	913	5843	9470	9198	2578	200	1498
22	1017	6136	9736	9234	2578	200	1582
23	1120	6474	10012	9271	2578	200	1648
24	1205	6804	10281	9320	2578	200	1729

[1]Calculated in dozens of eggs per 1000 birds housed.

Table 50. The Monthly Cumulative Egg Size Distribution[1] of Strain I Females Hatched on April 1, 1958.

Mo. of Lay	Cumulative Dozens of Eggs per 1000 Layers: Jumbo	X-Lg.	Lg.	Med.	Sm.	Pee-wee	Under Grade
10	104	983	3911	5971	2286	301	448
12	124	1390	4763	6441	2311	301	614
13	142	1596	5140	6647	2320	301	704
14	172	1859	5494	6773	2329	301	785
15	222	2115	5785	6874	2333	301	863
16	262	2366	6036	6976	2336	301	924
17	336	2660	6330	7083	2336	301	1005
18	374	2867	6564	7145	2338	301	1081
19	415	2986	6716	7128	2338	301	1120
20	443	3170	6915	7247	2338	301	1156
21	477	3354	7137	7332	2341	301	1199
22	515	3586	7407	7417	2341	301	1243
23	547	3796	7636	7518	2341	301	1297
24	585	3934	7801	7599	2341	301	1341

[1]Calculated in dozens of eggs per 1000 birds housed.

Table 51. The Monthly Cumulative Egg Size Distribution[1] of Strain II Females Hatched on April 1, 1958.

Mo. of Lay	Cumulative Dozens of Eggs per 1000 Layers						
	Jumbo	X-Lg.	Lg.	Med.	Sm.	Pee-wee	Under Grade
10	239	2608	4478	4112	1192	168	825
12	323	3336	5308	4372	1202	168	1031
13	387	3715	5659	4479	1202	168	1104
14	496	4107	5991	4544	1202	168	1194
15	611	4461	6273	4612	1202	168	1289
16	697	4825	6503	4651	1202	168	1351
17	796	5057	6659	4668	1202	168	1397

[1]Calculated in dozens of eggs per 1000 birds housed.

Table 52. The Monthly Cumulative Egg Size Distribution[1] of Strain I Females Hatched on June 1, 1958.

Mo. of Lay	Cumulative Dozens of Eggs per 1000 Layers						
	Jumbo	X-Lg.	Lg.	Med.	Sm.	Pee-wee	Under Grade
10	38	665	3968	7597	2229	261	489
12	75	1131	4938	8038	2250	261	651
13	112	1480	5479	8247	2255	261	732
14	148	1862	5914	8389	2264	261	816
15	192	2116	6217	8508	2264	261	888
16	230	2341	6556	8573	2264	261	967
17	274	2561	6882	8657	2264	261	1030
18	306	2784	7208	8746	2264	261	1065
19	343	3103	7646	8923	2270	261	1145
20	382	3397	8096	9126	2276	261	1235
21	402	3657	8409	9282	2284	261	1297
22	448	3905	8666	9364	2288	261	1375
23	478	4150	8928	9441	2288	261	1428
24	522	4398	9175	9515	2288	261	1485

[1]Calculated in dozens of eggs per 1000 birds housed.

Table 53. The Monthly Cumulative Egg Size Distribution[1] of Strain I Females Hatched on August 1, 1958.

Mo. of Lay	Jumbo	X-Lg.	Lg.	Med.	Sm.	Pee-wee	Under Grade
	Cumulative Dozens of Eggs per 1000 Layers						
10	50	728	3573	7409	3080	355	707
12	77	1247	4437	7722	3086	355	874
13	111	1595	4927	7912	3086	355	1004
14	131	1870	5433	8004	3086	355	1138
15	180	2175	5865	8092	3086	355	1236
16	211	2506	6318	8204	3086	355	1338
17	250	2827	6819	8344	3086	355	1439
18	294	3237	7448	8554	3086	355	1548
19	333	3598	7966	8764	3086	355	1643
20	385	3898	8315	8840	3086	355	1739
21	448	4194	8636	8920	3090	355	1815
22	498	4515	8922	8974	3090	355	1869
23	569	4837	9172	9011	3090	355	1936

[1]Calculated in dozens of eggs per 1000 birds housed.

Table 54. The Monthly Cumulative Egg Size Distribution[1] of Strain II Females Hatched on August 1, 1958.

Mo. of Lay	Jumbo	X-Lg.	Lg.	Med.	Sm.	Pee-wee	Under Grade
	Cumulative Dozens of Eggs per 1000 Layers						
10	187	1789	5125	6640	1947	257	972
12	308	2675	5750	6760	1947	257	1177
13	447	3157	6103	6846	1947	257	1330
14	502	3494	6355	6882	1947	257	1446
15	569	3768	6618	6930	1947	257	1535
16	643	4119	6879	6971	1947	257	1625
17	722	4491	7142	7017	1947	257	1700
18	876	5058	7570	7093	1947	257	1825

[1]Calculated in dozens of eggs per 1000 birds housed.

Table 56. The [illegible]
Strai[illegible]

No. of day	[illegible]
[illegible]	[illegible]

Calculated [illegible]

Table 5[illegible]. The [illegible]
Stra[illegible]

No. of day	[illegible]
10	[illegible]

Calculated in [illegible]

Table 55. The Monthly Cumulative Egg Size Distribution[1] of Strain I Females Hatched on October 1, 1958.

Mo. of Lay	Cumulative Dozens of Eggs per 1000 Layers						
	Jumbo	X-Lg.	Lg.	Med.	Sm.	Pee-wee	Under Grade
10	121	1181	4355	7775	2217	215	667
12	192	1963	5298	8134	2217	215	871
13	233	2279	5774	8222	2217	215	986
14	267	2616	6188	8317	2217	215	1047
15	301	2903	6542	8420	2217	215	1116
16	353	3262	6954	8551	2221	215	1183
17	403	3616	7339	8680	2221	215	1274
18	446	3840	7561	8749	2221	215	1336
19	524	4086	7766	8783	2221	215	1392
20	575	4363	7949	8828	2221	215	1434
21	640	4642	8127	8851	2221	215	1481

[1]Calculated in dozens of eggs per 1000 birds housed.

Table 56. The Monthly Cumulative Egg Size Distribution[1] of Strain I Females Hatched on December 1, 1958.

Mo. of Lay	Cumulative Dozens of Eggs per 1000 Layers						
	Jumbo	X-Lg.	Lg.	Med.	Sm.	Pee-wee	Under Grade
10	95	562	2782	6296	3612	1219	894
12	105	890	3866	6681	3617	1219	1071
13	119	1074	4360	6869	3622	1219	1149
14	133	1247	4796	7083	3631	1219	1212
15	148	1464	5286	7309	3633	1219	1303
16	175	1702	5666	7486	3635	1219	1403
17	215	1931	5933	7555	3642	1219	1463
18	235	2204	6216	7598	3642	1219	1506
19	269	2427	6461	7652	3642	1219	1575

[1]Calculated in dozens of eggs per 1000 birds housed.

Table 57. The Monthly Cumulative Egg Size Distribution[1] of Strain II Females Hatched on December 1, 1958.

Mo. of Lay	Cumulative Dozens of Eggs per 1000 Layers: Jumbo	X-Lg.	Lg.	Med.	Sm.	Pee-wee	Under Grade
10	99	1126	2992	4606	3102	1195	943

[1]Calculated in dozens of eggs per 1000 birds housed.

Table 58. The Monthly Cumulative Dozens of Jumbo Eggs[1] Laid by Two Commercial Strains of Females Hatched at Different Seasons of the Year.

Mo. of Lay	Season of Hatch: A	B		C	D		E	F	
	St. I	St. I	St. II	St. I	St. I	St. II	St. I	St. I	St. II
10	67	104	239	38	50	187	121	95	99
12	128	124	323	75	77	308	192	105	
13	165	142	387	112	111	447	233	119	
14	204	172	496	148	131	502	267	133	
15	235	222	611	192	180	569	301	148	
16	289	262	697	230	211	643	353	175	
17	359	336	796	274	250	722	403	215	
18	491	374		306	294	876	446	235	
19	650	415		343	333		524	269	
20	837	443		382	385		575		
21	913	477		402	448		640		
22	1017	515		448	498				
23	1120	547		478	569				
24	1205	585		522					

[1]Calculated per 1000 birds housed.

Table 59. The Monthly Cumulative Dozens of Extra-large Eggs[1] Laid by Two Commercial Strains of Females Hatched at Different Seasons of the Year.

Mo. of Lay	Season of Hatch A St. I	B St. I	B St. II	C St. I	D St. I	D St. II	E St. I	F St. I	F St. II
10	1498	983	2608	665	728	1789	1181	562	1126
12	2260	1390	3336	1131	1247	2657	1963	890	
13	2612	1596	3715	1480	1595	3157	2279	1074	
14	2956	1859	4107	1862	1870	3404	2616	1247	
15	3314	2115	4461	2116	2175	3768	2903	1464	
16	3709	2366	4825	2341	2506	4119	3262	1702	
17	4105	2660	5057	2561	2827	4491	3616	1931	
18	4486	2867		2784	3237	5058	3840	2204	
19	5039	2986		3103	3598		4086	2427	
20	5497	3170		3397	3898		4363		
21	5843	3354		3657	4194		4642		
22	6136	3586		3905	4515				
23	6474	3796		4105	4837				
24	6804	3934		4398					

[1]Calculated per 1000 birds housed.

Table 60. The Monthly Cumulative Dozens of Large Eggs[1] Laid by Two Commercial Strains of Females Hatched at Different Seasons of the Year.

Mo. of Lay	Season of Hatch A St. I	B St. I	B St. II	C St. I	D St. I	D St. II	E St. I	F St. I	F St. II
10	4817	3911	4478	3968	3573	5125	4355	2782	2992
12	6103	4763	5308	4938	4437	5750	5298	3866	
13	6659	5140	5659	5479	4927	6103	5774	4360	
14	7156	5494	5991	5914	5433	6355	6188	4796	
15	7581	5785	6273	6217	5865	6618	6542	5286	
16	7952	6036	6503	6556	6318	6879	6954	5666	
17	8269	6330	6659	6882	6819	7142	7339	5933	
18	8549	6564		7208	7448	7570	7561	6216	
19	8867	6761		7646	7966		7766	6461	
20	9199	6915		8096	8315		7949		
21	9470	7137		8409	8636		8127		
22	9736	7470		8666	8922				
23	10012	7636		8928	9172				
24	10218	7801		9175					

[1]Calculated per 1000 birds housed.

Table 61. The Monthly Cumulative Dozens of Medium Eggs[1] Laid by Two Commercial Strains of Females Hatched at Different Seasons of the Year.

Mo. of Lay	Season of Hatch A	B		C	D		E	F	
	St. I	St. I	St. II	St. I	St. I	St. II	St. I	St. I	St. II
10	7926	5971	4112	7597	7409	6640	7775	6296	4606
12	8374	6441	4372	8038	7722	6760	8134	6681	
13	8559	6647	4479	8247	7912	6846	8222	6869	
14	8717	6773	4544	8389	8004	6882	8317	7083	
15	8848	6874	4612	8505	8092	6930	8420	7309	
16	8912	6976	4651	8573	8204	6971	8551	7486	
17	8972	7083	4668	8657	8344	7017	8680	7555	
18	9005	7145		8746	8554	7093	8749	7598	
19	9065	7182		8923	8764		8783	7652	
20	9143	7274		9126	8840		8828		
21	9198	7332		9282	8920		8851		
22	9234	7417		9364	8974				
23	9271	7581		9441	9011				
24	9320	7579		9515					

[1]Calculated per 1000 birds housed.

Table 62. The Monthly Cumulative Dozens of Small Eggs[1] Laid by Two Commercial Strains of Females Hatched at Different Seasons of the Year.

Mo. of Lay	Season of Hatch A	B		C	D		E	F	
	St. I	St. I	St. II	St. I	St. I	St. II	St. I	St. I	St. II
10	2573	2286	1192	2229	3080	1947	2217	3612	3102
12	2573	2311	1202	2250	3086	1947	2217	3617	
13	2573	2320	1202	2255	3086	1947	2217	3622	
14	2578	2329	1202	2264	3086	1947	2217	3631	
15	2578	2333	1202	2264	3086	1947	2217	3633	
16	2578	2336	1202	2264	3086	1947	2217	3635	
17	2578	2336	1202	2264	3086	1947	2221	3642	
18	2578	2338		2264	3086	1947	2221	3642	
19	2578	2338		2270	3086		2221	3642	
20	2578	2338		2276	3086		2221		
21	2578	2341		2284	3090				
22	2578	2341		2288	3090				
23	2578	2341		2288	3090				
24	2578	2341		2288					

[1]Calculated per 1000 birds housed.

Table 63. The Monthly Cumulative Dozens of Peewee Eggs[1] Laid by Two Commercial Strains of Females Hatched at Different Seasons of the Year.

Mo. of Lay	A St. I	B St. I	B St. II	C St. I	D St. I	D St. II	E St. I	F St. I	F St. II
10	200	301	168	261	355	257	215	1219	1195
12	200	301	168	261	355	257	215	1219	
13	200	301	168	261	355	257	215	1219	
14	200	301	168	261	355	257	215	1219	
15	200	301	168	261	255	257	215	1219	
16	200	301	168	261	355	257	215	1219	
17	200	301	168	261	355	257	215	1219	
18	200	301		261	355	257	215	1219	
19	200	301		261	355		215	1219	
20	200	301		261	355		215		
21	200	301		261	355		215		
22	200	301		261	355				
23	200	301		261	355				
24	200	301		261					

[1]Calculated per 1000 birds housed.

Table 64. The Monthly Cumulative Dozens of Under Grade Eggs[1] Laid by Two Commercial Strains of Females Hatched at Different Seasons of the Year.

Mo. of Lay	A St. I	B St. I	B St. II	C St. I	D St. I	D St. II	E St. I	F St. I	F St. II
10	422	488	825	489	707	972	667	894	943
12	621	614	1031	651	874	1177	871	1071	
13	720	704	1104	732	1004	1330	986	1149	
14	789	785	1194	816	1138	1446	1047	1212	
15	893	863	1289	888	1236	1535	1116	1303	
16	971	924	1351	967	1338	1625	1183	1403	
17	1059	1005	1397	1030	1439	1700	1274	1463	
18	1158	1081		1065	1548	1825	1336	1506	
19	1297	1120		1145	1643		1392	1575	
20	1388	1156		1235	1739		1434		
21	1498	1199		1297	1815		1481		
22	1582	1243		1375	1869				
23	1648	1297		1428	1936				
24	1729	1341		1485					

[1]Calculated per 1000 birds housed.

DISCUSSION

The postulation that the time of year or month of hatching chicks, plus the techniques of rearing under commercial environmental conditions, did not affect total egg production was suggested by the data gathered and analyzed in this investigation. The rate of lay of the females hatched at different seasons of the year seemed to be inconsistent due to unexplained managerial procedures. These unexplained and immeasurable factors, present on a commercial poultry farm, were controllable within limits of managers of poultry farms. However, it appeared that the uncontrollable factors, such as genetic differences of the strains within or between years, had the greatest effect on total egg production.

Abplanalp et al. (1957) were able to show no consistent trend effect of season of hatch on performance of caged layers hatched each month of the year. Platt (1959) made a two-year study with White Leghorns. He found that season of hatch had little effect on egg production and obtained inconclusive results. He concluded that, in planning hatching dates, it would seem more desirable for the poultryman to operate in accordance with his own convenience rather than on a set pattern of hatching chicks. A set pattern of hatching chicks seasonally over a series of years, based on expected egg prices, might prove to be of little economic importance.

The results were not consistent in this investigation, after statistically analyzing the data of total egg production from females hatched in different seasons, using analysis of variance and Duncan's Multiple Range test. The total egg production between pens of the same strain of breeding and the same hatching date was not significant consistently. Effects of the hatching date on total egg production between years also were not consistent. Statistical comparisons were not made between years in this study. This decision was made after reviewing Hill and Nordskog's (1956) work. Hill and Nordskog found that location X year variance for hen-day production data was large. This made the comparisons of strains tested in different years within a location less accurate. It was observed in this investigation that the same hatching seasons were not significant in different years. Strains I and III[1] plus Strains II and IV[1] were compared. These analyses were made on total egg production, but there are other factors to be considered relative to seasonal hatching plans such as the seasonal egg size distribution, the expected egg prices and the convenience of seasonal hatching to the poultry farm operator.

It would appear from these data that seasonal hatching date effects were not important, as far as total egg

[1] Represent the same commercial strains, but different years of hatching dates.

production was concerned. The egg production patterns did not indicate effects of hatching data on total egg production. Management effects, although immeasurable in this study, appeared to be more important than the hatching dates. Management factors, for example, light control in the brooder house, affected sexual maturity and altered the December hatch (season "F") egg production pattern. Further, a poultry disease called Hemorrhagic disease, caused the egg production pattern of the April hatched (season B) birds to be relatively low.

The data did suggest that good management practices must be employed in order to reach the highest possible peak in egg production. Once a high peak in egg production was achieved and good management practices continued, the decline in egg production was relatively constant in keeping with the breeding of the bird.

Two methods of comparison were used in order that any strain differences would be apparent in the consideration of the seasonal variation in egg weights. Only the seasonal egg weight distribution data of strain I females were graphically presented for comparative purposes. However, egg weight data from the females of both Strains I and II, representing two different commercial strains, were utilized when dozens of eggs produced were considered in relation to the second year of lay.

When considering plans for seasonal hatching, seasonal variations in distributions of egg weights must be considered. Therefore, prospective egg prices could influence the planning of the start of an egg production enterprise. There were season of production influences in the egg weight distributions of the eggs laid by the Strain I birds. The effect of season of lay was more marked in the large and medium egg weight classifications. The choice of a particular strain, when considering egg size distribution, appeared to be more important than the consideration of the possible seasons of hatch. This strain observation was based on the data of the cumulative dozens of sized eggs produced per comparable flock size.

In reviewing the hatching Season A data, which appeared to be representative of production results to be expected when consistent good management practices were followed, the pattern of the egg size distribution was inconsistent with results reported by other workers. Cunningham _et_ _al_. (1960) reported that egg weight measured continuously from August to December, leveled off during the spring months of February, March, April, and May; and after a slight decrease in June tended to increase again from July to August. Their work disagrees in part with the results reported by Jull (1924) who noted a decrease in egg size from February to April.

The first winter period of lay, if within the pullet year of egg production, was relatively non-significant as to the genetic potential of egg production if the economics of keeping the pullets in the laying house for at least one full year were considered. The consideration of keeping the yearling hens over for a second year of lay involved the factor of egg size distribution. The data of this study of hatching Season A (February) agreed with Cunningham's et al. (1960) work for the first winter season of lay. It also agreed with the study of Jull (1924) for the extended lay period during the second winter.

The season in which birds are laying affects the egg size distribution percentages and were most evident in the medium egg size distribution of the eggs of the Strain I birds hatched during all seasons. The percentage of medium eggs increased during the spring and summer months, especially during the second year of egg production. However, the season of lay effects on the large egg size distribution were not so pronounced. The net effect was that less extra-large and jumbo eggs were laid during the spring and summer months. This observation disagreed in part with the work of Cunningham et al. (1960) but did agree with these workers in that the percentage of extra-large eggs leveled off during the spring and summer months. This might be expected, when one considers that birds have had

a winter pause[1] and would resume laying again.

The observation that some birds were coming into egg production and some were going out of egg production was evident when the pens of birds were reduced to a smaller size for the extended laying period. There was a temporary increase in hen-day egg production as a result of the culling of hens and the consoldiation of certain pens. The decline in egg production continued downward at the same rate as these birds stopped laying. It appeared that some birds were going out of production at all times during the second year of lay while other companion birds were coming back into egg production. The evidence of birds resuming egg production was substantiated by the studies of albumen quality. On an individual pen sample basis, there was a wide range of Haugh units in the individual broken out eggs. However, the average albumen quality measured in Haugh units remained relatively constant during the extended lay period. The average egg quality was above the A quality[2] standard in these periods.

The effect of early sexual maturity on egg size distribution was apparent in the egg size distribution

[1]Any abstention from egg laying in the winter caused by a distinct biological phenomenon or induced by environmental influences.

[2]Haugh units for U.S.D.A. Egg Quality Standards: AA quality - 72 Haugh units and up; A quality - 55 to 72 Haugh units; B quality - 31 to 55 Haugh units; and C quality - 31 Haugh units and below.

patterns of the eggs laid by the December-hatched females. These birds did mature relatively early. As a result, the percentage of small and peewee eggs was higher and carried over a sustained period of lay. This effect delayed the time needed to achieve the higher percentages of extra-large and large eggs. This observation agrees with Tanaka and Rosenberg (1952) who reported that if a pullet matured too early in life, initial egg size would be smaller and a longer time would be required to attain maximum egg size.

Seasonal hatch effect on the egg quality factor of albumen height was not evident. The egg quality factors were measured at varying times after the eggs were laid. When the age of the bird was considered, seasonal hatch effects were not observed. A decline in Haugh units, as a measure of albumen quality, has been reported by Jull (1953) and others to be due entirely to aging of the bird. However, there was decline in interior egg quality observed in the present investigation.

There was a considerable variation in albumen quality of individual eggs measured within the eggs measured from a single pen of hens carried in an extended laying period. Mueller et al. (1960) also found that there was a considerably higher variation in albumen quality of the eggs laid by yearling hens than of the eggs of pullets. Snyder and Orr (1960) confirmed these findings of variations in albumen quality of eggs laid by older birds.

Seasonal hatch effects on shell thickness were not evident in this study. Pfost (1960) reported a decline in shell thickness as the birds grew older; on the other hand, Mueller et al. (1960) observed that during the second year of lay, the shell thickness was greater than the shell thickness of the pullet year. There was a slight decline, not important, in shell thickness measurements of this study during the second year of lay which amounted to 0.0005 of an inch. The location of the measurement on the shell was randomized, as no effort was made from week to week to measure the shell at the same place on the shell.

It was observed that the incidence of detectable, candled blood spots in the eggs increased with the age of the layer. However, the increase in percentage of blood spots depended on the season of lay. There was evidence of a regular pattern of larger numbers of blood spots in the eggs laid by birds hatched during different seasons of the year. The larger numbers of eggs with blood spots occurred during a period corresponding to the late summer, fall and winter months of egg production regardless of season of hatch. No explanation can be offered why these periods of higher numbers of blood spots did not reoccur during the second year of lay. Unexplained also was the observation that, following these seasons, the incidence of detectable blood spots in the eggs dropped to unimportant numbers again. An explanation might be forthcoming

if the data on all hatches were continued to completion. The available data suggest that a season of production (fall and winter) effect increased the blood spot incidence. The season of lay seemed to have a greater influence on the incidence of blood spots in the eggs than did the influence of the age of the bird. Further study is needed in the field of the production of eggs with blood spots during these various seasons of laying.

Total cumulative egg production per season of hatch was calculated to indicate probable egg production if certain environmental factors were present. The data, as presented, were performance records for the particular genetic strains studied. The cumulative egg size distribution was obtained under a particular set of environmental conditions. It is not expected that like-performance could be secured from the birds of different hatch dates under different sets of environmental conditions. It was not known if the highest hatch-date record encountered was the maximum performance that could be achieved under ideal commercial conditions. Likewise, it was concluded that the lowest hatch-date record was not obtained under completely adverse conditions. These observations agree with conclusions advanced by Platt (1960) in New Jersey.

Even though the data might have shown significant seasonal hatch differences in the egg production of one year, the data of another year did not concur. When the

egg production from similar hatching dates were compared, the significant hatching seasons of one strain were not confirmed by the production records of another strain.

Inspection of the data, relative to the cumulative dozens of eggs produced, indicates that even though there were no consistent seasonal differences in total egg production, there were considerable differences between strains when egg size distribution was considered. The numerical advantages of more dozens of larger eggs laid by Strains II and IV were not offset by an inferior egg quality, as measured by total undergrade eggs.

The practical observation of the disadvantage of holding over birds for a second year of lay has been suggested by the financial compensation paid to the Burns' Poultry Farm, Inc., under the Memorandum of Understanding (Appendix Table 1). The older birds, held over for the extended lay periods after 24 months of age, were found to be deficient in comparative egg production to the younger birds. The deficiency payments were based on U. S. Grade A large eggs and calculated at five cents per dozen less than the Federal-State Market News Service Report from Detroit.

Therefore, the economic disadvantage of holding old hens over for a second year of egg production has been substantiated by the necessity of these deficiency payments based on only 50% egg production. Michigan State University

Extension poultrymen, for years, have advised Michigan poultrymen that 60% egg production was an average break-even point of profit in the poultry operation.

The egg production and egg size distribution data for females hatched at two different seasons of the year (April vs. August, 1958) were compared using the actual egg prices which prevailed in Michigan during the production periods of these females. It was theorized that if expected egg prices were applied to monthly egg size distribution patterns for females hatched at different seasons of the year, a break-even point might be calculated.

As shown in Table 65, the April-hatched females laid a total of 17,329 dozen eggs over a period of fifteen months of lay. The August-hatched females laid a total of 19,398 dozen eggs over a comparable period. The total receipts from the sale of large eggs from the April-hatched females were $96.41 more than the receipts from the August-hatched females, although 98 fewer dozens of eggs were produced by April-hatched birds.

The April-hatched females produced 6874 dozen medium eggs and the total receipts were $1901.59. Although the August-hatched females produced 1218 more dozens of eggs of this size the income was identical to the April-hatched females ($1901.60).

The total receipts would suggest that it is important that the poultryman buy his chicks in order to take advantage of the high price season for large and medium eggs. This would mean that the poultryman should be cognizant of the egg size distribution patterns which result from hatching chicks at different seasons of the year.

The above calculations are representative of actual data. However, the poultryman would need to utilize expected egg prices in planning hatching dates.

Table 65. Estimated Receipts from Eggs[1] During Selected Periods

	Season of Hatch	
	April 1958	August 1958
Numbers of Dozens of Eggs in 15 Months of Lay	17,329	19,398
Numbers of dozens of large eggs	8,122	8,220
Average price of large eggs	$ 0.33	$ 0.31
Receipts from large eggs	$2644.62	$2548.21
Numbers of dozens of medium eggs	6,874	8,092
Average price of medium eggs	$ 0.28	$ 0.23
Receipts from medium eggs	$1901.59	$1901.60
Numbers of dozens of small eggs	2,333	3,086
Average price of small eggs	$ 0.23	$ 0.23
Receipts from small eggs	$ 525.21	$ 718.52
Total Receipts	$5071.42	$5168.33
Average price of all eggs	$ 0.29	$ 0.27

[1]Calculated in dozens of eggs per 1000 birds housed.

CONCLUSIONS

The analyses of the data, under the particular environmental conditions of this study, have indicated that satisfactory egg production may be expected from females hatched at any time of the year. These results have suggested that the improved systems of poultry breeding, developed through Federal, State and private research, have improved the predictability of egg production. This progress in poultry breeding to the date of this study would be expected when one has reviewed the past egg production records. As an example: Thirty years ago, the average hen in the United States laid 121 eggs per year, while today, the average hen is annually laying 206 eggs or an increase of 85 eggs. As a result, 13 percent fewer hens on farms in 1959 produced 60 percent more eggs than their ancestors produced in 1930.

It appeared that there were no consistent differences in the basic shape of the total egg production pattern due to hatching chicks at different times of the year. However, as also reported by other workers, the factor of age at sexual maturity in this study did affect the shape of the total egg production curve. There were significant seasonal hatch effects, involving some strains and one set of records, on total egg production. In other test years, analyses of the egg production data of the same commercial

strain of birds indicated no significance of similar dates of hatch. Other complete annual representative seasons of hatch were also analyzed but they were not found to be significant. Therefore, it can be concluded that no consistent seasonal hatch effects on total egg production could be expected on the basis of season of hatch alone.

Location effects within the poultry farm, involving different pens of similar date of hatch and strain, were not significant according to the data analyses of this study. Comparable results were concluded to be expected in total egg production, if reasonably similar environmental conditions were encountered by different pens of birds within the farm.

The pullet year of egg production, at least, was concluded to be not pertinent to total egg production from the modern chicken kept under optimum environmental conditions. Consideration of keeping the yearling hens over for the second year of lay involved other factors. Egg weight distributions between the eggs produced by females hatched at different times of the year were important. Egg size decreased in the summer months as reported in this investigation of the extended lay periods. There were also differences in egg weight distributions between strains.

Expected economic returns could be affected by season of hatch, but varying wholesale egg prices would

result in inconclusive expected returns from year to year. Any practical economic factor of holding over old hens was nullified, when the calculations were made for the cash payments for a mutually agreed-upon deficient egg production. Given an individual poultry farm operator's cost figures for producing eggs plus expected egg production, then egg production patterns under optimum environmental conditions could be derived for the determination of maximum profit. It has been pointed out, however, that seasonal hatch effects on total egg production were not significant in this study. Therefore, it is recommended or suggested that the poultryman would be further ahead operating in accordance with his market demands and facilities rather than based on a set calendar pattern; because over a series of years, the hatching date may not be of particular economic importance.

Seasonal effects of hatch date on albumen quality of the eggs laid in the extended laying periods involved in this study were not evident. Consideration of the egg quality data of this study indicated that the method in which the eggs were handled was more important than the age of the birds. The decline in average egg quality in the extended lay periods was not important in this study, because the average egg quality of the samples was A or better. There was a great variation in the quality of eggs produced as the birds became older.

Studies of the shell thickness data of the eggs produced by the hens in the extended laying periods demonstrated that the method in which the eggs were measured was more important than the effect of the bird's age on the shell thickness. No important decline in shell thickness should be expected in 24 months of lay if reasonable management practices were employed by the poultry farm operator.

Seasonal hatch effects on the incidence of detectable candled blood spots were significant, when the period of egg production was involved. The larger numbers of blood spots were found in the very late summer, fall and winter months regardless of date of hatch. The poultry farm operator should consider this economic loss as excessive when confronted with the choice of keeping yearling hens over for a second year of lay.

The different hatching date effects on total egg production, in total numbers of eggs produced, were not suggested. The results of this study indicate that: given (1) a set of hatching dates, (2) a particular year with certain environmental conditions, and (3) a modern strain of chickens, then certain egg production results were obtained in this investigation. Therefore, it can be concluded that, given the modern laying pullet, it is best for the poultryman to schedule his chick-starting dates according to his market demands for egg sizes rather than on set calendar pattern.

BIBLIOGRAPHY

Abplanalp, H. 1957. Genetic and Environmental Correlations Among Production Traits of Poultry. Poultry Sci. 36:226-228.

Bennion, N. L. and D. C. Warren. 1933. Temperature and its Effect on Egg Size in the Domestic Fowl. Poultry Sci. 12:69-82.

Blyth, J. S. S. 1952. The Correlation Between Egg Number and Egg Weight in the Fowl: An Investigation of Its Inconstancy. Poultry Sci. 31:254-268.

Brant, A. W., and H. L. Shrader. 1952. How to Measure Egg I. Q. (Interior Quality). Bureau of Animal Industry, A. R. A. Circular PA-202, U.S.D.A.

Bray, D. F., S. C. King and V. L. Anderson. 1960. Sexual Maturity and the Measurement of Egg Production. Poultry Sci. 39:590-601.

Clark, T. B. 1940. The Relation of Production and Egg Weight to Age in White Leghorn Fowls. Poultry Sci. 19:61-66.

Cotterill, O. J., and A. R. Winter. 1954. Egg White Lysozyme. 1. Relative Lysozyme Activity in Fresh Eggs Having Low and High Interior Quality. Poultry Sci. 33:607-611.

Cunningham, F. E., O. J. Cotterill and E. M. Funk. 1960. The Effect of Season and Age of Bird on Egg Size, Quality and Yield. Poultry Sci. 39:289-299.

Dawson, L. E., L. R. Champion, J. A. Davidson, and H. C. Zindel. 1953. Improving Egg Quality Through R.O.P. Breeders - A Progress Report. Poultry Sci. 32:896.

Dawson, L. E., and C. W. Hall. 1954. Relationship Between Rate of Cooling, Holding Container and Egg Albumen Quality. Poultry Sci. 33:624-628.

Duncan, D. B. 1955. Multiple range and F tests. Biometrica, 11(1):1-42.

Froning, G. W., and E. M. Funk. 1958. Seasonal Variation in Quality of Eggs Laid by Caged Layers and Their Sisters on the Floor. Poultry Sci. 37:215-223.

Fry, J. L., and G. W. Newell. 1957. Management and Hold Conditions as they Affect the Interior Quality of Eggs. Poultry Sci. 36:240-246.

Funk, E. M., and H. L. Kempster. 1934. Egg Weight in the Domestic Fowl. Missouri Agr. Exp. Sta. Bull. #332.

Goodale, H. D. 1918. Internal Factors Influencing Egg Production in the Rhode Island Red Breed of Domestic Fowl. Am. Nat. 52:65-321.

Gowe, R. S. and W. T. Wakely. 1954. Environment and Poultry Breeding Problems. 1. The Influence of Several Environments on the Egg Production and Viability of Different Genotypes. Poultry Sci. 33:691-703.

Grotts, R. F. 1956. Seasonal Variations in Egg Quality. M. S. Thesis, University of Missouri, 66 p.

Gutteridge, H. S. and J. B. O'Neil. 1942. The Relative Effect of Environment and Heredity Upon Body Measurements and Production Characteristics in Poultry. II. Period of Egg Production. Sci. Agr. 22:482-491.

Hale, R. W. 1952. Experimental Error in Laying Experiments. J. Agric. Sci. 42:347-352.

Hale, R. W. 1959. Absence of Pen Effects in Laying Experiments on a Semi-Intensive Plant. Poultry Sci. 38:739.

Haugh, R. R. 1937. The Haugh Unit for Measuring Egg Quality. U. S. Egg Poultry Magazine, 43:552-573.

Harris, J. A. and H. D. Goodale. 1922. The Correlation Between the Egg Production of the Various Periods of the Year in the Rhode Island Red Breed of Domestic Fowl. Genetics 7:446-465.

Hill, J. F. and A. W. Nordskog. 1956. Efficiency of Performance Testing in Poultry. Poultry Sci. 35:256-265.

Hunter, J. A., A. Van Wagenen and G. O. Hall. 1936. Seasonal Changes in Interior Egg Quality of Single Comb White Leghorn Hens. Poultry Sci. 15:115-118.

Hutchinson, J. C. D. 1953. Effect of Hot Climates on Egg Weight. Poultry Sci. 32:692-696.

Jeffery, F. P. 1941. Changes in Pullet Year Albumen Index as Affected by Age of Bird. Poultry Sci. 20:298-301.

Jeffery, E. P. and J. Pino. 1943. The Effects of Heredity and Certain Environmental Factors on the Incidence of Blood Spots in Chicken Eggs. Poultry Sci. 22:230-234.

Jerome, F. N., C. R. Henderson and S. C. King. 1956. Heritabilities, Gene Interactions, and Correlations Associated with Certain Traits in the Domestic Fowl. Poultry Sci. 35:995-1013.

Johnson, A. S. 1956. Genetic and Seasonal Variation in Incidence of Blood and Meat Spots in Chicken Eggs. Can. J. Agr. Sci. 36:390-393.

Johnson, A. S., and R. S. Gowe. 1956. The Performance of Eight Strains of White Leghorns at Three Locations with Respect to Egg Quality Traits. Poultry Sci. 35:1149.

Jull, M. A. 1924. Egg Weight in Relation to Production. II. The Nature and Cause of Changes in Egg Weight in Relation to Annual Production in Pullets. Poultry Sci. 3:154-172.

Jull, M. A. 1953. Egg Quality Declines as Layers Increase in Age. World's Poultry Sci. J. 9:273-274.

Kinder, O. B. and E. M. Funk. 1960. Effect of Hatch Date on Productive Performance of Laying Hens. Paper presented at the 49th Poultry Science Association Meeting. 1960.

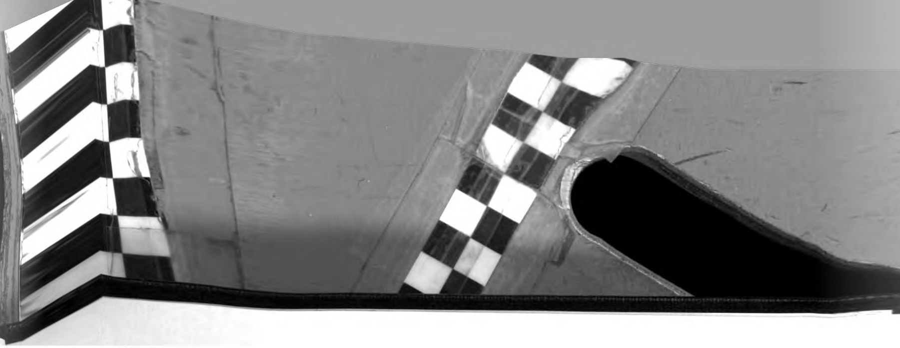
King, S. C., and G. O. Hall. 1955. Egg Quality Studies at the New York Random Sample Test. Poultry Sci. 34:799-809.

King, S. C. and C. R. Henderson. 1954. Heritability Studies of Egg Production in the Domestic Fowl. Poultry Sci. 33:155-159.

Kurnick, A. A., H. B. Hinds, M. W. Pasvogel and B. L. Reid. 1960. Effects of Season of Hatch and Caloric Density on Performance of Laying Hens. Paper presented at 49th Annual Meeting of the Poultry Science Association.

Lamoureux, W. F. 1957. Albumen Quality. The Kimberchick News, November.

Lorenz, F. W., and H. J. Almquist. 1936. Seasonal Variations in Egg Quality. Poultry Sci. 15:14-18.



Marble, D. R. 1930. The Non-Linear Relationship of Egg Weight and Annual Production. Poultry Sci. 9:257-265.

Marble, D. R. 1931. A Statistical Study of Factors Affecting Egg Weight in the Domestic Fowl. Poultry Sci. 10:84-92.

May, K. N., F. J. Schmidt and W. J. Stadelman. 1957. Strain Variation in Albumen Quality Decline of Hen's Eggs. Poultry Sci. 36:1376-1379.

McKee, D. E. and M. A. Gervais. 1958. Optimum Length of Laying Period and Timing of Laying Flock Replacement. Michigan State University Quarterly Bulletin, 40:(4) 942-954.

Mortenson, W. P. 1956. Trends in the Poultry Industry ... Effects on the Midwest. Wisconsin Agr. Exp. Sta. Bull. #523.

Mueller, W. J., A. J. G. Man and E. G. Buss. 1960. The Influence of Season and the Age of Layers on Egg Weight, Shape Index, Albumen Quality and Shell Thickness. Poultry Sci. 39:854-860.

Munro, S. S. 1936. The Inheritance of Egg Production in the Domestic Fowl. I. General Considerations. Sci. Agri. 16:591-607.

Nordskog, A. W. 1960. Importance of Egg Size and Other Factors in Determining Net Income in Random Sample Tests. Poultry Sci. 39:327-338.

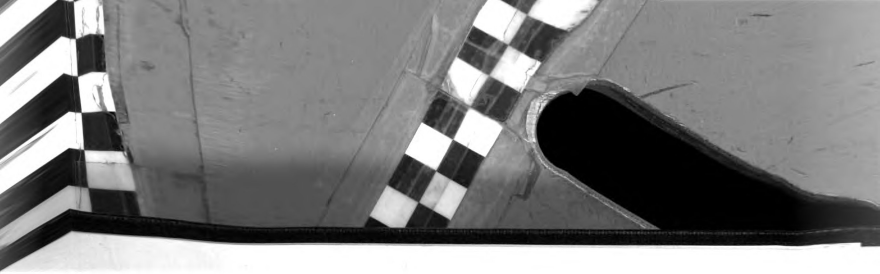
O'Neil, J. B. 1952. No Evidence of Compensatory Production Following A Slump. Poultry Sci. 31:510-513.

Oliver, M. M., B. B. Bohren and V. L. Anderson. 1957. Heritability and Selection Efficiency of Several Measures of Egg Production. Poultry Sci. 36:395-402.

Parkhurst, R. T. 1926. Certain Factors in Relation to Production and Egg Weight in White Leghorns. Poultry Sci. 5:121-126.

Pfost, R. E. 1960. Decline of Interior Egg Quality as Affected by the Season of the Year and the Age of the Hen. Paper presented at the 49th Annual Meeting of the Poultry Science Association.

Platt, C. S. 1960. A Study of the Seasonal Hatching of White Leghorn Pullets. New Jersey Exp. Sta. Bull. 790.



Romanoff, A. L., and A. J. Romanoff. 1949. The Avian Egg. John Wiley and Sons, Inc., New York, N. Y.

Rosenberg, M. M., and T. Tanaka. 1951. Effect of Temperature on Egg Weight in Hawaii. Poultry Sci. 30:745-747.

Sauter, E. A., J. V. Harns, W. J. Stadelman and B. A. Mc Laren, 1954. Seasonal Variations in Quality of Eggs as Measured by Physical Properties and Functional Properties. Poultry Sci. 33:519-524.

Sauter, E. A., W. J. Stadelman and J. S. Carver. 1952. Factors Affecting the Incidence of Blood Spots and Their Detection in Hens' Eggs. Poultry Sci. 31:1042-1049.

Snedecor, G. W. 1944. Statistical Methods. 4th Edition, The Iowa State College Press, Ames, Iowa.

Snyder, E. E., and H. L. Orr. 1960. The Effect of Length of Lay, Holding Temperature, Holding Time and Forced Molting. Paper presented at 49th Annual Meeting of the Poultry Science Association.

Spencer, J. V., W. J. Stadelman, E. A. Sauter, and J. G. Darrock. 1956. Measured Albumen Quality as Affected by Time after Break-out. Poultry Sci. 35:319-322.

Strain, J. H., and A. S. Johnson. 1957. Seasonal, Strain and Hatch Effects on Egg Quality Traits. Poultry Sci. 36:539-546.

Tanaka, T. and M. M. Rosenberg. 1952. Interrelationships of Certain Economic Characters in Four Strains of New Hampshires. Poultry Sci. 31:56-64.

United States Bureau of the Census, 1956. U. S. Census of Agriculture:1954. v I Part 6 U. S. Government Printing Office, Washington D. C., p. 256.

Warren, D. C., R. Conrad, A. E. Schumacher and T. B. Avery. 1950. Effects of Fluctuating Environment on Laying Hens. Kansas Agr. Exp. Sta. Tech. Bull. 68.

Warren, D. C., and R. L. Schnepel. 1940. The Effect of Air Temperatures on Egg Shell Thickness in the Fowl. Poultry Sci. 19:67-72.

Waugh, A. E. 1943. Elements of Statistical Method. 2nd Edition, McGraw-Hill Book Company, Inc., New York and London.

MEMORANDUM OF UNDERSTANDING
BETWEEN
POULTRY SCIENCE DEPARTMENT, MICHIGAN STATE UNIVERSITY
AND
BURNS POULTRY FARMS, INC.
A COOPERATING EGG PRODUCER

Situation:

The cooperating egg producer conducts a commercial poultry enterprise that involves keeping flocks of layers hatched in various seasons of the year, and he is now freely supplying the Michigan Agricultural Experiment Station with data on rates of lay, egg-size distributions, feed consumption, and mortality in these flocks. The value of these data will be increased substantially if some of the flocks can be retained on the farm after reaching 21 months of age, to provide comparable information for a period of the birds' life that has commonly been regarded as unprofitable.

Purpose of Agreement:

To provide inducement for the cooperating egg producer to supply the Michigan Agricultural Experiment Station with additional experimental data, by establishing a basis of compensating him for retaining certain poultry flocks on his farm under potentially unprofitable circumstances.

Obligations and Responsibilities:

In all respects, the cooperating egg producer is to retain full responsibility for the operation of his farm,

and for the outcome thereof. The Station's responsibility shall be limited to compensating the producer, on the basis outlined below, for supplying experimental data from certain flocks to be retained at its request for specified periods of time. Payments for performance in each calendar quarter will be made promptly after the end of the quarter. Station personnel will enter the producer's farm only at his invitation and while on his farm will abide by any precautionary measures the producer requests.

Procedure:

The Experiment Station project leaders will request the cooperating farmer, in writing, to retain certain groups of layers for a specified period of extended flock life beyond the age of 21 months. The size of each group will depend upon available housing facilities. If the farmer is willing to retain these birds, he will provide housing and care according to his usual practice, supply requested data, and be compensated as outlined below.

Flocks Eligible for Compensation:

Each separate retained flock will become eligible for earning compensation during and after the first two-week period (centered on the egg sampling dates) when that flock produces fewer than seven eggs per bird, provided,

(a) that the flock is at least 21 months of age, and

(b) that the project leaders have requested that the flock be retained to provide experimental data

during a specified period of extended flock life. Eligibility will continue throughout the requested period of extended flock life, and will cease at the end of that period, unless terminated earlier as outlined below (see "payment for advance concellation").

Amount of Compensation:

Compensation for each two-week period will be determined by multiplying

(a) the average weighted price per dozen of large US grade A white eggs (loose) paid by first receivers at Detroit, as reported by the Federal-State Market News Service for the last day of each two-week period by

(b) the net egg production deficiency for that period of all eligible flocks combined. This deficiency will be the number of dozens by which actual production of all eligible flocks during the two weeks falls short of seven eggs per layer. The number of layers will be the average retained during the two-week period.

Payment for advance cancellation:

Eligibility of one or more flocks may be terminated before the end of the period of extended flock life originally requested by the project leaders, upon their notice to the farmer. In this case, a payment of 12 cents per layer on hand will be made to the farmer for each remaining

two-week period of extended flock life originally requested. This provision is intended to permit the liquidation of a highly unprofitable flock without excessive loss to the University or the cooperating farmer.

Liability:

The University shall not be held liable for any outbreak of disease. In the event of disease, the cooperator will determine whether to retain or dispose of individual birds or flocks, in accordance with his usual management practice.

Poultry Science Department	Burns Poultry Farms, Inc.
______________________________	______________________________
H. C. Zindel Head of Department	
______________________________	______________________________
Date	

Appendix 2

LAYING FLOCK RECORD

For the month of ________ 19__

Lights on ______ to ______
______ to ______

Farm ______________
Pen No. ______________
Strain ______________

Month & year of hatch ______________ 19__

Heat used ______________

Unit of feed ______________

Layer numbers			Date	Eggs collected				Quantity fed		Notes (sickness, extreme weather, etc.)
On hand	Died	Sold or moved		1	2	3	Total	Mash		
			1							
			2							
			3							
			4							
			5							
			6							
			7							
			8							
			9							
			10							
			11							
			12							
			13							
			14							
			15							
			16							
			17							
			18							
			19							
			20							
			21							
			22							
			23							
			24							
			25							
			26							
			27							
			28							
			29							
			30							
			31							

Appendix 3

TWO-DAY EGG GRADING RECORD AND SUMMARY

Extreme weather last 2 days? ____________

Farm ____________
Eggs grading on ____________ (dates)
from production of ____________ (dates)

Pen no.	Day	Number of sound eggs by size												Cracks						Leakers		Bloods		Total eggs	Eggs produced
		Jumbos		X-Lge		Lge		Med.		Small		P. Wee						Small							
		Doz	E	Doz	E	Doz	E	Doz	E	Doz	E	Doz	E	Doz	E	Doz	E	Doz	E	Doz	E	Doz	E		
	1																								
	2																								
	1 & 2																								
	%																								
	1																								
	2																								
	1 & 2																								
	%																								
	1																								
	2																								
	1 & 2																								
	%																								
	1																								
	2																								
	1 & 2																								
	%																								
	1																								
	2																								
	1 & 2																								
	%																								
	1																								
	2																								
	1 & 2																								
	%																								

Extreme weather last
2 days? ____________

Farm ____________________
Eggs grading on ____________________ (dates)
from production of ____________________ (dates)

TWO-DAY
EGG GRADING RECORD
AND SUMMARY

Pen no.	Day	Number of sound eggs by size												Cracks						Leakers		Bloods		Total eggs	Eggs prod- uced
		Jumbos		X-Lge		Lge		Med.		Small		P. Wee						Small							
		Doz	E	Doz	E	Doz	E	Doz	E	Doz	E	Doz	E	Doz	E	Doz	E	Doz	E	Doz	E	Doz	E		
	1																								
	2																								
	1 & 2																								
	%																								
	1																								
	2																								
	1 & 2																								
	%																								
	1																								
	2																								
	1 & 2																								
	%																								
	1																								
	2																								
	1 & 2																								
	%																								
	1																								
	2																								
	1 & 2																								
	%																								
	1																								
	2																								
	1 & 2																								
	%																								

Two-week Summary Form of Production Factors

Week Periods			BIRDS				EGGS		FEED		BROODINESS	NOTES
n	To	Age	Begin.	Deaths	Culls	Av.	Total no.	@Bird	Total lbs.	@Bird	(no. of cases)	
		10										
		11										
		12										
		13										
		14										
		15										
		16										
		17										
		18										
		19										
		20										
		21										
		22										
		23										
		24										
		25										

Appendix 5

Egg Grading Record

Farm ______________________ Date ____________________

Eggs of		Number of sound eggs, by size						Cracks		Bloods & rejects	Loss by accident	Notes
Date	Pen No	Jumbo	X-lge	Lge	Med	Small	P.Wee					

EGG QUALITY RECORDS

Date Laid: ______________________ Date Broken: ______________________

EGG	CANDLE GRADE	U.S.D.A. SCORE	ALBUMEN HEIGHT	WEIGHT GRAMS	HAUGH SCORE	SPOTS P-- S -C	REMARKS	SHELL THICK-NESS

Appendix Table 7. Individual Pen Identification of Duplicated Strains of Birds Used in Location Analysis

Code Letter	Actual Corporation Pen Identification Number
a	12-1
b	7-2E
c	5
d	6-1W
e	10-2
f	6-2
g	10-1
h	8-3
i	8-4
j	6-4
k	9-2

Appendix Table 8. Monthly Outside Temperature Ranges[1] at Flint, Michigan, 1958.

Month	Mean Outside Temperatures: Mean Maximum	Mean Minimum	Mean
January	29.6	13.4	21.5
February	26.5	10.9	18.7
March	41.2	27.5	34.4
April	59.4	34.3	46.9
May	69.1	41.1	55.1
June	72.3	49.6	61.0
July	79.8	59.2	69.5
August	80.2	55.9	68.1
September	71.4	49.9	60.7
October	62.6	41.0	51.8
November	48.8	31.1	40.0
December	27.3	8.2	17.8
		Average Temperature	45.5

[1]Source - United States Weather Bureau, East Lansing, Michigan.