COMPARISON OF VARIOUS TYPES OF CROSSES OF WHITE LEGHORN AND RHODE ISLAND RED BREEDS

THESIS

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ABHAYA SINGH

INTRODUCTION

CHAPTER - I

INTRODUCTION

Upto the turn of the century, most poultry breeders were concerned with the breeds and varieties. They were more concerned with the "look" of the breed. There was no science of poultry production nor was there a poultry industry as we know it today. It was an age of fancy looking birds with hardly any stress on their productive capacity.

There was no information about the inheritance of egg production. Genetics was still in its age of infancy. Little was known regarding vetamin requirement, nutritional physiology, applied genetics and economics of poultry keeping.

All this has changed during the last twenty years since the advent of scientific advancement in the field of Genetics. Now we know far more about the Genetics of the fowl than is known about any other animal species of economical importance.

Scientific investigation and experimentation has also led to an exacting knowledge as regards the

nutritional requirements of the growing chick and concurrently a study into the economics of all aspects of poultry keeping has become too imperative.

With this advancement together with the production of ultramodern incubation, brooding and management equipment, the art of poultry breeding and management have become a very specialised subject and a very prospective commercial enterprise.

Conversely breed and variety have become of minor importance except where they affect economic production and returns. Very few poultryman today are concerned with the physical points or the "look" of the bird. More and more stress is being laid on selection for high production qualities in the birds.

Opportunities in the field of poultry breeding for commercial production and scientific investigation are closely related to the food needs and economic status of a population.

In a growing nation like India it became very necessary to introduce poultry in the private sector so as to meet the nutritional demand of the growing millions. As it is not possible to change the food habits of the masses from pure vegetarian diet to mutton or fish recipes, the egg has played an important role as it has been accepted as a dietary

constituent by those who are crossing the floor towards nonvegetarianism.

The egg has also come as an answer to the demands of the middle and the lower income groups of our country. The nutritional qualities of the egg and its low cost of production have provided a moral boost to the growth of poultry industry in India.

The 1961 census indicates an annual consumption of 11 eggs per year per capita as against the recommended intake of 1 egg per day per capita.

The scientists of our country are, today, aware of this situation more so in view of the existing food crisis in the country. More and more research projects as being introduced in the country as Coordinated Research Projects in Poultry for Meat and Egg Production. It is the aim of the future plans to fully exploit the recent findings in population genetics, breeding and nutritional physiology to make a break-through by evolving a programme for the production of high producing breeds, strains and crosses in poultry. The main aim is to exploit the more modern trend towards Hybridization.

Hybridization has vertually revolutionised the field of agriculture science and in all high

yielding agricultural varieties of corn, fruits and vegetables, "Hybrid" is the word of the day.

Similarly great deal of experimentation has been carried out in poultry breeding to harness the potentialities of genetics applied to breeding as regards hybridization.

With extensive and elaborate all out activities of poultry development work in the country, it is evident that scientists are planning more and more towards the exploitation of hybrid vigour by various systems of breeding. The object is to evolve a suitable system of crossing to give maximum expression of hybrid vigour in terms of eggs or meat as the case may be.

Comstock et al (1949) proposed a type of selection programme, which they called reciprocal recurrent selection, which was designed to make maximum use of both general and specific combining ability. This programme as originally proposed for corn involved selection in each of two segregating population for improvement of the cross between them. The application of this breeding procedure as it might be used with poultry is given by Comstock and Robinson (1956).

Godfrey (1955) is of the opinion that though there is no doubt that heterosis produces considerable

positive effects on some characteristics of economic importance but the number of such characteristics is in the minority. The continued improvement of genetic traits not influenced by heterosis will remain the task of breeders utilizing selection methods which are more effective for characteristics under the control of additive gene effects.

The mass of experimental evidence available, according to King (1955), demonstrates that important increment of heterosis are obtained when more or less dissimilar stocks within a species are mated together and the performance of their progeny is evaluated. It is of particular economic importance that hybrid vigour is so often found in reproductive traits.

Nordskog and Ghostley (1953) (in their experiment on strain crossing and crossbreeding compared with close flock mating) have stated that there is a great deal of interest today in the possibility of utilizing hybrid vigour in the breeding of poultry. The best way to accomplish this is yet a highly controversial issue. There are those who advocate crossbreeding for both broiler and egg production. Some have found success by crossing strains, more or less distinct, of the same breed. Others believe that only after a period of intensive inbreeding followed by crossing will it be possible

to derive the maximum benefits from heterosis. At the other extreme there are those, who advocate close flock mating in the same pure-breed.

This lack of agreement calls for more extensive and accurate information concerning the possible ways to utilize hybrid vigour in poultry.

The crossing of two or more strains or breeds will utilize the additive portion of the genetic variance in the parent stock and will show heterosis for the loci where dominance occurs and the parent stock have opposite alleles. Similarly crossing takes advantage of genetic variance at loci where overdominance occurs. As far as utilization of genetic variance goes, crossing would seem to be equal to or better than the purebred scheme.

Experimental evidence in this direction seems to indicate that substantial heterosis for egg production may be realized.

Amongst the many poultry breeds, which we imported in India after independence, two major bre have stood the test of time and have survived under climatic and managemental conditions of our countr These have been: the Single Comb White Leghorn, an the Rhode Island Red.

The above two breeds have been chosen to be the basis for the future development of pure-breeds and crosses in our country.

The present study was conducted at the U.P. Veterinary College Poultry farm with a view to compare the economic traits in the various types of crosses and pure strains viz.

1. Pure Rhode Island Red.
2. Pure White Leghorn (Mathura Strain).
3. Pure White Leghorn (Babugarh Strain).
4. Incrossbreds.
5. Topcrosses.
6. Topcrossbreds.
7. Crossbreds.
8. Strain Crosses.

The above purebreeds, strains and crosses were subjected to a detailed study so as to evolve a method of breeding which would enable the production of superior chicks for commercial production under our own conditions.

An attempt has also been made to evaluate the various pure breeds and crosses on the basis of their "performance efficiency" by taking into consideration their total consumption of feed and

total output in terms of body weight gain and the weight of eggs laid during a specific period. A comparative study of the performance efficiency index values obtained for the different groups would enable us to get a clear picture into the nicking of various crosses including the incrossbreds (Morgan and Carlson, 1967).

The traits observed for comparison are those affecting the relative economic importance of the birds. The traits taken for this study are:

1. Age at Maturity.
2. Weight at Maturity.
3. Egg Production.
4. Adult Body Weight.
5. Performance Efficiency.

REVIEW OF LITERATURE

CHAPTER - II

REVIEW OF LITERATURE

A. AGE AT FIRST EGG :

Age at first egg or age at sexual maturity is an important character indicating the number of days between the date a pullet is hatched and the date she lays her first egg. From the purely practical stand point it is obvious of course, that the earlier in life a pullet commences laying, the sooner she begins to yield financial returns to her owner. A pullet that commences to lay early in life costs less to rear up.

Though detailed information about the effect of inbreeding on the age of maturity is lacking, the effect of crossing has been reported by many workers. Romanoff and Romanoff (1949) are of the view that increase in egg size throughout the first year of laying is associated with gain in body weight. An early onset of laying may retard growth and as a result, the pullets that mature first are the last to reach their full body weight and their full egg

size. The age at which pullets begin to lay and the size of their eggs varies according to the season in which the birds are hatched (refer Table below): 9

Season of Hatch	Age at Maturity	Av. Wt. of Egg
Early Winter	156	36.4
Late "	185	41.3
Early Spring	236	48.6
Late "	234	48.9
Early Summer	229	48.1
Late "	214	45.7
Early Fall	196	41.8
Late "	179	40.4

It is evident that pullets hatched in the natural breeding season i.e. Spring require the longest time to reach maturity and lay the heaviest egg.

Sannan, Sterlund and Kostad (1965) conducted experiments with White Leghorn hens hatched in different seasons of the year. Five groups of White Leghorn were hatched on 29th. January, 26th. February, 4th June, 28th. August and 29th. October. It was observed that the birds hatched in January came into lay at the earliest and those hatched in October at the latest average age. Both in the first and second year of laying, the January hatched birds had the highest egg

production and the lowest food consumption.

Lerner (1945) studied nicking in relation to sexual maturity in the Single Comb White Leghorns. From his observations on 31 sets of sire by dam diallele matings, he was unable to demonstrate statistically significant sire X dam interaction effects, indicating that nicking was not of major importance as regards the age at maturity.

In their experiment on Cross Breeding for egg production, Glazner et al (1952) compared several crosses involving White Leghorn, Barred Plymouth Rock, Rhode Island Red and New Hempshires. Nine of the 15 crossbreds were equal to or superior to their respective pure-bred parents in age at sexual maturity, indicating that crossbreeding did, to a certain extent, affect this trait.

Hutt and Cole (1952) compared an inter strain cross of Leghorns with the two slightly inbred parental strains. The strain cross was superior in hatchability, sexual maturity rate of laying and body weight.

While comparing strain crossing and cross-breeding with closed flock mating for all important production traits including age at maturity, Nordskog

and Gostley (1953) are of the view that for most of the traits including age at sexual maturity, the crosses were generally found to be equal or superior to the pure strains. On the basis of overall performance, the strain crosses were intermediate to the crossbreds and pure strains.

In their experiment involving the reciprocal crosses between Leghorns, heavy breeds and Fayoumi, Nordskog et al (1959) were of the view that the crossbreds (Leghorns X Heavy breed) matured earlier than their parental purebreds.

Scossiroli and Meriggi (1954) compared the age at first egg in the pure bred White Leghorn, Rhode Island Red and their reciprocal crosses. The respective ages at maturity were found to be:

White Leghorns	...	...	196-202 days
Rhode Island Red	...	...	239-277 "
Crossbreds (WL X RIR)	...		225 "

Sahanova (1958) compared the different crosses of various breeds and concluded on the basis of his observations that the age at maturity was mostly inherited from the sire, whereas body weight and meat characters from the dam.

Merritt and Gowe (1960) indicated that the

hybrid vigour is exhibited for age at first egg and showed that the specific combining ability accounted for a large proportion of the subclass differences for age at first egg and egg production whereas the general combining ability was important for body weight and egg weight.

Byerly and Knox (1946) have reported that the pullets from the later (i.e. during June-Sept.) hatches laid their first egg at older ages than those of earlier hatches (i.e. during the months January - March). They further noticed that the age at first egg laid was closely associated with the day light length at maturity.

B. BODY WEIGHT AT MATURITY :

Body weight at maturity is an indication of the body size of the bird when it lays its first egg. Body weight at maturity also reflects upon the management and nutrition that has been available to the pullet during the early part of its life.

Hussaini (1963) is of the view that in addition to other economic traits, faster rate of growth is a highly desirable trait, particularly in broiler production. It has been established that weight at any particular stage depends upon the

initial weight and the absolute increment or the actual weight gained. The economy of this would further depend upon the least amount of feed with maximum gain in terms of body weight and egg production because in poultry industry 1/2 to 2/3 of the total investment goes to the cost of feeding.

Body weight at maturity is highly correlated with the age of the bird (Husain, 1960). It is highly heritable and economically important in all breeds of poultry.

Hazel and Lamoreux (1947) reported the heritability of body weight at 22 weeks of age as 31.6% with 4% S.E. By di-allele mating they showed that about 5% of the variation in body weight was due to maternal effects. No sex linkage was evidenced in the data. As nicking was small, they suggested that necking is likely to be unimportant, generally in non-inbred matings.

Hussaini (1963) in his study involving White Leghorn, Rhode Island Red and New Hempshire has stated that the heterotic effects on the body weight at first egg do not seem to be important. According to his observations, the White Leghorn purebreds have shown lower weight at maturity than the Rhode Island Red and the New Hempshire. The weight at

first egg of different crossbreds ranged from 1.495 Kg. (in WL X RIR) to 1.840 Kg. (in NH X RIR).

The differences between average body weight at maturity of crossbred and purebred pullets were shown to be negligible.

C. EGG PRODUCTION :

Egg production is one of the most desirable expressions of productive capacity in poultry enterprise. With egg production is closely linked the economic gains of the breeder as well as the means for the propagation of the germplasm to the future generation. High egg production is basically the object of all selection programmes in the field of poultry breeding. It is for the egg that one keeps the birds.

Egg laying is subject to the influence of various internal and external factors. It is, largely controlled by the individual birds heredity; her physiological efficiency and metabolic activity. These in turn, although inherited to a certain extent, may be profoundly affected by many environmental circumstances.

Egg production has been reported to be negatively correlated with the age of maturity as reported by Jerome et al (1954). It has also been

shown to be negatively correlated with egg weight and adult body weight.

Some workers have reported an advantage in using inbred lines for crosses. According to Jull (1938) inbreeding lowers the egg production in the resulting progeny. However, Maw (1942) reports a slightly better production in the progeny of inbred males used on unrelated inbred females than in the progeny of inbred males mated to related inbred females.

Knox (1950) in his experiment compared the progenies from out-breeding, crossbreeding and crossing inbred lines and on the basis of his findings he concluded that the egg production was markedly affected by the system of mating. Egg production increased in the same order i.e. outbred, crossbred and incrossbred. It was also shown that the performance of the crossbred progeny was intermediate between that of the parental breeds.

Ghostley and Nordskog (1951) from an experiment using 8 strains of four breeds viz. Orpington, Barred Plymouth Rock, New Hempshire and Rhode Island Red found 9 per cent better egg production from the crossbred and strain cross progenies than from the purebred parents.

Hutt and Cole (1951) while studying heterosis in an interstrain cross of White Leghorn have reported better egg production by the strain cross progeny than by the individual parent strain.

While comparing strain crossing and cross breeding with close flock mating, Nordskog and Gostley (1953) found that consistent hybrid vigour was evident in the crossbred progeny as compared to the purebreds and strain crosses in respect to fertility. The crossbreds exceeded the strain crosses which in turn exceeded the purestrains in respect to egg production and fertility. Each of the three years of experimental results showed that there was a consistent advantage in per cent egg production for the crossbreds and strain crosses over the pure strains. The three year average favoured the strain crosses by 4 per cent and the crossbred by 5 per cent over the pure strains. In this study a significant interaction between mating system and breed was observed. The evidence indicated that crosses are superior to the pure strains in laying ability.

Nordskog and Gostley (1953) in their experimental comparison of the various types of crosses

(strain crosses and crossbreds with purebreds) have observed that the total eggs produced during the three year duration of the experiment showed a clear superiority of strain crosses and crossbreds by 10 per cent and 12 per cent respectively over pure strains.

Skaller (1954) in his investigation on crossbreeding in poultry is of the opinion that there was a superiority of 18 eggs per bird in the crossbred flock to which the parent belonged.

Yao (1957) is of the opinion that inbreeding and crossing the inbred lines to obtain incross or incrossbred chicken can be considered as one of the reliable methods to increase egg production. His experiment on egg production performance of single and 4 way cross showed that the single incrossbreds were superior to the four way incrossbreds and the randombreds.

Nordskog et al (1959) in their experiments on heterosis in poultry have compared the profitability of crossbreds and topcrossbreds. It was noticed that top-crossing inbred Leghorn males on Leghorn females gave better results in both viability and egg production than noninbred Leghorn controls. The results of this investigation also showed that there was a consistent superior progeny performance of the four

outbred male lines compared with the highly inbred male lines in each of the two year duration of this test.

Goto and Nordskog (1959) conducted a testing program to identify superior cross combinations in commercial poultry breeding by crossing inbred lines in all possible combinations. They have cited literature review of Wyatt (1953) who studied top-crosses of five inbred lines of Leghorns on five single crosses of heavy inbred lines. The performance of the topcross progeny was compared with that of the Leghorn inbreds for body weight, hatchability, mortality, egg production and egg weight. The results indicated that there seemed to be little relation between the performance of the inbred crosses and that of the topcross progeny. The findings of the original experiment indicated that sire line and dam line differences were significant and there was a high general combining ability for all characters including egg production.

Merritt and Gowe (1960) have reported that the crosses were superior in egg production than the purebreeds, and further observed that the specific combining ability accounted for a large proportion of the sub-class differences for egg production and

age at first egg, whereas, the general combining ability was responsible for the same in body weight and egg weight.

In a study of the laying capacity and feed cost of laying hens, Chen (1965), while conducting a trial in 5 breeds (White Leghorn, New Hempshire, Cross, Barred Plymouth Rock and Rhode Island Red), found that the performance of the cross was superior to that of the parental varieties.

D. EGG WEIGHT :

Egg weight and egg size are synonymous so long as newly laid eggs are concerned. The size of an egg obviously is determined by the collective weights of its component parts. In all studies the weight of an egg has been considered as the most easily obtained criterion of egg size.

Egg weight as employed in this study has been incorporated in the calculation of the performance efficiency of the various types of crosses for a valid comparison in this aspect.

Egg weight has been shown to be positively correlated with body weight of the bird according to Jerome Henderson and King (1956). Egg weight has a

negative genetic correlation with the egg number.

Jeffrey (1941) has shown that pullets hatched in November and January months produce smaller egg than pullets hatched in April, June and September. The reason attributed to it was the effect of date of hatch on the season of commencement of laying and the temperature when the laying started.

Hays and Talmadge (1949) have pointed out that inbreeding, apparently has little effect on egg weight.

Crossbreeding has been shown to be affecting the egg weight to some extent. Ghoneim et al (1957) stated that in general, total egg weight in all crosses was superior to that of the parent breeds.

Merritt and Gowe (1960) have shown that hybrid vigour is exhibited in crossbreds for egg weight also. It has also been shown that for egg weight and body weight, general combining ability accounted for most of the differences.

Nordskog and Gostley (1953) have shown that the egg weight did not appear to be influenced by mating system to any significant extent.

E. ADULT BODY WEIGHT :

The body weight at any age depends upon the initial weight and the rate of growth per unit of time. Adult body weight is an indication of body size and is highly correlated with the age of the bird.

The adult body weight that is attained is a result of the cumulative effects of the rate of growth and the length of time that growth continues. The economy of this would further depend upon the least amount of feed consumed with maximum gain per unit of time at any particular stage.

Jull (1938) is of the view that in experiments conducted at the National Agriculture Research Centre, in which the two breeds crossed differed widely in adult body size, it has been found that the adult weight of the progeny was slightly below the mid weight of the two breeds crossed. On the otherhand in experiments in which the two breeds crossed did not differ widely in adult body size, it has been found that the adult size of the progeny was approximately intermediate between the size of the two breeds crossed. The wide variability in adult body weight that usually exists among both males and females of parental breeds that are crossed and the relatively few progeny that are sometimes secured from the

crosses make it impossible to draw definite conclusions concerning size inheritance except that it is obvious that a large number of genes are involved.

The body weight of the laying hen is not constant; it changes with the age and with the season of the year. The birds weight steadily increases from the time she lays her first egg until it reaches a peak, sometime during the first laying year presumably when she is about 12 months of age (Romanoff and Romanoff, 1949). Her weight then drops, however, it increases again during the second laying year. Maximum weight is reached during the second or third year. Any change in body weight after the first year appear chiefly to represent changes in fat accumulation.

Romanoff and Romanoff (1949) are of the opinion that increase in egg size throughout the first year is associated with gain in body weight. Early onset of laying may retard growth and as a result, the pullets that mature first are the last to reach their full body weight and their full egg size. Body weight at the commencement of laying, is accordingly a factor on which annual egg weight depends.

Nordskog and Gostley (1953) have compared the strain crosses and crossbreds with pure strains. The experiment involved 2 strains from each of the

four breeds (New Hempshire, Rhode Island Red, Barred Plymouth Rock and Australop), which were mated in all possible combinations to yield the experimental material. Comparison was made for all traits of economic importance. Based on the average of three years, certain conclusions were drawn. It was seen that all the strains used with the exception of New Hempshire strains showed better growth and a better adult body weight in all cross combination than as pure strains. The strain crosses and crossbreds were heavier by 0.3 pounds over the pure strains. In respect to adult body weight the crossbreds ranked higher than the strain crosses which in turn ranked higher than the pure strains. Adult body weight of strain crosses and crossbreds was about 5 per cent greater than the pure strains.

Sahanova (1958) while studying the different types of crosses involving various breeds concluded that the sexual maturity and reproduction were mostly inherited from the sire, whereas body weight and meat characters were inherited from the dam.

In a comparison of topcrossbreds and crossbreds, Nordskog et al (1959) used Leghorn X heavy breed, crossbreds and topcrossbreds from four highly inbred Leghorn male lines. Data was obtained on fertility, hatchability body weights, egg production,

egg weight etc. Results of this investigation showed consistent superior progeny performance of the four outbred male lines compared with the highly inbred male lines in respect to adult body weight.

Merritt and Gowe (1960) indicated that the hybrid vigour is exhibited for age at first egg, and showed that specific combining ability accounted for a large proportion of the sub-class differences, for age at first egg and egg production, whereas it was mainly general combining ability which was important for adult body weight and egg weight.

Hussaini (1963) is of the view that adult body weight is of significant economic importance, when we assess the performance efficiency of a group of birds. The economy of this trait would further depend upon the least amount of feed with maximum gain in terms of body weight and egg production during a specific time period for which efficiency of feed utilization is estimated.

Kurdjukov (1967) in an estimation of the relationship of live weight to egg production and egg weight in various breeds of fowl stated that egg production and egg weight increased as body weight increased upto 2.2, 2.9 and 2.6 Kg. in Russian Whites,

Ukeranian Clays, and Australops respectively and decreased thereafter.

An interesting study on the"body weight and egg production paradox" was conducted by Nordskog and Briggs (1967). This study was based on four years data. Each year, commercial varieties of chicken (including pure strains, breeds and all types of cross-breds) were tested in duplicate pens. Egg production, age at maturity, egg weight and mortality were regressed on housing body weight (i.e. regression of performance index on body weight). This study showed that lowering the body weight by 0.1 Kg. from the overall mean of 1.5 Kg., is expected to increase hen housed egg production by 12 eggs and decrease age at maturity by 4 days on the genetic scale but decrease egg production by 18 eggs and increase age at maturity by 14 days on the environmental scale. It was further concluded that relatively speaking, the condition (body weight) of the bird was more important in determining productivity than body size (length of the bones).

F. PERFORMANCE EFFICIENCY IN LAYING HENS :

An assessment of performance efficiency is a very important criterion if we desire to know the economics of an individual or a group of individuals

under study. In case of poultry keeping it is the only measure by which one can have an insight into the economic aspect of the enterprise.

In the past, for many years, percent production was regarded as a most useful criterion in appraising the value of laying hens. Although it remains as one of the best efficiency indicators, measure of additional factors such as egg weight, egg quality body weight and feed consumption have been utilized in the sophistication of productive analyses. With the development of commercial laying stocks, which routinely attain the desired 57 gram egg weight, the measure of feed efficiency has, for the past decade, concerned itself with the relationship of feed consumed to eggs produced.

According to Quisenberry (1965) experiments have been conducted on protein phase feeding of commercial layers to provide data for measure of production efficiency i.e. a feed to food conversion ratio. Calculations were made on the percentage of dietary proteins that were converted to egg protein. This gives a simple conversion ratio that may prove more useful in determining the specific phase feeding program to adopt than measures heretofore used, eg. egg numbers, egg size, feed efficiency and body weight changes. To be more practical, conversion ratio must

be closely correlated with production costs. Conversion ratio declined as the laying period advanced. The average conversion ratio varied from 23.9% to 32.1%.

Quisenberry (1965) has strongly advocated that egg size should be included in the calculation of performance efficiency.

A standard comparison which has been successfully employed is one that defines feed efficiency as the pounds of feed required to produce a dozen "24 ounce" eggs.

Random Sample Tests currently report feed efficiency in terms of pounds of feed required to produce a pound of eggs.

Morgan and Carlson (1967) have evolved a useful measure of performance efficiency in laying hens. In their opinion a useful value for those who are interested in selective efficiency for laying flocks must consider rate of lay, per cent production, egg size and feed consumed. Other considerations which might be considered pertinent by some are body weight and egg quality. The following formula as suggested by Morgan and Carlson (1967) considers hen size, egg size, feed consumed and per cent production in determining a unit value of performance efficiency index (PEI). The PEI value may be used for

comparative purposes between flocks or between individuals.

$$PEI = \frac{K\ (EW)P}{F}$$

Where K = 30 EW ÷ BW

EW = Egg Weight

BW = Body Weight of Laying Hen.

P = Per Cent Production.

F = Feed Consumed Per Day.

According to this method of calculating PEI it is assumed that a hen that is 100% efficient (PEI = 100) might be expected to produce one 57 gm. egg each day while consuming 57 gm. of feed.

The calculated PEI in experimental cases would be a fraction of percentage of the assumed 100% efficient hen.

Morgan and Carlson (1965) state that when considering the efficiency of egg production, 3 eggs from each of the hens be weighed in gms. They found that the 3 eggs weight was approximately 10% of the adult weight i.e. in a 30 day period the hen (if assumed to lay an egg a day) will have laid the equal of her own body weight equivalent of eggs.

Hess, Byerly and Jull (1941) are of the opinion that the efficiency of feed utilization is inherited. The crossbreds between Barred Plymouth Rock and New Hempshire were found to be relatively more efficient in utilizing feed than purebred progeny of the two parental breeds. This indicates that the system of breeding has a bearing on the efficiency of feed utilization in resulting progeny.

Hess and Jull (1948) observed heritable differences in feed utilization that could not be explained on the basis of body weight, rate of gain or time. They also showed that inbreeding had detrimental effect on efficiency of feed utilization. This was due to the inherent difference in the rate of growth.

Smith and Wiley (1950) showed that the feed requirement of the crossbred groups was consistently lower than those of the parental means.

Moskalenko (1957) has shown that the crossbred progeny from the mating of White Leghorn and Rhode Island Red were more efficient in utilizing feed than the parental breeds.

MATERIAL AND METHODS

CHAPTER - III

MATERIAL AND METHODS

A. SOURCE AND DESCRIPTION OF DATA :

The data used in this study were collected by the author from the State Poultry Farm, attached to the U.P. College of Veterinary Science and Animal Husbandry, Mathura, during the period from 1st. of August, 1969 to 31st. December, 1969. The purebreds straincross, crossbreds, topcross and topcrossbreds were obtained by the mating scheme depicted in Table I. The dates of hatch for each type of progenies are also given in the same Table. The Mathura strain of White Leghorn (WL. Mt.) is being maintained as a close flock since, 1962. The Babugarh strain of White Leghorn (WL. Bb.) was brought from Australia in 1966 at Poultry Farm, Babugarh. This strain was brought to State Poultry Farm, Mathura in the year 1967 and since then it has been maintained as close flock. Since 1948 the Rhode Island Red (R.I.R.) is being maintained as a close flock at the State Poultry Farm, Mathura.

From the above pure and crossbred groups, 60 birds were taken at random for the experiment. The birds were housed in pens with an average of 12 birds per pen.

Incrossbreds were produced during 1968-69 from the inbred lines of W.L. and R.I.R. evolved in the scheme for studies in various systems of breeding for hybrid vigour to increase egg and meat production. All the inbred lines used in this study were having an inbreeding coefficient of 50%. The incrossbred progenies were obtained by first crossing inbred R.I.R. males and inbred W.L. females and then reciprocally. The total progeny of the incrossbreds was obtained in 12 hatches during the period ranging from 4.10.68 to 30.12.68. A total of 200 birds of this group were selected at random and housed in pens each containing on an average 10-12 birds.

The above mentioned groups of birds were legbanded and housed in pens having trapnesting facilities for recording of egg production. All the pens in which the birds were housed were in a single shade having uniform climatic conditions.

Management and Feeding :-

Housing, management and feeding were uniform for all the 8 groups of birds throughout the experimental period i.e. 1st. August, 1969 to 31st. December, 1969.

All birds were housed in pens of similar dimension, provided with deep litter bedding and feeding and watering troughs of the same type. All attempts were made to provide a uniform managemental and climatic conditions.

Regular deworming of the birds was carried out every 21 days throughout the experimental period.

The birds were fed on an all mash system. All rations were mash ad libitum. The constituents of the mash as prescribed by the Department of Animal Nutrition were as follows:

Yellow maize	...	...	50 parts
Wheat bran	...	...	16 "
Ground nut cake	..	...	16 "
Fish meal	...	...	10 "
Chalk	...	...	5 "
Mindif	...	...	3 "
"Rovimix"	...	...	0.025 parts
			100

Parameter

(1) Egg size & Egg weight
(2) Fertility & hatchability
(3) Relationship between egg wt & hatch wt.
(4) along with growth rate
(4) Feed efficiency
(5) Economics of Broiler raising
(6) Mortality.

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Since the birds taken for this investigation were distributed unequally among the subclasses (hatches and crosses), an orthogonal comparison between the traits under study could not be carried out. The non-orthogonality thus

A daily record of the pen-wise hens housed was kept. The number and weight of eggs were recorded for each day pen-wise. Also feed consumption per pen was recorded for each day. Mature body weights were taken for all the individual birds when the flock had reached approximately 50% production.

Records were made available for the age at maturity and weight at maturity of all the birds.

B. STATISTICAL ANALYSES :

(a) Comparison of the various types of crosses :-

Disproportionate subclass frequencies always cause the different classes of effects to be non-orthogonal. The different types of effects cannot be separated directly without entanglement. In order to free these effects from the entanglement or confounding, it is necessary to resort to simultaneous consideration of all effects.

Since the birds taken for this investigation were distributed unequally among the subclasses (hatches and crosses), an orthogonal comparison between the traits under study could not be carried out. The non-orthogonality thus

caused by the unequal subclass frequency distribution was removed and the orthogonal comparisons were made by fitting least squares constants according to the technique designed by Harvey (1960).

To analyse the available data, the mathematical model for the two-way classification when the interactions of H and C are nonexistent, was as follows:

$$Y_{ijk} = \mu + h_i + c_j + e_{ijk}$$

$$i = 1, 2, \ldots\ldots\ldots\ldots, 20$$

$$j = 1, 2, \ldots\ldots\ldots\ldots, 8$$

Where :

Y_{ijk} = the kth observation in the jth cross and the ith hatch.

μ = Overall mean when equal subclass numbers exist.

h_i = Effect of the ith hatch

c_j = Effect of the jth cross.

e_{ijk} = Random errors NID $(0, \sigma^2 e)$

For fitting the least squares constants simultaneously for all the effects included in the above model, two symmetrical matrices with frequency

distribution were prepared, their dimensions being 29 x 29 and 23 x 23. Both matrices were subjected to similar calculation procedures.

Since no restriction was imposed, a unique solution for all these effects could not be achieved. To arrive at the precise estimates of all the effects, certain restrictions on the least squares equations were imposed.

$$\sum_i hi = \sum_j cj = 0$$

For doing so the 20th. hatch was absorbed in all the remaining 19 hatches, once by column operation and once by row operation. Likewise, similar operations were carried out for absorbing the 8th. cross with the remaining ones. During the column and row operations with the hatches and the crosses, the μ - equation was kept unchanged.

These operations reduced the original matrix in 27 x 27 (and the other 21 x 21) dimension.

The RHM (right hand members) which were the subclass totals of the corresponding frequencies considered in the matrix were also reduced to 27 by row operation, keeping the μ total unchanged.

The reduced matrices (No.1. 27 x 27 and No.2. 21 x 21) were inverted and multiplied with their corresponding reduced right hand column matrix to obtain the corresponding b_i values (the least squares constants).

$$\underset{27x27}{\left[n_{ij} \right]} \left[\hat{b}_i \right] = \underset{27x1}{\left[Y_{ij} \right]}$$

$$\left[\hat{b}_i \right] = \left[n_{ij} \right]^{-1} \underset{27x1}{\left[Y_{ij} \right]}$$

Where :

n_{ij} = is the 27x27 reduced matrix.

$\hat{b}_i$ = the unknown quantities to be estimated.

Y_{ij} = the sub-class totals.

Later on, the constants for the absorbed values were estimated as follows:

$$\text{Absorbed Constant} = -\left(\sum \hat{h}_i \text{ or } \sum \hat{c}_j \right)$$

The standard error (S.E.) of these constants were estimated by the formula given by Harvey (1961)

as follows:

$$S.E.(\hat{b}i) = \sqrt{c^{ii} \; \hat{\sigma}^2 e}$$

Where b_i are the estimated least squares constants and c^{ii} is the inverted diagonal element corresponding to each b_i (least squares constant).

$\sigma^2 e$ = the error variance obtained as follows:

$$\hat{\sigma}^2 e = \frac{1}{n \ldots - h+c-1} \left[\sum_i \sum_j \sum_k Y^2_{ijk} - R(\mu, hi, cj) \right]$$

Where: $\sum_i \sum_j \sum_k Y^2_{ijk}$ = the total sum of squares uncorrected.

$$R(\hat{\mu}, \hat{h}_i, \hat{c}_j) = \underset{1x27}{[\hat{b}i]} \; \underset{27x1}{[Y_{ij}]}$$

The significance of the estimated constants was tested by the T-test as follows:

$$t(bi) = \frac{\hat{b}_i}{S.E.(b_i)} \text{ at n-2 degree of freedom.}$$

Similar operations were applied to the other matrix (21x21).

The estimates mentioned above were obtained

by feeding a suitable programme for matrix inversion, least squares constants etc. to the computer (IBM 7044 at I.I.T. Kanpur), which in return furnished the desired estimates. Comparisons were then made between the various groups and subgroups to evaluate the findings and draw necessary conclusions.

(b) Estimates of the performance efficiency in the laying hens of the various crosses and purebreds :-

A useful formula has been evolved by Morgan and Carlson (1967), which considers hen size (body weight), egg size, feed consumed and per cent production in determining a unit value of performance efficiency. This unit value has been termed as the PERFORMANCE EFFICIENCY INDEX (PEI). The PEI value has been used here to compare the various types of crosses and purebreds involved in this study.

The following formula was used for the calculation of PEI.

$$PEI = \frac{K\ (KW)\ P}{F}$$

Where : K = 30 EW ÷ BW

EW = Average egg weight.

BW = Average body weight of the laying hen.

P = Per cent production.

F = Feed consumption per day by the laying hen.

The above model for PEI has been designed for the purpose of comparison between flocks as well as between individual. In this study, the above formula has been used to compare the different groups i.e. the various crosses and purebreds.

The data relevant to the above formula furnished by calculating group-wise:

1. Average egg weight: The groups total egg weight produced in 150 days divided by the total number of eggs produced.

2. Body weight was taken in all groups on a single day, and average calculated.

3. Per cent production was calculated on hen day basis.

4. Average feed consumption was calculated by taking the average consumption of the group.

Metric measures were used in all determinations.

TABLE I. MATING SCHEME FOR OBTAINING THE VARIOUS PURE AND CROSS PROGENIES

Females	MALES				
	White Leghorn (Mathura strain)	White Leghorn (Babugarh strain)	Rhode Island Red	Inbred Rhode Island Red	Inbred White Leghorn
White Leghorn (Mathura strain)	WL (Mt.) (Dec. 16 Jan. 2)	Straincross (Oct. 25, 31 Nov. 8, 17, 27)	-	-	-
White Leghorn (Babugarh strain)	-	WL (Bb.) (Nov. 27, Dec. 16, Jan. 2, Feb. 4,)	-	-	Topcross (Oct. 25, 31, Nov. 8, 17, 27)
Rhode Island Red	Crossbred (Oct. 25, 31, Nov. 8, 17, 27)	-	RIR (Dec. 16)	-	Topcrossbred (Nov. 8, 27, Dec. 8)
Inbred Rhode Island Red	-	-	-	-	Incrossbreds (Oct. 4, 10, 15, 22, 28 Nov. 2, 10, 17,23, Dec. 1, 9)
Inbred White Leghorn	-	-	-	Incrossbreds (Oct. 4, 10, 15, 22, 28 Nov. 2, 10, 17,23, Dec. 1, 9)	-

RESULTS AND DISCUSSION

CHAPTER - IV

RESULTS AND DISCUSSION

Comparison amongst the crosses and pure strains with respect to the economic traits was undertaken in this study.

A. AGE AT FIRST EGG :

Comparison amongst the five types of crosses viz. incrossbreds, topcrosses, crossbreds, straincrosses and topcrossbred, to establish the superiority of one over the others, was made. Twenty three constants (one for the mean, seventeen for the hatches and five for the crosses) were fitted with respect to age at maturity. The constants along with their standard errors (S.E.) are summarised in Table II. The effects studied accounted for 98 per cent of the variation in the age at first egg of the birds.

The mean age at maturity was found to be 195.3±6.5 days ((Table II). Out of the 17 hatch effects, 9 are having positive values and the rest 8 are having negative values, with varying

degrees of magnitude. The effect of hatch number six and fourteen on age at maturity was significant. Chicks hatched in these two hatches had delayed maturity.

It was not possible to make a comparison between the pure breds and the different types of crosses, as information on the age at first egg for the pure breds was not available. Hence comparison of different types of crosses was made. Between cross comparison indicated that the age at maturity of topcrossbreds was significantly higher in comparison to topcrosses, crossbreds and strain crosses. However, there was no significant difference along the top crosses, crossbreds and strain crosses.

Scossiroli and Meriggi (1954) observed that crossbreds of White Leghorn and Rhode Island Red gave average age at first egg inbetween the pure stock involved in the crosses. Hutt and Cole (1952) have observed that strain crosses were superior in comparison with the parental stock with respect to age at first egg. Nordskog and Gostley (1953) found that the strain crosses were intermediary to the crossbreds and pure strain in their study.

Merritt and Gowe (1960) indicated that the hybrid vigour was exhibited for age at first egg and they also found that the specific combining ability accounted for large proportion of variation for the age at first egg. All these studies indicated that the strain crosses, crossbreds and top crosses can be used for ensuring early maturity so as to take maximum advantage in poultry enterprise.

TABLE II. AGE AT MATURITY (DAYS)

Source	No.	Effect	S.E.
1	2	3	4
Hatch 1	8	5.42	8.74
2	15	0.87	7.28
3	20	-10.17	6.80
4	19	-8.53	6.88
5	14	-10.03	7.41
6	8	23.79*	8.74
7	3	-2.65	12.64
8	20	9.67	8.41
9.	3	-7.65	12.64
10	8	0.17	8.74
11	3	6.34	12.64
12	1	-3.32	20.66

Table contd....

TABLE II. (Contd.....)

1	2	3	4
13	13	-13.18	10.63
14	71	19.74*	9.38
15	18	-5.46	10.47
16	31	2.12	9.86
17	8	7.11	8.42
CROSSES			
Incrossbreds	105	2.05 ab	10.76
Topcross	41	-6.90 b	4.01
Crossbred	45	-3.32 b	3.85
Straincross	43	-4.54 b	4.09
Topcrossbred	29	12.71 a*	5.62
Mean	263	195.27	6.49
R^2		0.98	

* - Significant at five per cent leve of probability.

- Effects not having a common letter are significantly different at five per cent level of probability.

B. BODY WEIGHT AT MATURITY :

Comparisons with respect to the weight at maturity were made on the basis of the 23 least squares constants, so that an inference could be drawn as to the superiority of a cross. The standard errors for these constants have been calculated and have been shown in Table III.

The least squares mean for the weight at maturity is seen to be 1474.5±40.6 gm. Of the total 17 hatch effects, 9 hatch effects (H-2, H-4, H-7, H-9, H-13 to 17) are positive, whereas the other remaining 8 hatch effects are negative. However, the effect of none of the hatches was significantly different from zero.

Amongst the different types of crosses, the incrossbreds, topcrosses and straincrosses are having negative constants, whereas, the crossbreds and the topcrossbreds are having positive constants. The standard errors of these constants as given in Table III are either approximately equal or higher in magnitude than their respective constants. On account of the high standard errors, the constants are not significant. Hazel and Lamoreux (1947) have also reported that nicking was likely to be unimportant

for body weight at 22 weeks of age.

Since the stock used in this study has been produced and maintained for egg production, the not-significant difference in body weight at maturity among the crosses, and lower age at maturity of topcrosses, crossbreds and straincrosses suggest that these three types of crosses can be looked for their egg production.

TABLE III. WEIGHT AT MATURITY (gms.)

Source	No.	Effect	S.E.
1	2	3	4
Hatch 1	8	56.17	54.67
2	15	-16.57	45.54
3	20	74.42	42.57
4	19	-57.83	43.06
5	14	-39.00	46.35
6	8	-12.57	54.67
7	3	80.76	79.10
8	20	-55.89	52.64
9	3	4.09	79.10
10	8	-8.82	54.67
11	3	-49.24	79.10
12	1	-122.57	129.28

Table contd.....

TABLE III. (Contd.....)

1	2	3	4
13	13	36.07	66.50
14	71	16.69	58.69
15	18	53.11	65.54
16	31	11.83	61.73
17	8	29.34	49.80
CROSSES			
Incrossbreds	105	-51.95[a]	67.36
Topcross	41	-14.61[a]	25.09
Crossbred	45	41.47[a]	24.10
Straincross	43	-12.27[a]	25.62
Topcrossbred	29	37.37[a]	35.12
Mean	263	1474.52	40.62
R^2		0.99	

- Effects having a common letter are not significantly different at five percent level of probability.

C. EGG PRODUCTION :

Eggs and meat are the two end products from the poultry enterprise that decide the net returns and profitability in any commercial undertaking as they are the major sources of income for the poultry breeder. Ability of the flock to lay more eggs is always preferred over broiler production. It is the ultimate objective of all selection programmes to evolve a strain that would lay more eggs of a desirable size for a longer span of time.

To evaluate the five crossbred groups (incrossbreds, topcrosses, crossbreds, straincrosses and topcrossbreds) and three pure strains (pure White Leghorn Mathura strain, pure White Leghorn Babugarh strain and pure Rhode Island Red) on the basis of egg production, their 150 day production was recorded. In order to assess the superiority and merit in respect to egg production, 29 least squares constants were estimated.(Table IV). Their standard errors were also estimated. 't' test of difference was used to test the significance of their comparative merits. All the statistics have been summarised in Table IV.

The overall mean egg production was found to be 46±5 eggs. This production does not prove to be very promising one and gives a vivid picture of the potential for egg laying. However, a comparative study could nevertheless be made possible by analysing the effects obtained herewith.

Twelve out of the 20 hatches (3-6, 8, 11-16, 19) are exerting a depressing effect on egg production while the remaining eight hatches (1, 2, 7, 9, 10, 17, 18 and 20) are having a favourable effect in respect to egg production. However none of the hatch effects was significantly different from zero.

The primary interest of the study was to compare the various crosses and pure strains. Hatch effects were removed so as to obtain a valid comparison between different types of crosses and pure breds. The effect of different types of mating on egg production as given in Table IV reveals that Mathura strain of White Leghorn, Babugarh strain of White Leghorn and Rhode Island Red were inferior to the different types of crosses; Mathura strain of White Leghorn having lowest production. When the significance of difference between the various types of pure breds was studied, it was revealed that none of the pure breds were significantly different with

each otherwith respect to egg production. The superiority of the crossbreds over the purebreds has been reported by many including Goto and Nordskog (1959) and Merritt and Gowe (1960).

Amongst the different types of crossbreds apparently the strain crosses were the best followed by topcross and topcrossbreds with respect to egg production. Nordskog et al (1959) in their study on heterosis in poultry have compared the profitability of crossbreds and topcrossbreds. It was noticed that topcrossing inbred Leghorn male on Leghorn females gave better results for both viability and egg production than non-inbred Leghorn controls. Knox (1950) in his experiment observed that the egg production increased in the order: outbreds, crossbreds and incrossbreds. In the present study, the incrossbreds and crossbreds were not significantly different from each other. From results obtained in this study for egg production it appears that the inbre lines used should have been inbred to relatively higher coefficient of inbreeding in comparison to what was available in order to harvest the maximum advantage of those inbred lines. From the present study it remains unconclusive as to the superiority of one system over the other

for producing hybrid chicks. An experiment on relatively larger scale for this purpose is called for.

The age at maturity of the topcrossbreds was found to be significantly higher in comparison to topcross, crossbreds and strain crosses. The weight at maturity among the four types of crosses mentioned above was not significantly different from each other. Incorporating egg production also, it is evident from the present study that straincross and topcross would be, in general, superior to all other types of crosses and the various types of purebreds.

Another important consideration may be of the egg mass obtained from the various groups under study. For this purpose the average egg weight of the various groups was also recorded. The average egg weight in gms. for the incrossbreds, topcrosses, crossbreds, strain crosses, topcrossbreds, White Leghorn Mathura strain, White Leghorn Babugarh strain and Rhode Island Red was in the order of 52, 54, 54, 53, 53, 51, 50 and 49 gms. respectively. The consideration of egg weight also reveals that the different types of crosses were in general superior to purebreds.

TABLE IV. EGG PRODUCTION

Source	No.	Effect	S.E.
1	2	3	4
Hatch 1	8	0.90	6.75
2	15	1.00	5.86
3	20	-4.34	5.58
4	19	-5.01	5.63
5	14	-3.23	5.94
6	8	-5.34	6.75
7	3	12.74	9.26
8	20	-5.59	5.35
9	3	10.40	9.26
10	8	5.90	6.75
11	3	-14.59	9.26
12	1	-0.59	14.64
13	13	-10.85	6.79
14	71	-5.00	5.84
15	18	-6.14	6.62
16	33	-3.34	5.99
17	8	0.53	8.24
18	77	5.75	11.03
19	30	-0.86	11.14
20	2	27.65	14.78

Table Contd.....

TABLE IV. (Contd.....)

1	2	3	4
CROSSES			
Incrossbred	105	1.48[ab]	9.09
Topcross	41	6.88[b]	4.77
Crossbred	45	3.72[ab]	4.74
Straincross	43	8.07[b]	4.85
Topcrossbred	29	6.47[b]	5.27
White Leghorn (Mt.)	44	-13.14[a]	7.49
White Leghorn(Bb.)	24	-7.76[ab]	6.85
Rhode Island Red	43	-5.72[ab]	7.60
Mean	374	46.11	4.89
R^2		0.91	

- Effects not having a common letter are significantly different at five per cent level of probability.

D. ADULT BODY WEIGHT :

The genetic economic value of a breeding flock is a function of rate of lay, egg size, and body weight. Here, an attempt was made to compare the various crosses with the pure strains with respect to adult body weight, as there is good reason to believe that body weight and egg size, are positively correlated phenotypically (Hogsett and Nordskog, 1958).

Birds from five crosses and three pure strains were taken for comparison so as to select a superior group for further breeding and also to evaluate the inherent potential for the trait amongst the groups.

The effects shown in Table V reveal that the hatches Nos. 4-6, and 13-20 affected the adult body weight adversely. It can be interpreted that the chicks raised from the above hatches will not be so efficient in gaining weight to a desired level as their counter-parts of hatches 1-3, and 7-12. The constants, however, were not significantly different from zero.

It is also evident that for the major group comparison (i.e. crosses and pure strains),

we may say that the incrossbreds and the topcrosses are inferior in their ability to reach a desirable body weight level. The White Leghorn strains are much inferior in maintaining themselves in full vigour to regulate their own physiological functions, reflected in terms of the adult bodyweight, thus being less efficient in utilization of feed for body size, and egg production.

The crossbreds and topcrossbreds were significantly heavier than the Mathura strain of White Leghorn. It is probably due to the hetrotic effects contributed by the two parents.

Out of the pure strains, the pure Rhode Island Red birds have shown a mean adult body weight of 2.116 Kg., which was highest amongst all the groups.

TABLE V. ADULT BODY WEIGHT (gms.)

Source	No.	Effect	S.E.
1	2	3	4
Hatch 1	8	55.87	118.15
2	15	57.95	102.57
3	20	32.12	97.66
4	19	-28.01	98.45
5	14	-86.09	103.93

Table contd....

TABLE V. (Contd.....)

1	2	3	4
Hatch 6	8	-62.88	118.15
7	3	107.95	162.00
8	20	7.96	93.66
9	3	341.28	162.00
10	8	18.37	118.15
11	3	91.28	162.00
12	1	74.61	256.14
13	13	-23.70	118.86
14	71	-146.36	102.18
15	18	-8.43	115.77
16	33	-58.98	104.88
17	8	-134.54	144.12
18	77	-11.82	193.00
19	30	-92.19	194.93
20	2	-133.99	260.88
Incrossbreds	105	-93.12[ab]	159.05
Topcross	41	-62.74[ab]	83.46
Crossbred	45	128.34[b]	82.93
Straincross	43	52.79[ab]	84.85
Topcrossbred	29	116.43[b]	92.24
White Leghorn (M)	44	-230.13[a]	131.10
White Leghorn (B)	24	-109.53[ab]	119.84
Rhode Island Red	43	197.94[b]	132.98
Mean	374	1918.51	85.54
R^2		0.98	

- Effects not having a common letter are significantly different at five per cent level of probability.

E. PERFORMANCE EFFICIENCY :

The estimates of the performance efficiency index (PEI) for the various types of crosses and pure strains are given in Table VI. The intermediate values used in the computation of PEI are also given in Table VI.

These estimates of PEI, based on the average egg weight, average body weight, percentage of lay and the average daily feed consumption of the laying bird, range from 12.73 to 18.85. PEI has been calculated by the formula given by Morgan and Carlson (1967).

The wide variations in these estimates indicate the differences in the efficiency of performance amongst the individual groups.

The computation of the PEI by the formula devised by Morgan and Carlson (1967) incorporates the average egg weight, the average body weight and the per cent of lay of the bird in the numerator and the average feed consumed per day by the laying hen in the denominator. This is indicative of the fact that a bird becomes more and more efficient in performance as the numerator values increase without any significant increase in the denominator.

Table VI indicates that amongst the eight groups of laying birds, the Rhode Island Reds are having a lowest PEI of 12.73 and the topcrosses and straincrosses are having the highest PEI of the order of 18.85 and 18.19 respectively. The other groups that fall intermediate in merit are, topcrossbreds 17.79, crossbreds 16.98, incrossbreds 15.98, Mathura strain of White Leghorn 15.43 and Babugarh strain of White Leghorn 15.71.

After a study of Table VI it becomes clear that the topcross and the strain cross group of birds have proved to be of a higher performance efficiency than the other groups. It is also seen that the egg weight in most instances varied directly with the body weight. Both egg weight and body weight have relatively high heritability values. As such these factors might seem to be detrimental to selection by meansof PEI values. In reality selection for a high K value is selection for a negative correlation between egg weight and body weight.

However, the inclusion of an acceptable EW in the numerator of the formula guards against low PEI values for practical consideration. The final criterion, however, are the PEI values themselves.

A basic advantage of this formula used for the calculation of PEI over most others of the past is the use of the metric system of measures.

Present day determination of feed efficiency are basically of two kinds. The first is in terms of Kg. of feed required to produce a dozen eggs. The second is in terms of Kg. of feed required to produce one Kg. of eggs.

Egg weight in most instances varies directly with body weight. Both egg weight and body weight have high heritability values. Thus it will be clear as to the importance of incorporating the measures of egg weight and body weight in the formula for the estimation of PEI.

According to this method of calculating PEI there is a special advantage in an economic evaluation of the birds for deciding the future breeding policy for the production of high producing stock.

It can be concluded that in terms of net profitable returns for a given quantity of feed consumed, the topcrosses and the straincrosses have proved to be most efficient. It can further be said that the crossbred progeny obtained by crossing the

White Leghorn inbred male with noninbred W.L. females, and the progeny obtained by crossing the two divergent strains of W.L. (i.e. the W.L. Mathura strain and the W.L. Babugarh strain) have exhibited more heterosis than the other groups, which range next in merit of their performance.

Thus we see that PEI may be useful not only in terms of a selection programme for poultry breeders, but also in terms of a flock analysis programme to make valid comparisons between flocks or between individuals. A comparative study of the various PEI values for the different crosses and pure strains would enable us to get a clear picture into the nicking of the various crosses including incrossbreds.

TABLE VI. INTERMEDIATE AND ULTIMATE VALUES DERIVED IN THE CALCULATION OF RELATIVE PERFORMANCE EFFICIENCY FOR EIGHT GROUPS

Type of Birds	P	E.W.	B.W.	F	K	PEI
Incrossbreds	38.79	52.4	1807	110.60	0.8699	15.99
Topcrosses	41.84	53.8	1778	108.38	0.9077	18.85
Crossbreds	40.36	53.7	1963	104.92	0.8215	16.98
Straincrosses	44.08	52.9	1871	108.88	0.8490	18.19
Topcrossbreds	47.07	53.2	1970	114.40	0.8115	17.79
White Leghorn (Mathura strain)	34.52	51.3	1629	108.68	0.9460	15.43
White Leghorn (Babugarh strain)	40.28	49.8	1756	114.84	0.8514	15.71
Rhode Island Red	40.29	49.1	2105	108.74	0.6999	12.73

P = Per cent of lay. B.W. = Average body weight (gm.) $K = \frac{30 \times EW}{Av.BW.}$

PEI = Performance efficiency index. E.W. = Average egg weight (gm.).

F = Average feed consumed per day (gm.).

SUMMARY

CHAPTER - V

SUMMARY

The data used in this study were collected from the State Poultry Farm, attached to the U.P. College of Veterinary Science and Animal Husbandry, Mathura, during the period from August, 1969 to December, 1969. The purebreds, straincrosses, crossbreds, topcrosses and topcrossbreds were compared with respect to age at first egg, body weight at maturity, egg production and adult body weight by the least squares technique. The performance efficiency was also judged for all the groups of birds by means of an index which takes into consideration average egg weight, average body weight, per cent production and average feed consumption per day.

The primary interest of the study was to obtain a valid comparison between different types of crosses in purebreds, hence the hatch effect, a nongenetic source of variation was eliminated.

Age at first egg of the crossbred was

significantly higher in comparison to topcrosses, crossbreds and straincrosses, but there was no significant difference among themselves. Statistically there was no difference among the various types of crosses with respect to body weight at maturity. Egg production of the Mathura strain of White Leghorn was lowest and not significantly different from the production of Babugarh strain of White Leghorn and Rhode Island Red. Amongst the different types of crosses the egg production of the strain crosses was best, followed by the production of topcrosses and topcrossbreds. The adult body weight of the Rhode Island Red stock was highest amongst all the groups studied.

Amongst the 8 groups of laying birds, included in this study, the performance efficiency index of the Rhode Island Red was lowest (12.73).[22/23] The topcrosses and strain crosses had an index of 18.85 and 18.19 respectively. The other groups had the performance efficiency index inbetween (topcrossbreds, 17.79; crossbreds, 16.98; incrossbreds, 15.98; Mathura strain of White Leghorn, 15.43 and Babugarh strain of White Leghorn, 15.71).

On the basis of the above study it can be concluded that in terms of net profitable returns

for a given quantity of feed consumed, the topcrosses and the straincrosses have proved to be most efficient amongst all the groups studied.

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APPENDIX

Appendix - I.

	Total Hen Days	Total Eggs Produced	Per Cent Lay	Total Wt. of eg-gs(gm.)	Av. Wt. of eggs	Total Feed con-sumed(Kg)	Av. Feed Consumed /day	Adult Body Wt. (gm.)
Incrossbreds	29563	11468	38.7	601505	52.4	2368.8	110.6	1807
Topcross	6918	2895	41.8	156012	53.8	748.0	108.6	1778
Crossbred	7253	2928	40.3	157410	53.7	760.5	104.9	1963
Straincross	6948	3063	44.0	162215	52.9	756.3	108.8	1871
Topcrossbred	4784	2252	47.0	120025	53.2	547.3	114.4	1970
White Leghorn (M)	7905	2729	34.5	140210	51.3	857.8	108.6	1629
White Leghorn (B)	4563	1838	40.2	91620	49.8	520.0	114.8	1756
Rhode Island Red	7696	3101	40.2	152316	49.1	832.8	108.7	2105

Appendix - II

Relative Merits of Ranking of the Various Groups with Respect to the Traits Under Study

PEI		Age at Maturity		Weight at Maturity		Egg Production		Adult Weight	
T.C.	18.8	T.C.	188 days	C.B.	1515.9 gm.	S.C.	+8 eggs	R.I.R.	2116.4 gm.
S.C.	18.1	S.C.	190.7 "	T.C.B.	511.8 "	T.C.	+6 "	C.B.	2046.8 "
T.C.B.	17.7	C.B.	191.9 "	S.C.	1462.3 "	T.C.B.	+6 "	T.C.B.	2034.9
C.B.	16.9	I.C.B.	197.2 "	T.C.	1460.0 "	C.B.	+3	S.C.	1971.2
I.C.B.	15.9	T.C.B.	207.9 "	I.C.B.	1422.9 "	I.C.B.	+1	T.C.	1855.8
W.L.(B)	15.7		-		-	R.I.R.	-5	I.C.B.	1825.4
W.L.(M)	15.4		-		-	W.L.(B)	-7	W.L.(B)	1809.0
R.I.R.			-		-	W.L.(M)	-13	W.L.(M)	1688.4

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