EFFECT OF FLOOR SPACE AND BROODING SYSTEMS ON THE PERFORMANCE OF TURKEYS

By

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DEDICATED

TO

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HIS BIRTH CENTENARY YEAR

(1889-1940)

CERTIFICATE I

This is to certify that this dissertation entitled "Effect of floor space and brooding systems on the performance of turkeys" submitted for the degree of Ph.D., in the subject of Livestock Production and Management (Poultry Science) to the Haryana Agricultural University, is a bonafide research work carried out by Shri Jagbir Singh under my supervision and that no part of this dissertation has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

5.8.89.

(Dr.C.K.Aggarwal)
Major Advisor

CERTIFICATE II

This is to certify that the dissertation entitled "Effect of floor space and brooding systems on the performance of turkeys" submitted by Shri Jagbir Singh to the Haryana Agricultural University in partial fulfilment of the requirements for the degree of Ph.D., in the subject of Livestock Production and Management (Poultry Science) has been approved by the Student's Advisory Committee after an oral examination on the same, in collaboration with an External Examiner.

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Major Advisor

External Examiner

Head of the Department

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Dean, Post-Graduate Studies

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CONTENTS

LIST OF TABLES

Contd.......

Contd......

Contd.....

CHAPTER - I

INTRODUCTION

Turkeys are American birds and are generally kept for meat production because their egg production potentials is very low. The name 'turkey' was perhaps assigned because the head of these birds resembles the helmet of Turkish soldiers and one of the call notes of these birds is 'turk' 'turk'.

In olden days Khatiks in Mirzapur and Allahabad maintained Desi turkeys which had poor production. The University of Udaipur in the year 1960 imported large Broad-Breasted White turkeys from an Ohio turkey breeder. Turkeys were also being maintained at College of Agriculture, Ludhiana during the years 1960-64. This flock was later slaughtered and disposed of in 1966. The Haryana Agricultural University imported a Cannon strain of BeltSville Small White turkeys for the first time in 1972 and another strain of large turkeys was obtained from University of Udaipur in 1972. These birds were allowed to mate in all possible combinations which resulted in a synthetic population of turkeys consisting of crosses between these two varieties.

Assuming 1971-81 as growth rate of Christian population of India to prevail during 1981 to 1989, the estimated Christian population during 1989 is about 17.8 millions. They would like to have a turkey dish at least twice a year at Christmas and Thanks giving functions. In addition five star hotels, embassies and foreign tourists are other prospective buyers of turkey meat. Thus there appears to be a market for about 35 million turkeys per year, even if these are sold at a little higher rate than chickens. The turkey production can also fit in the Government plans of upliftment of poor farmers who can raise turkeys and sell it to elite population at higher profit.

Although, at present the turkeys do not feature to a great extent in the poultry map of India, yet the foregoing paras indicate that there is a possibility to boost commercial turkey production through suitable research and extension support.

Turkey offer a major challenge to research workers to create a break-through in poultry production. In India, the research workers have started taking interest to exploit the potentials for turkey meat production as a measure to diversify poultry farming. However, this diversified system of poultry farming is likely to be influenced by managemental practices. Researches are needed to quantify the management, housing, feeding, breeding and disease control programmes under Indian conditions. Although some information is available on these aspects on the basis of work carried out in foreign countries, yet the experience has shown that the practices recommended in many other countries have to be modified to meat Indian conditions. Lot of information like cost of production of turkey meat vis-a-vis the cost of production of broiler and other meats is required to compare the utility of turkey production in India.

A better understanding of physiological behaviour and managemental conditions affecting turkey production will go a long way in its development. Therefore, a need was felt to study the effect of floor space and brooding systems on production traits of turkeys. The present study was, therefore, undertaken with the following broad objectives:

1. To study the effect of different levels of floor space on egg production, egg size, shape index, fertility and hatchability of turkey eggs.
2. To study the relationship of egg size and shape index with hatchability and poult weight.
3. To study the effect of battery, infra-red and incandescent lamp brooding systems on growth, feed consumption and mortality in turkey poults.
4. To compare the cost of raising poults under three different brooding systems.

CHAPTER – II

REVIEW OF LITERATURE

Effect of floor space on egg production and egg weight

An understanding of physiological behaviour and managemental conditions affecting future production will go a long way in development of turkey industry in India. One of the objective of the study is to find the effect of floor space on production traits of turkeys.

The managemental studies on turkeys under Indian conditions have not been carried out even to a minimum desired extent. The scientists have neglected this field even in foreign countries and the review of literature shows that the managemental studies on turkeys have hardly been reported. Whether the managemental studies carried out on chickens can be applied to turkeys is not yet known. However, the review presented here includes similar work done on chickens for comparison and drawing some conclusions.

Bergi _et al_.(1968) reported that the high density pens (0.31 sq.m/hen) showed a greater yield of eggs, poults/pen and total income.

Well (1972) found that the use of high stocking densities during the rearing stage cause no impairment of the performance of layers kept in batteries, but was possibly responsible for a small decline in productivity of layers housed on deep litter.

Quart and Adams (1982) compared the effect of bird density on performance of commercial Single Comb White Leghorn strain. Birds housed 3 per cage produced more eggs with fewer body checks and cracks, tended to be less nervous, and had better feather cover than those housed 4 per cage ($P \angle 0.05$). In another experiment they compared the effect of bird density in cages and found that hens with 3 birds per cage laid at 5.4 % higher rate (HH) and produced 2.8 % fewer undergrade eggs than hens housed 4 per cage.

Roush et al.(1984) found quantitative relationship between the cage area allotted per hen and parameters associated with egg production by regression analysis in White Leghorn layers. Hens were placed with 516, 387 and 310 cm^2 of floor area per pen respectively. Egg production declined and egg weight increased as the area per hen was reduced.

Kryukene (1984) reported that the optimum stocking density was 4.5 birds per m^2 of floor area. The growth rate of birds at this stocking density exceeded that of birds at 6.5/m^2 by 7.47 and 7.33 per cent for males and females, respectively. Stocking density of females from 7-20 week of age affected their egg production to 60 week. The highest egg production was in birds that had been stocked at 4.5/m^2.

Carey (1987) claimed that a less rapid decline in egg production was noted among laying hens reared at the highest stocking density. Egg weight of birds reared at 222 cm^2 per bird was significantly greater than that of birds reared at 311 cm^2/bird.

Davami et al.(1987) observed that increased population size, reduced floor space and reduced floor area per hen resulted in a significant ($P < 0.01$) decline in per cent egg production. As the cage space allowance increased, feed consumption and weight gain were higher, whereas mortality, feed conversion and egg weight were lower.

Results of such studies were not available in turkeys.

Effect of egg weight and shape index on fertility and hatchability

Very large or very small eggs would have a different rate of drying down as compared with normal eggs because of difference in surface area. Such eggs required different conditions of ventilation and humidity to ensure good hatching. With increasing egg size significant change takes place in the chemical nature of the egg contents. The variation in the egg weight may be due to variation in the albumen contents of the egg. The greater quantity of albumen in the large sized eggs may require greater time for its assimilation by the developing embryo, reducing the possibility of their hatching (Limaye *et al.*,1983).

Funk (1937) reported that mean weight of 768 turkey eggs was 84.5 g with a standard deviation of 6.82 g. 68 % eggs were in the range from 77.68 to 91.32 g. Mean diameter was 48.6 mm with standard deviation 1.49 mm. Mean length was 66.6 mm with standard deviation 2.32 mm. Coefficient of variability of weight, diameter and length of turkey eggs indicated that diameter and length varied less than weight.

Sharma and Bora (1966) reported an inverse relationship between egg weight and hatchability in WLH. The rate of hatchability was highest in eggs with weight range of 50.1 to 60 g.

Kumar and Shingari (1969) in WLH eggs found a very low (statistically non significant) positive relationship between size and shape of egg with hatchability.

Briquet (1970) analysed data on 5277 eggs from Plymouth Rock x Cornish hens and found that hatchability averaged 79.72 per cent for fertile eggs weighing 50-55 g and 84.30, 86.17 and 79.76 per cent for eggs weighing 55-60, 60-65 and 65-70 g, respectively; the differences among the weight groups were significant.

Chung and Han (1970) analysed data on 12800 eggs laid by 2 year old White Leghorn and New Hampshire hens. Hatchability averaged 83.5, 88.0 and 75.5 per cent for eggs weighing 51-54, 55-58 and 59-62 g respectively and 81, 94 and 85 per cent for eggs with shape index of $<$ 0.7, 0.7 and $>$ 0.7 units, respectively.

Mendonca (1970) studied 1456 eggs weighing 51-55 g (group 1), 56-60 g (group 2) or 61-65 g (group 3) from 2 broiler strains, A and B. Egg fertility averaged 87.8, 89.3 and 88.1 per cent respectively in the 3 groups. There was no significant difference in fertility between the strains. Egg fertility was correlated with egg weight (0.56). Group 3 eggs had the highest hatchability (93.7 % of fertile eggs V 90.0 and 89.8 per cent respectively for groups 1 and 2).

Georgiev (1972) hatched 493 ♂ and 555 ♀ Hybro broilers from 1481 eggs weighing 66-70, 61-65, 56-60, 51-55 or 48-50 g. Egg weight was significantly correlated with hatchability 0.51 and fertility (0.68).

Agarwal _et al._(1973) observed that medium sized WLH eggs (52.5 $\pm$ 5 gm) had better hatchability (76.72 $\pm$ 1.95 %) whereas too small and too large eggs had poor hatchability. The phenotypic correlation between hatchability and egg weight was negative (-0.156) and statistically non-significant.

Tikk (1973) placed 1800 eggs of Moscow White turkeys in 3 groups based on their weight: $<$ 76 g, 76-90 g and $>$ 90 g. The percentage of eggs falling in the 3 groups were 16.4, 75.7 and 7.9 respectively. Hatchability of fertile eggs was 80.2, 82.6 and 67.8, respectively.

Basnet _et al._(1974) collected eggs from White Leghorn, White Rock, New Hampshire and White Cornish hens and found that eggs weighing $>$ 50 g had a significantly better hatchability than those weighing $<$ 50 g.

Cherms, and MacIlraith (1974) found that the turkey hatching eggs weighing 80-100 g had higher hatchability than those either above or below this range.

Cramer (1974) developed a line of medium White turkeys. One half of the population was selected for 7 generation for increased hatchability based on individual hen performance; the other half was randombred each year. Hatchability and fertility were consistently higher in the selected than in the non-selected group. Average egg weight decreased in both groups. No consistent significant correlations were found between hatchability and any of the traits measured.

Tsarenko (1974) estimated the egg shape index of 28425 eggs by a semi-automatic apparatus. For indices of 66-68, 69-71, 72-74, 75-77, 78-80 and 81-83 per cent, respectively, egg fertility was 89.5, 90.2, 90.2, 90.4, 89.2 and 82.4 per cent and hatchability of fertile eggs 87.7, 90.4, 91.7, 91.6, 91.2 and 89.5 per cent.

Bobyleva and Kurguzova (1976) found that in 152, 144 and 136 eggs weighing 47-49, 52-55 and 56-60 g respectively, egg fertility was 98.7, 99.3 and 97.1 per cent and hatchability of fertile eggs 86.0, 93.0 and 87.9 per cent.

Misra and Reddy (1976) studied 992 White Leghorn eggs divided into 3 groups according to weight (small, medium or large) and into 2 groups according to shape (oval or elongated). In these 5 groups, hatchability of eggs set was 61.18, 60.13, 57.5, 62.5 and 60.3 per cent, respectively; the differences were not significant.

Son and Sarda (1978) investigated 1500 White Leghorn eggs weighing 46.0 - 48.9, 49.05 - 51.9, 52.0 - 54.9, 55.0 - 57.9 or 58.0 - 60.9 g and found that egg weight significantly affected hatchability, which was highest (89.5 %) for the eggs of lowest weight.

Menge <u>et al</u>.(1979) reported that fertile turkey eggs weighing $>$ 100 g had a significantly lower hatchability than those weighing $<$ 100 g.

Goher <u>et al</u>.(1980) studied the fertility and hatchability of 2151 and 1597 duck eggs incubated and hatched during two successive years. For the 1st, 2nd and average of the 2 year respectively, fertility percentage averaged 83.33, 85.97 and 84.74. Fertility was significantly correlated with egg length (0.82), but not with egg width or shape index (egg width/length x 100). Hatchability was significantly correlated with egg index (0.87), but not with egg length or egg width.

Sharma and Vohra (1980) studied the relationship of egg weight and shape index with fertility and hatchability of Japanese quail eggs. The fertility of eggs did not depend upon either the egg weight or the shape index. The hatchability of fertile eggs, to some extent depended upon egg weight as well as shape index.

Ahmed et al.(1983) studied 1025 White Leghorn eggs stored for 10 days at an average temperature of 19.5^{o}C and RH of 80 per cent. Hatchability of fertile eggs was significantly higher for eggs weighing 50-52 g (78.05 %) than for those weighing 7/ 62 g (60.16 - 70.27 %).

Limaye et al.(1983) studied the influence of egg weight on fertility and hatchability in White Leghorn birds. For eggs weighing less than 49, 50-56 and more than 57 g respectively, egg fertility was 85.54, 84.98 and 78.66 per cent and the hatchability of fertile eggs 60.56, 55.83 and 43.47 per cent, respectively.

Narahari et al.(1983) studied the hatchability of duck eggs as influenced by egg weight. A total of 750 hatching eggs collected over a period of one week were divided into three weight group namely the egg weighing 60.5 - 69.5 g, those weighing 60 g and below and those weighing 70 g and above. The fertility and fertile hatchability were lower in small sized egg.

Among *et al.*(1984) studied the effect of egg weight on fertility and hatchability of White Leghorn hens eggs. Altogether 1327 hatching eggs were selected and grouped into three weight groups as small (44-46 g), medium (49-51) and large (54-56 g). There was significantly higher fertility in medium weight group followed by large and small weight groups. Significant highest mean hatchability was recorded in large weight group.

Costantini and Panella (1982) in 5100 Hubbard eggs incubated in 5 weekly collections and allotted to 5 weight groups found that egg weight had no significant effect on egg fertility and hatchability.

Prabakaran *et al.*(1984) studied the influence of egg size on hatchability. 952 eggs were collected from New Hampshire hens during May and June. The percentage of infertile eggs was 12.05 for large eggs (56-60 g) Vs 15.5 and 14.20 for medium (51-55 g) and small (46-50 g) eggs respectively. The hatchability of fertile eggs and of eggs set was 76.66 and 67.42 per cent respectively, for large eggs, 73.97 and 62.77 per cent for medium and 71.33 and 61.20 per cent for small eggs ($P < 0.05$).

Sergeeva (1986) carried out studies on large number of fowls, turkeys and duck eggs. For the 3 species, egg shape index averaged 73.5, 74.5 and 62.0. The correlation between egg hatchability and egg shape index was 0.09 to -0.29 for fowl eggs, 0.14 - 0.20 for turkey eggs and 0-15 - 0.26 for duck eggs.

Sergeeva and Moskvin (1986) studied the results of incubation of turkey eggs. Incubation of batches of eggs of similar weight resulted in eggs hatchability 79.7 % and percentage of viable poults 72.9 Vs 76.4 and 69.8 for batches containing eggs of different weights.

Badawy _et al._ (1987) studied Hubbard broiler breeder hens eggs in the 4 age groups, egg weight averaged 63.36, 60.75, 57.88 and 58.96 g respectively, fertility 90.17, 91.27, 91.0 and 91.34 per cent, hatchability of eggs set 80.47, 83.35, 82.28 and 79.01 per cent and hatchability of fertile eggs 89.25, 91.50, 90.20 and 86.50 per cent.

Bunaciu and Bunaciu (1986) studied 23936 WPR and 13927 WC eggs and found egg fertility 92.7 and 86.0 per cent, hatchability of fertile eggs 91.7 and 91.8 per cent and hatchability of eggs set 85.0 and 79.0 per cent.

Lasmini and Herijati (1984, Publ. 1985) reported the effect of fresh egg weight on hatchability and body weight of day old Alabio and Tegal ducks. The hatchability of eggs weighing 61.70 g fresh (53.33 %) was significantly higher than that of eggs weighing 50-60 g (35.00 %) or 71-80 g (42.08 %).

From the above review of literature it is difficult to arrive at any definite conclusion particularly in case of turkeys as to the best and medium size of the eggs that should be preferred over the others for getting higher hatchability. Similarly it is not possible to arrive at conclusions that gives the best shape index of turkey eggs.

However, the relationship between egg size, shape index, hatchability and chick weight does exist in nature.

<u>Relationship of egg weight and shape index with poult weight</u>

Egg weight is a factor that hatching industry has always taken carefully into account. In domestic birds the relationship between the weight of eggs and the weight of chick at hatching has interested the investigators since the early years of the present century. One of the first few reports was made by Halbersleben and Mussehl (1922) who indicated that egg weight and chick weight at hatching were highly correlated and that chick weight was about 64 % of the unincubated egg weight.

The degree to which growth rate of the young at a given growth period is influenced by the weight of the egg, is without doubt of great practical interest. However, the bulk of evidence in hand show that the initial close correlation between egg and hatching weight diminishes rapidly during post-hatching growth to a point where correlation are too low to be of significance.

Scott and Phillips (1936) in turkeys found that egg weight was highly correlated with day-old weight, but not with subsequent weight, except the 2 week weight of the males.

Sharma and Bora (1966) in White Leghorn found positive and highly significant correlations between chick and egg weight. Similar relationship was also reported by Rao (1970) and Gurung and Taylor (1981). However, Agarwal <u>et al</u>.(1973) reported higher values of correlation (0.982) between egg weight and chick weight at hatching. Kumar and Shingari (1969) reported lower estimates of correlation between these traits, the results being positive and significant.

Georgiev (1972) hatched 493 ♂ and 555 ♀ Hybro broilers from 1481 eggs divided into 5 weight categories weighing (66-70, 61-65, 56-60, 51-55 or 48-50 g). Correlation between day-old body weight and egg weight were highly significant (0.52-0.69 for ♂♂ and 0.58-0.79 for ♀♀).

Griem (1973) divided White Leghorn eggs into 10 groups on the basis of average egg weight (51.6, 52.5, 53.4, 54.7, 55.5, 56.5, 57.5, 58.3, 59.3 and 60.5 g) respectively. Chicks of relatively higher weights were obtained from eggs weighing 52-53 or 56-57 g at the beginning of incubation than from eggs of other weights.

The hatching weight of 225 chicks, hatched from eggs weighing on an average 50.88, 55.71, 60.00 and 65.67 g, respectively, averaged 35.90, 38.62, 43.00 and 46.50 g, the differences being significant (Bokhari and Sangiorgi, 1975).

Kumar _et al_.(1975) observed significantly high positive correlation between egg size and chick size in Desi as well as White Leghorn.

Misra and Reddy (1976) divided 992 White Leghorn eggs into 3 groups (small, medium or large) and into 2 groups according to shape (oval or elongated). Egg weight at incubation was significantly correlated with chick weight (0.57). About 3 % more ♂ than ♀ chicks were hatched from elongated than from oval eggs; the difference was not significant.

Son and Sarda (1978) investigated 1500 White Leghorn eggs and found that there was a correlation (0.98) between egg weight and chick weight.

Reddy et al.(1979) reported that egg weight was significantly correlated with duckling weight at 1 day of age (0.38) and with egg shape index (-0.20). In Japanese quails egg weight was correlated (0.79) with chick weight. (Sreenivasaiah et al.,1980).

Proudfoot and Hulan (1981) reared broiler chicks grown to slaughter age (48 days). The chicks hatched from smaller eggs (46-50 g) weighed less at 28 and 48 days than chicks hatched from the larger eggs (53-57 g). Mortality and feed conversion were not significantly ($P > 0.05$) affected by egg size.

Moran and Reinhart (1981) categorised the broiler turkey eggs into heavy, medium heavy, medium light and light. A sample of poults from each weight category were recombined in the same proportions as obtained from the egg population and grown in floor pens. Poult growth and feed efficiency through 14 weeks of age were unaffected by parent productivity. Body weight at placement was influenced by egg weight but this effect disappeared prior to marketing.

Narkhede et al.(1981) obtained crossbred chicks (WLH x RIR) in three hatches and found the existence of positive and highly significant correlations between eggs and chick weights.

Narahari *et al*.(1983) reported that hatch weight of ducklings were directly proportional to the corresponding egg weight.

Costantini and Panella (1982) reported that weight of chick at hatching increased from 35.2 to 45.3 g with increasing egg weight ($P < 0.01$) in Hubbard eggs. The correlation between two traits was 0.95. Hatch had no significant effect on chick weight at hatching. Hatching weight had a significant effect on daily gain, food conversion efficiency and mortality.

Shanawany (1984) reported that hatching weight was highly correlated with egg size at setting. Flock age had no effect on this relationship.

Wyatt *et al*.(1985) found that broilers from large eggs were significantly heavier and had greater livability upto 49 days of age than broilers from small eggs.

Sergeeva (1986) reported that poult weight was about 63 % of egg weight (60.4 % to 64.4 %) and correlation coefficient between the two traits was 0.93.

Tserveni-Gousi (1987) undertook studies on quails and found significant correlation between egg weight and chick weight ($R^2 = 0.32$) and age and chick weight ($R^2 = 0.86$).

Yannakopoulos and Tserveni-Gousi (1987) reported a strong linear relationship between egg weight, age and chick weight in commercial breeder hens.

From the above review it appears that there is a relationship between egg weight and day-old poult weight and this relation goes on decreasing with increase in age.

Although the results in chicken can be applied to turkeys also which are physiologically similar to chickens yet, direct studies on turkeys are required to draw valid conclusions. Relationship of shape index of eggs with poult weight and further growth has not been sufficiently studied and reported in the literature.

Effect of brooding systems

It is said that infrared energy warms the chicks without heating the air through which it passes. According to Bakers and Bywaters (1951) infrared energy after striking the litter is changed into sensible heat which helps to keep the chicks comfortable. It was further stated that over exposures may cause reddning of skin (hyperemia) which disappears after the subject is removed from exposure to infrared radiation. Some of the workers claim that labour cost and initial investment for small broods were low and operation was easy for these broods and chicks were visible at all times.

Bakers and Bywaters (1951) compared infrared brooding of chicks with hot water brooding. There was no significant difference in body weight (8 week) or rate of feathering but the mortality for infrared brooded group was lower than with other types of brooding.

Tomhave et al.(1951) reported that the cost of fuels used for brooding was highest for infrared bulb compared to oil, gas or coal brooding. Coal brooding had the lowest cost.

Francis et al.(1954) observed that infrared brooding resulted in marked increase in barebacks of chicks.

Marble and Jeffrey (1955) reported that more electricity is consumed by infrared lamps and this system of brooding is unsuitable when environmental temperature is below 40°F (in winter). It was further stated that cannibalism may be a serious problem due to the lack of darkened area and during electric interruptions this brooding system cannot be so efficient due to absence of any hover.

Wilson and Card (1956) reported that infrared brooding is used extensively in mild climates with a complete view of chicks at all times.

That the infrared lamp brooders are light in weight and easy to set, move and store was reported by Parnell (1957).

Winter and Funk (1960) reported that infrared brooding results in low initial cost, minimum labour and easy operation but provides insufficient heat in cold weather, has high cost of operation and electricity interruption problems.

The chicks are protected from floor draughts as heat is reflected on the backs of the chicks in infrared lamp brooding and the equipment is relatively cheap and simple (Wilson, 1961).

Thompson (1962) reported that infrared lamp brooder does not provide enough heat to brood too many chicks. Contrary to this Batty (1980) observed that chicks can be reared intensively by infrared lamps and the heat can be adjusted by raising or lowering the lamps.

McCluskey and Arscott (1967) compared the infrared heat lamps with white and red glass and incandescent lamp. Feed efficiency and growth did not differ statistically between infrared lamp with red or white glass. The incandescent lamp brooding resulted in higher growth rate and better feed efficiency compared to infrared lamp brooding. Both (infrared and incandescent lamp brooding) caused the chicks to develop abnormal (slant) eye condition. Average weight of eye was significantly more in birds brooded under infrared lamp with red glass compared to those reared under infrared lamp with white glass followed by those reared under incandescent lamp.

According to McArdle (1967) infrared rays have a beneficial effect on blood flow and disease resistance in chickens. He further observed that the chickens grow as faster as in battery brooder.

Marquand (1968) compared the infrared (cool air) brooder with lincoln (warm air) brooder and observed that both types of brooders performed well and required very little maintenance. The birds under infrared heaters could easily find their comfort zone, whereas lincoln brooder heated whole of the room which caused discomfort to the workers.

Aralov and Meljukov (1969) observed that the use of infrared lamps increased the environmental temperature and reduced the relative humidity in animal houses. Growth rate was increased and mortality was reduced, he added.

Griffin and Vardaman (1971) reported that the additional radiant heat energy provided by the infrared heat lamps to broiler chicks at market age resulted in a heat load on chicks and the chicks showed significantly lower weight gain and poorer feed conversion compared to untreated chicks. There was significantly heavy mortality.

Kostin and Sersunova (1968) found a higher survivability rate for chicks hatched from eggs subjected to infrared or ultraviolet irradiation. Similarly Sersunova (1968) observed an improvement in survival rate of chicks irradiated with different doses of infrared light with or without ultraviolet light upto 60 days of their age.

Lysenko (1970) observed that weight gain in White Cornish x White Plymouth Rock chicks to 70 days of age was lesser in birds brooded under infrared lamps compared to those reared under gas fixed infrared and normal electric heaters. The rate of survivability was in the order of gas fixed infrared heaters, infrared lamps and normal electric heaters.

Radhakrishnan (1976-77) claimed that infrared lamp brooding helps to decrease mortality (as it kills germs), results in better feed conversion, keeps the litter dry, increases growth rate and helps in easy inspection of the chicks without disturbances.

Singh (1976) used infrared ray lamps for raising broilers and observed higher feed consumption, better feed conversion ratio, lower mortality, better growth to market weight, overall less investment and higher returns. He found the system clean and easy to handle.

Portsmouth (1978) also reported that infrared brooders were cheap, without fumes or canopies, well ventilated, efficient to use and required almost no space. He further suggested that feed should not be placed under lamp rays while using gas infrared lamps.

Ramappa et al.(1978) reported that infrared lamp brooding is a simple, easy and less expensive method to raise birds. The differences between body weights of chicks brooded under infrared and incandescent lamp brooders were statistically non significant. Feed efficiency was hardly effected by infrared brooding. However, per cent mortality under infrared brooder was apparently lesser.

S.B.M. infrared heating Inc. U.S.A. (Anonymous, 1980) claimed in one of its advertisements that infrared brooders provide heat, just like the sun. Accordingly the birds and floor are well heated and the visibility of the stock is perfect. The company claimed that there was an energy saving upto 25.0 %, improvement in feed conversion upto 1.5 % and reduction in mortality upto 2.0 %.

Gasolec, Vlaardingen, Holland (Anonymous, 1981c) claimed that 750 to 3000 birds could be brooded by different types of infrared brooders run with the help of gas.

Peico Electronics & Elect.Ltd., Bombay, India (Anonymous, 1981b) claimed that infrared heating is economical, looses no energy while heating the chicks, causes no air draughts and hence creates no difficulty in providing good ventilation. It further claims that localised heating by infrared lamps allows the chicks to move freely between heated and unheated zones, provides light as well as heat, chicks are easy to inspect and build up early resistance to temperature variations.

Pruthi (1981) reported that the broilers brooded under infrared lamp brooding system were lighter in weight and showed poorer feed efficiency (6-10 week of age) compared to those brooded under incandescent lamp brooder. However, differences in mortality under two systems of brooding were non-significant. He stated that cost of rearing to 10 weeks of age was nine paise more for infrared compared to incandescent lamp brooding system.

Verma (1982) compared the performance of broilers under three systems of brooding (battery, infrared and incandescent lamp). He concluded that battery brooding was better compared to infrared and incandescent lamp brooding systems, during all the hatching months except summer, for growth, feed consumption, feed efficiency and per cent mortality in broilers. No appreciable differences were observed for 6 and 8 week body weight, shank length, feed consumption, feed efficiency and mortality in broilers raised under the two floor brooding systems.

A number of workers have reported that system of housing effects the performance of birds (Manfredini et al.,1967; Rao et al.,1968; Pho et al.,1971; Patrik,1974; Sirbu et al., 1976; Beremski,1979). Continued interest in growing broilers in cages may be attributed to several factors, such as the growing shortage of litter material in some areas, the greater bird density per unit of house volume, shortage of labour for catching finished broilers, reduced diseases and parasitic problems and less clean up time. Similarly a number of other systems of housing and brooding are prevalent.

Halama (1959) did not find a difference in 9 week body weight and mortality of broilers grown either on deep litter or wire floor but feed efficiency was found to be better for deep litter raised birds.

Reed et al.(1966) observed that in broilers, raised in wire cages, highest frequency of breast blisters is produced but the same may be reduced by covering the cage bottom with soft material like polyester urethane.

Higher weekly gains, better feed efficiency and lower dressing percentage was observed by Manfredini et al.(1967), for both light and heavy birds, raised in cages compared to those raised on floor.

Broiler chickens had significantly higher body weight gains, better dressing and eviscerated percentage, better feed efficiency and lower mortality in battery compared to the birds reared on floor (Rao et al.,1968; Iocjus and Stele,1968; Patrik,1974 and Sirbu et al.,1976).

Succi (1967) reported that battery reared broiler chickens performed better in body weight gain, feed efficiency and dressing percentage compared to floor reared birds. However, higher meat yield was observed for floor reared birds. Similar results except for no differences in dressing percentage of both groups were reported by Bosticco and Bonomi (1969).

Ragab et al.(1969), Toth et al.(1978) and Patil and Kulkarni (1979) observed that battery reared birds had higher growth rate and better feed conversion than the floor reared birds.

Pho et al.(1971) reported that battery reared broilers were heavier than floor reared birds. They further observed that these had better feed efficiency and higher eviscerated weight. The mortality between the two groups was similar.

Reece et al.(1971) and Andrews (1972) reported that caged broiler chickens had faster growth rate and poorer feed efficiency in winter compared to floor reared birds. Mortality was almost not affected by rearing system. Feed used per unit of gain for the cage reared birds was more in winter than in summer. Breast blisters were more in cage reared birds and accordingly higher down grading of carcasses was observed. On the contrary Welch et al.(1971) and Ghany et al.(1975-76) found that caged broilers were lighter in body weight and had poorer feed conversion compared to litter reared birds.

Aggarwal et al.(1972) reported better growth rate, improved feed efficiency and lesser mortality for battery reared White Leghorn chicks compared to deep litter reared chicks.

Caged birds had significantly faster growth rate than the floor reared birds (Andrews and Goodwin,1973; Volisovskii, 1975 and Abdou et al.,1979).

According to the observations of Seay et al.(1973) broilers reared in wire cages and on floor, showed higher incidence of breast blisters in cages and none on floor.

Andrews et al.(1974) observed higher growth rate, better feed efficiency and higher incidence of breast blisters and leg abnormalities in cage reared broilers compared to floor reared birds. Similar results for growth rate and feed efficiency were obtained by Helmy and Afifi (1972), Iotsyus and Sereikene (1973) and Nelson et al.(1974). Helmy and Afifi (1972) also reported higher dressing percentage and better meat quality for caged birds compared to floor reared birds. Contrary to this White Plymouth Rock broilers were found to be heavier when reared on littered floors compared to cage reared birds (Siegel et al.,1973 and Andrews,1978).

Andrews et al.(1975) and Bhargava et al.(1974) found no significant difference in the performance of caged and floor reared broilers but better feed conversion, in floor reared birds, was observed. The results of the former's study showed a slightly better survivability in caged birds.

Bezborodov and Konopleva (1974) and Tsonkov and Beremski (1974) observed heavier Cornish birds in cages with better survivability and feed conversion compared to floor reared birds.

Kumar et al.(1975) reported that commercial broiler chickens were heavier in floor pens between 2nd to 10th week of age compared to those reared in battery. A lower per cent mortality and significantly higher per cent eviscerated weight of carcass for floor reared birds was observed. There was no significant difference in feed efficiency among the two rearing systems. The net profit was found to be higher in floor reared birds compared to those kept in battery.

Broilers reared in cages had better daily gain, higher mortality and better feed efficiency compared to floor reared birds (Sushkevich, 1975). It was further observed that meat production/m^2 floor area was more in cages compared to floor.

Nekrashevich and Stesko (1975) found no difference in 8 week weights of Rock and Cornish chicks when raised in cages or floor.

Thaxton et al.(1978) brooded broiler chicks in cages and grown out on litter or on litter throughout the trials during warm to mild weather and extremely cold weather. They observed significantly better feed conversion ratio for cage brooded birds and greater final (56 days) body weights in floor reared birds, in all the trials.

Anderson et al.(1979) reported that weight gain and gain/feed ratio of the female turkeys raised in cages was of the same order as noted in commercial production in sheds.

Beremski (1979) reported non-significant differences in feed efficiency among the caged and deep litter reared broiler chickens. He further observed higher oven ready carcass weight and meat production/m^2 floor area in caged birds compared to floor reared birds.

Thaxton et al.(1980) reared broiler chicks in Petersime brooding batteries for three weeks and then reared these on floor pens for five additional weeks. The hatch mates of these birds were reared in floor pens during 0-8 weeks. The battery brooded birds exhibited lower final body weights and lower feed conversion ratios than the floor reared birds. Differences in mortality and physiological fitness were not found.

Mel'nik and Bisk (1980) compared the performance of broilers reared in cages from 1-61 days of age with those reared on floor from 1-15 days and in cages from 16-61 days. Body weight at 61 days averaged 1208 and 1277 g, mortality 18.2 and 7.6 per cent and food consumption per kg body weight gain 4.5 and 3.9 kg respectively.

Silva et al.(1979) reported that type of housing (cage vs floor) had no significant effect on 63 days body weight, feed conversion, incidence of breast blisters, or mortality in broilers.

Fort (1983) compared the performance of turkeys fattened in cages, on grid floors or on deep litter. The body weight of turkeys averaged 5.49, 5.41 and 5.40 kg respectively at 15 weeks of age. For females an average body weight of 4.20, 4.14 and 4.19 kg was recorded at the same age. No significant difference was observed in mortality.

Riad and Yamani (1984) in Iraq White turkeys reported that body weights at 12 weeks of age were significantly higher for birds reared on floor than those kept in cages. Food conversion ratio was better for floor reared birds.

Farr et al.(1986) reported that floor reared broilers were slightly heavier than cage reared birds at 45 and 50 days of age. No effect of housing system was detected on mortality.

Shpalex and Erk (1986) on the basis of discussion of work carried out in German Democratic Republic concluded that battery cages were more efficient than floor rearing for broiler production, in terms of feed consumption and labour, energy and floor space requirement.

Scientific reports comparing the performance of birds brooded in batteries or under infrared heat lamps have hardly been reported in the literature.

From the foregoing discussion it may be seen that the scientific reports regarding the performance of birds raised under infrared lamp and other systems of brooding are insufficient to arrive at a definite conclusion. No report was available that compared the performance of turkey poults under these brooding systems.

CHAPTER - III

MATERIAL AND METHODS

To study the effect of different levels of floor space and three different brooding systems on the performance of turkeys, a study was undertaken at the College of Animal Sciences, Haryana Agricultural University, Hisar. Four different experiments as detailed below were carried out.

1. Effect of floor space on egg production, egg size, shape index, fertility and hatchability of turkey eggs.
2. Effect of battery Vs incandescent lamp brooding system on growth, mortality and feed consumption of poults.
3. Effect of incandescent Vs infrared lamp brooding on growth, mortality and feed consumption of poults.
4. Effect of infrared Vs battery brooding on growth, mortality and feed consumption of poults.

To study the effect of floor space on the performance of birds (Experiment 1), a total of 177 (21 toms and 156 hens) were used. The adult turkeys of same genetic group and age were housed in different pens of same size located in the same building and were provided same ration. The birds were provided different amount of floor space (treatments) as detailed in Table 1 A. There were 3 treatments and 3 replications of each treatment. The number of birds used in each treatment is also given in Table 1 A.

The following observations were recorded during the period 20.1.88 to 3.4.88.

1. Daily egg production of birds from each pen.

Table 1. Plan of experimental work

A. Experiment-1

Treatment No.	Floor space/ bird $(cm)^2$	Male:Female ratio	No. of males	No. of females	No. of replications
1	3600	1:7.3	3	22	3
2	4500	1:7.5	2	15	3
3	5400	1:7.5	2	15	3
A total of 177 (21 toms and 156 hens) were used					

B. Experiment-2

System of brooding	Number of poults at the start
Battery	345
Incandescent	346
Total	691

C. Experiment-3

System of brooding	Number of poults at the start
Infra-red	261
Incandescent	261
Total	522

D. Experiment-4

System of brooding	Number of poults at the start
Battery	495
Infra-red	495
Total	990

2. Egg weight, egg length and egg breadth of all the eggs produced by birds assigned to different treatments.
3. The eggs of each hatch were properly marked, and set in a forced draft incubator after collection and storage for about 9-10 days. Four hatches were obtained and fertility and hatchability of eggs of each hatch and each treatment (amount of floor space) was recorded. After completion of hatch the day old poult weight was recorded and birds were wing banded for further study.

Performance of birds under different types of brooding systems

A 250 watt infrared bulb with aluminium reflector was used for infrared brooding. The lower face of the bulb was kept at a height of 15-18" from the litter depending upon the environmental temperature. The height of the bulb was adjusted and these were switched off and on, depending upon the need of the heat during day/night. A brooder guard was provided in the beginning and removed after a week. For incandescent lamp brooding ordinary bulbs were fitted in a wooden brooder of 90 x 75 cm size. Other managemental conditions were kept similar. During battery brooding two bulbs were fitted in each tier of a 3 tier battery of 1.90 x 0.75 Mt. size. The poults were reared in brooding battery upto four weeks of age and afterwards were kept on floor.

To compare the performance of birds raised under battery and incandescent lamp brooding systems (Experiment 2).

Table 2. Composition of ration (kg) fed to turkey poults at different ages

Ingredients	0-8 weeks	After 8 weeks
Maize (kg)	36	54.5
Groundnut cake(kg)	52	34.0
Fish meal (kg)	10	10.0
Mineral mixture[1] (kg)	2	1.5
Rovibe[2] (g)	25	-
Rovimix[3] (g)	30	25
Total (kg)	100.055	100.025
*Crude fibre (%)	5.88	4.77
*Crude protein (%)	28.39	22.81
*Metabolizable energy (K cal/kg)	3000.82	3151.88
*Protein:Energy	1:108	1:140

1. Mineral mixture: Contained 28 % Ca; 5 % P, 0.35 % Fe; 0.20 % Mn; 0.12 % Zn; 0.08 % Mg; 2.3 % NaCl; 0.010 % Cu; 0.005 % Co and 0.001 % I.

2. Rovibe : Contained 4 mg B_1; 8 mg B_6; 40 Mcg B_{12}; 6 mg Niacin; 40 mg Calcium pentothenate and 40 mg Vit.E.

3. Rovimix : Each gram contained 40,000 IU Vitamin A; 20 mg Vitamin B_2 and 5,000 IU Vitamin D_3.

*Calculated values

The birds hatched in four hatches were wing banded and randomly assigned to two different treatments (Table 1B). The birds were given similar managemental conditions and were fed similar ration (Table 2). The four hatches represented four replications. The following observations were recorded.

1. Body weight of individual birds at bi-weekly intervals during 0-12 weeks of age.
2. Feed consumption of poults of each hatch and each treatment separately during 0-2, 2-4, 4-6, 6-8, 8-10 and 10-12 weeks of age.
3. Daily mortality of individual birds.
4. Units of electricity consumed during brooding for each treatment of individual hatch.

To compare the performance of birds raised under infra-red and incandescent lamp brooding systems (Experiment 3), the birds were hatched in four hatches and assigned to two different treatments (Table 1C). The observations on body weight, feed consumption and mortality of poults were recorded as detailed in foregoing paras.

Similarly the 4th experiment (Table 1D) was carried out to study the differences in the performance of poults when raised under battery and infrared brooding systems.

From these observations, the following parameters were calculated for estimation of means standard errors and statistically significant differences between various treatments.

1. Egg production: The average egg production per bird per ten day period of each treatment and each hatch was

calculated and the same was used for further statistical analysis.

2. Per cent shape index was calculated for each individual egg by using the following formula:

$$\frac{\text{Breadth}}{\text{Length}} \times 100$$

3. Egg weight and day old poult weights were recorded for individual eggs upto the nearest gram.

4. Per cent fertility and hatchability were calculated for each treatment separately with in a hatch.

Means and standard errors were calculated and the data were subjected to least squares analysis of variance using the method of weighted squares of means (Harvey, 1966). For pair-wise comparison of means the critical difference test was applied. The data on all or none traits like mortality, fertility and hatchability were compared using X^2 test of goodness of fit.

CHAPTER - IV

RESULTS AND DISCUSSION

Turkey raising is a new enterprise and the fascilities in terms of availability of breeding stock or number of hatchable eggs is very limited. Therefore, the managemental experiments were carried out in different trials and at different parts of time. The first major objective of the present study was to know the effect of floor space on egg production, egg size, shape index, fertility and hatchability of turkey eggs.

The effect of three floor spaces per adult bird (3600, 4500 and 5400 cm^2/bird) were studied. Since the study of effect of these floor spaces on per cent fertility was one of the objectives, the male female ratio was kept constant for birds provided with different floor space. It was also kept in view that either 2 or 3 males are left in each pen because the fertility is also affected by pen and flock matings which result in preferential mating. However, the differences in fertility in samples of males used under various treatments had to be ignored as a part of experimental error. Since there were 3 replications in each treatment, it was possible, as presumed, that above error might be nullified.

The least squares means showing the effect of three different floor spaces on a few production parameters has been presented in Table 3. The analysis of variance was run (Table 4) and highly significant differences were observed between hatches for egg production, egg weight, per cent

Table 3. Least squares means and standard errors for number of eggs laid, egg weight (g), shape index (%) and day old poult weight (g) in turkeys reared on three different floor spaces

Floor space $(cm)^2$	No.of eggs per bird/ 10 day period	Egg weight (g)	Shape index (%)	Day old poult weight (g)
3600	3.50 ± 0.405^{a} (12)*	70.51 ± 0.147^{b} (927)	72.05 ± 0.111^{a} (920)	48.40 ± 0.190^{b} (526)
4500	4.00 ± 0.349^{a} (12)*	69.08 ± 0.170^{a} (698)	72.27 ± 0.128^{a} (689)	47.22 ± 0.247^{a} (309)
5400	3.97 ± 0.383^{a} (12)*	69.40 ± 0.168^{a} (707)	73.01 ± 0.127^{b} (699)	47.79 ± 0.229^{a} (359)

Within parentheses are number of observations.

*Based on the weighted average of a total of 2359 eggs laid by 156 birds in 4 hatches of 10 day interval each.

Figures in a column having common superscript do not differ significantly ($P \leq 0.05$)

Table 4. Means squares from analysis of variance showing the effect of floor space and hatch on the performance of turkeys provided 3 different floor spaces

Source of variation	Egg production		Egg weight		Shape index percentage		Day old poult weight	
	df	MS	df	MS	df	MS	df	MS
Between floor spaces	2	0.85	2	465.17**	2	200.40**	2	135.03**
Between hatches	3	6.43*	3	701.57**	3	12.59**	3	433.01**
Error	30	1.27	2320	20.06	2296	11.25	1182	18.89

*$p \leq 0.05$ **$p \leq 0.01$

shape index and day-old-poult weight. The effect of hatches on above parameters have been well documented in earlier literature(Narain _et al_.,1973; Bulbule _et al_.,1975; Chaudhuri _et al_.,1976 and Radke _et al_.,1983). Accordingly, the least squares analysis of variance was run in which the error and the main effect (between floor space) was obtained after necessary correction for hatch and hatch x treatment effects. The means presented in Table 3 are also independent of hatch effects.

The effect of floor space on number of eggs per bird was non significant. This suggests that a 3600 cm^2 of floor space is as good as 5400 cm^2. Effect of floor space on egg production and egg weight have not been sufficiently reported in the literature particularly for adult turkeys. Bergi _et al_. (1968) reported that in high density pens the yield of eggs was more. Well (1972), Quart and Adams (1982) and Carey(1987) reported that the egg production in chickens increased with increase in density. On the other hand, Roush _et al_.(1984), Kryukene (1984) and Davami (1987) observed a decline in per cent egg production with a reduction in floor area per hen. The amount of floor space for birds of various species can be decreased only to a limited extent which can be termed as optimum floor space. When the floor area is decreased more than optimum there is likelihood of poor production by birds. The floor space provided in chickens and turkeys in earlier studies were not the same and the environmental conditions under which these studies were carried out may be different than the present studies. As such the variation in results are expected and direct comparison of our study with earlier studies may not be very meaningful.

The egg weight for the turkeys provided 3600 cm^2 space in comparison to 4500 and 5400 cm^2 per bird was significantly higher by about 1.0 - 1.5 g. No significant difference was observed for egg weight between 4500 and 5400 cm^2 densities.

Conflicting reports on egg weight of chickens have been reported by earlier workers (Quart and Adams, 1982; Roush et al., 1984; Carey, 1987 and Davami et al., 1987). No comparable study on turkey was available.

From the above discussion it appeared that 3600 cm^2 floor space for adult turkey was optimum for egg production and egg weight. Further experimentation may be undertaken to find the possibility of reducing this further.

Shape index is a function of length and breadth of the eggs. The eggs having abnormal length or breadth have poor hatchability (Winter and Funk, 1960; Romanoff and Romanoff, 1963 and Nesheim et al., 1979). Therefore, the study of shape index is important particularly in turkeys where good fertility and hatchability is a problem. The birds provided 5400 cm^2 floor space had significantly higher per cent shape index (73) compared to 72 for 3600 and 4500 cm^2. Sharma(1986) did not find significant difference in per cent shape index of eggs of turkeys hatched in different hatches. He reported that shape index of eggs varied between 72 to 73. Our results were in close agreement with his findings.

The birds provided 3600 cm^2 could produce the day-old poults having about 1 g more weight than those provided 4500 and 5400 cm^2 which registered non significant difference amongst the later two. The poult weight is a function of egg weight which is indicated by the results presented in Table 3. This trait also favours the provision of 3600 cm^2 of floor space to adult turkeys.

The per cent fertility of adult turkeys provided different floor space is presented in Table 5. The birds provided 4500 cm^2 of floor space had significantly lower fertility than the birds of other two groups. The birds kept in higher density pens had the highest fertility in 2nd, 3rd and 4th hatches and the average per cent fertility over hatches. However, the differences were non significant on a statistical scale.

The per cent hatchability was calculated for total egg set as well as for the fertile eggs set. The results have been presented in Tables 6 and 7. Barring a few exceptions the per cent hatchability was highest for the birds provided minimum floor space in this experiment. The average per cent fertility of turkeys varied between 54.69 to 83.71; hatchability on total egg sett basis 33.33 to 63.80 and on fertile egg sett basis 50.52 to 84.48.

The results also suggest the provision of 3600 cm^2 of floor space per adult turkey.

Table 5. Average (%) fertility in turkeys provided different floor space in pens

Floor space per bird $(cm)^2$	Hatch No.				
	1	2	3	4	Pooled over hatches
3600	78.73^b	73.89^b	81.53^b	76.39^a	77.74^b
4500	67.66^a	54.69^a	62.05^a	67.05^b	62.62^a
5400	83.71^b	68.64^b	74.59^b	65.99^b	73.63^b

Figures in a column having common superscript do not differ significantly ($P \leq 0.05$) as tested by X^2 test.

Table 6. Average per cent hatchability (total egg basis) in turkeys provided different floor space in pens

Floor space $(cm)^2$	Hatch No.				
	1	2	3	4	Pooled over hatches
3600	63.80^{a}	54.42^{a}	61.85^{a}	50.00^{b}	57.68^{b}
4500	53.89^{a}	45.83^{a}	45.78^{a}	43.75^{ab}	47.22^{a}
5400	57.87^{a}	57.99^{a}	53.59^{a}	33.33^{a}	51.41^{ab}

Figures having common superscripts in a column do not differ significantly ($P \leq 0.05$) as tested by X^2 test

Table 7. *Average per cent hatchability (fertile egg basis) of eggs produced by turkeys given different floor spaces

Floor space per bird $(cm)^2$	Hatch No.				
	1	2	3	4	Pooled over hatches
3600	81.03	73.65	75.86	65.45	74.19
4500	79.65	83.81	73.79	65.25	75.40
5400	69.13	84.48	71.85	50.52	69.82

*The Chi square values indicated that differences in hatchability percentages were non-significant

Effect of systems of brooding

To study the effect of brooding systems (incandescent lamp, infrared lamp and battery), three different experiments were conducted. Because of small number of birds obtained in each hatch, the experiments were planned and conducted by taking two systems of brooding at a time.

The results obtained in the 2nd experiment have been presented in Tables 8 to 15. The performance of birds raised in battery and incandescent lamp brooding systems for body weight, feed consumption, feed efficiency and mortality was compared in this experiment.

The least squares means for body weights of turkey poults raised in these two brooding systems have been presented in Table 8 and the analysis of variance for this trait in Table 9. The effect of hatch as well as brooding system was found highly significant for body weights between 2 to 12 weeks of age. The performance of birds raised under incandescent lamp brooding was found better than those raised in battery brooders.

Although comparable reports on turkey have not been reported in the literature yet, the earlier reports on chickens are in favour of battery brooding in comparison to incandescent lamp rearing (Manfredini et al.,1967; Rao et al., 1968; Iocjus and Stele,1968; Patrik,1974; Sirbu et al.,1976; Succi,1967; Bosticco and Bonomi,1969; Ragab et al.,1969; Toth et al.,1978; Patil and Kulkarni,1979; Pho et al.,1971; Reece et al.,1971 and Andrews,1972). On the contrary Welch et al.(1971) and Ghany et al.(1975-76) reported that cage

Table 8. Least squares means and standard errors for body weights(g) of turkey poults raised in battery and incandescent brooding systems

Brooding systems	Age (weeks)					
	2	4	6	8	10	12
Battery	85.94±0.820 [a] (321)	189.62±2.413 [a] (296)	349.78±6.041 [a] (272)	636.20± 9.721 [a] (262)	951.62±14.478 [a] (258)	1279.79±19.849 [a] (257)
Incandescent	91.44±0.959 [b] (320)	200.81±3.242 [b] (234)	389.78±7.965 [b] (221)	686.06±12.749 [b] (214)	1037.07±19.049 [b] (209)	1435.63±26.070 [b] (209)

Figures in parentheses are number of observations.

Figures in a column having common superscript do not differ significantly ($P \leq 0.05$)

Table 9. Mean squares from analysis of variance to compare the difference in performance of turkeys raised in battery or incandescent light

Source of variation	Age (weeks)											
	2		4		6		8		10		12	
	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS
Between brooding systems	1	4315.71**	1	14630.06**	1	174578.02**	1	259615.98**	1	743639.72**	1	2471322.20**
Between hatches	3	5055.52**	3	78529.00**	3	150530.41**	3	422498.20**	3	319312.74**	3	1503844.30**
Error	633	249.03	522	1986.17	485	11420.78	468	28445.81	459	62047.39	458	116221.34

**Significant P $\leq$ 0.01

Table 10. Means and standard errors for feed consumption (g) of turkey poults raised in battery and incandescent brooding systems

Brooding systems	Feed consumption/bird/day during the age of(weeks)					
	0-2	2-4	4-6	6-8	8-10	10-12	0-12
Battery	9.59±0.39	21.09±1.20	30.52±3.63	43.70±2.40	60.67±1.81	71.79±1.96	37.42±0.71
Incandescent	9.61±0.39	19.61±1.20	31.57±3.63	41.39±2.40	57.65±1.81	67.32±1.96	34.64±0.71

Table 11. Mean squares from analysis of variance to compare the difference in feed consumption of turkeys raised in battery and incandescent light

Source of variation	df	Age (weeks)						
		2	4	6	8	10	12	0-12
Between brooding systems	1	0.008	4.381	2.194	6.589	18.210	39.962	15.429
Between hatches	3	0.517	20.655	38.906	44.060	208.612*	381.797*	31.620*
Error	3	0.611	5.763	52.721	23.107	13.040	15.441	2.010

*P $\leq$ 0.05

Table 12. Feed efficiency (g of feed consumed per g weight gain) in birds raised in battery and under incandescent lamp brooders

System of brooding	Feed efficiency*	
	0-8 weeks age	0-12 weeks age
Battery	2.42±0.120[a]	2.56±0.050[b]
Incandescent	2.09±0.120[a]	2.09±0.055[a]

*Mortality has been adjusted

Figures in a column having common superscript do not differ significantly ($P \leq 0.05$)

Table 13. Analysis of variance showing the effect of two brooding systems (Battery and Incandescent) on feed efficiency (0-8 and 0-12 week ages)

Source of variation	df	0-8 week age MS	0-12 week age MS
Between brooding systems	1	0.2048	0.4325**
Between hatches	3	0.1867	0.0211
Error	3	0.0579	0.0119

**Significant ($P \leq 0.01$)

Table 14. Average per cent survivability in turkey poults raised in battery (B) and under incandescent lamp brooders (I) during different periods

Hatch No.	Age (weeks)											
	0-2		2-4		4-6		6-8		8-10		10-12	
	B	I	B	I	B	I	B	I	B	I	B	I
1	90.0	87.5	91.7	100.0	90.9	94.3	<u>98.3</u>	<u>87.9</u>	96.6	100.0	100.0	100.0
	(0.085)		(3.090)		(0.358)		(4.574)		(1.006)		(0.00)	
2	92.3	90.6	<u>91.7</u>	<u>57.1</u>	91.8	90.1	96.0	100.0	<u>97.9</u>	<u>90.0</u>	100.0	100.0
	(0.198)		(32.763)		(0.034)		(1.630)		(4.262)		(0.00)	
3	92.6	91.3	<u>90.7</u>	<u>76.7</u>	89.7	96.4	95.1	98.1	98.3	100.0	100.0	100.0
	(0.048)		(5.302)		(1.904)		(0.802)		(0.922)		(0.00)	
4	96.3	97.7	<u>94.2</u>	<u>62.8</u>	93.8	98.1	95.6	100.0	100.0	100.0	98.9	100.0
	(0.348)		(28.738)		(1.474)		(2.396)		(0.00)		(0.612)	

The figures scored by a line differed significantly at $P \leq 0.05$. Figures in parentheses are X^2 values.

Table 15. Average cumulative per cent survivability in turkey poults raised in battery (B) and under incandescent lamp brooders (I) during different periods

Hatch No.	Age (weeks)											
	0-2		0-4		0-6		0-8		0-10		0-12	
	B	I	B	I	B	I	B	I	B	I	B	I
1	90.0	87.5	82.5	87.5	75.0	82.5	73.8	72.5	71.3	72.5	71.3	72.5
	(0.085)		(0.500)		(0.860)		(0.021)		(0.021)		(0.021)	
2	92.3	90.6	84.6	51.8	77.7	47.1	74.6	47.1	73.1	42.4	73.1	42.4
	(0.198)		(27.290)		(21.367)		(16.883)		(23.873)		(23.873)	
3	92.6	91.3	84.0	70.0	75.3	67.5	71.6	66.3	70.4	62.3	70.4	66.3
	(0.048)		(4.426)		(1.203)		(0.539)		(0.216)		(0.316)	
4	96.3	97.7	90.7	61.4	85.1	60.2	81.3	60.2	81.3	60.2	80.4	60.2
	(0.348)		(23.710)		(15.401)		(10.597)		(10.597)		(9.574)	

The figures scored by a line differed significantly ($P \leq 0.05$). Figures in parentheses are X^2 values.

broilers were lighter in body weight than those raised on litter.

Our practical experience shows that turkey poults are more susceptible to cold than chicks. On the basis of results obtained above it appeared that the control of temperature during cold weather in batteries may not be as full proof as on floor. The optimum environmental temperature is one of the major factor for proper growth.

The feed consumption of turkey poults raised under battery and incandescent lamp brooding system at bi-weekly intervals during 0 to 12 weeks of age have been presented in Table 10. No significant difference was observed in feed consumption on account of brooding systems (Table 11). The effect of hatch was significant only at 10 and 12 weeks of age. It was also significant on an overall basis.

Because of better growth of birds kept under incandescent lamp brooding and similar feed consumption, the feed efficiency was found better for birds raised under incandescent lamp system of brooding (Tables 12 and 13). The results are contrary to the findings of earlier workers who have worked with chickens.

The average per cent survivability in turkey poults belonging to the two groups of brooding systems under discussion have been presented in Tables 14 and 15. Significant differences were observed in mortality percentage during 2 to 4 weeks of age for the last three hatches out of four (Table 14). On a cumulative basis the survivability of birds differed for 2nd and 4th hatch. The results were not uniform so as to draw valid conclusions. On critical examination it is found that survivability was more in battery brooded birds than those raised under floor incandescent lamp brooding. These results are in agreements with those of earlier workers who have conducted studies on chickens (Rao et al.,1968; Iocjus and Stele,1968; Patrik, 1974; Sirbu et al.,1976; Aggarwal et al.,1972; Andrews et al., 1975; Bezborodov and Konopleva,1974 and Tsonkov and Beremski, 1974).

From the results of this experiment it was hard to definitely decide the superiority of one brooding system over the other. It can be said that proper temperature and good management in both the cases is likely to have similar performances. Since studies on turkeys on this aspect are lacking, it will be desirable to repeat the experiments in different seasons and under different climatic conditions.

The third experiment as a part of this study was carried out to study the effect of infrared and incandescent brooding systems on various traits.

The least squares means for body weights at bi-weekly intervals during 2 to 12 weeks of ages for the two treatments (brooding systems) have been presented in Table 16. At 2 weeks of age the effect of brooding system was significant (Table 17). The infrared brooding system produced heavier birds than those reared under incandescent lamp brooding system at 2 weeks of age. At 4, 6, 8 and 10 weeks of ages the effects of the two brooding systems were non-significant.

Table 16. Least squares means and standard errors for body weight(g) of turkey poults raised in infra-red and incandescent brooding systems

Brooding systems	Age (weeks)					
	2	4	6	8	10	12
Infra-red	$92.55^{b} \pm 1.051$ (242)	$175.79^{a} \pm 2.826$ (228)	$323.91^{a} \pm 5.540$ (222)	$505.22^{a} \pm 9.457$ (222)	$748.69^{a} \pm 14.795$ (216)	$931.46^{a} \pm 18:837$ (214)
Incandescent	$89.31^{a} \pm 1.200$ (242)	$176.90^{a} \pm 3.038$ (225)	$332.33^{a} \pm 5.954$ (222)	$527.51^{a} \pm 10.266$ (218)	$782.90^{a} \pm 16.221$ (209)	$1037.36^{b} \pm 20.725$ (206)

Figures in a column having common superscript do not differ significantly ($P \leq 0.05$)

Figures in parentheses are number of observations

Table 17. Mean squares from analysis of variance to compare the differences in performance of turkeys raised in infra-red and incandescent light

Source of variation	Age (weeks)											
	2		4		6		8		10		12	
	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS
Between brooding systems	1	2062.99**	1	131.93	1	7478.07	1	51993.16	1	188332.47	1	1119500.30**
Between hatches	3	26646.54**	3	5710.36*	3	111294.28**	3	69129.12*	3	512557.73**	3	1282404.20**
Error	476	271.22	445	1900.97	436	7303.49	432	21287.52	417	50783.29	412	81609.00

$*p \leqq 0.05$ $**p \leqq 0.01$

The trend of body weights for the two brooding systems was reversed in comparison to the body weights at 2 weeks of age. At 12 weeks of age the effect of brooding systems was significant. The birds reared under incandescent lamp brooders were heavier at all these ages. The results obtained agreed with the findings of McCluskey and Arscott (1967), Ramappa et al.(1978), Pruthi (1981) and Verma (1982). Most of these earlier works were carried out on chickens. This is perhaps the first study on turkeys. The hatch effects were significant all over on body weights of poults.

Feed consumption and feed efficiency for birds belonging to these two systems of brooding was also studied. The data was adjusted for mortality (Tables 18, 19, 20 and 21). The effect of brooding systems on feed consumption and feed efficiency was non-significant (Tables 19 and 21). However, the hatch effects had significant effect on these traits (Tables 19 and 21). The feed consumption was a little higher for the birds kept under incandescent brooding systems from 2 to 8 weeks of ages. The trend was reversed at 10 weeks of age and again showed a change in favour of incandescent lamp brooding system at 12 weeks of age. On an overall basis the feed consumption was a little higher for the incandescent group. The feed efficiency was better (2.52) for infrared group than the incandescent group (2.65) during 0-8 weeks of age. But, during 0-12 weeks of age the infrared group was found inferior in feed efficiency than the incandescent lamp group.

Table 18. Means and standard errors for feed consumption (g) of turkey poults raised under incandescent and infra-red brooding systems

Brooding systems	Feed consumptions/bird/day during the age of (weeks)						
	2	4	6	8	10	12	0-12
Incandescent	10.70±0.33	16.71±1.44	25.55±0.41	38.32±0.81	51.32±0.69	65.20±0.60	33.72±0.30
Infra-red	10.19±0.33	14.73±1.44	23.98±0.41	35.84±0.81	52.52±0.69	64.10±0.60	32.51±0.30

Table 19. Mean squares from analysis of variance to compare the differences in feed consumption of turkeys raised in incandescent and infra-red light

Source of variation	df	Age (weeks)						
		2	4	6	8	10	12	0-12
Between brooding systems	1	0.530	7.861	4.945	12.351	2.738	2.420	2.904
Between hatches	3	6.393*	10.153	45.640**	70.325**	18.181*	0.807	17.910**
Error	3	0.433	8.323	0.677	2.617	1.913	1.430	0.350

*$P \leqq 0.05$ **$P \leqq 0.01$

Table 20. Feed efficiency (g of feed consumed per g weight gain) in birds raised under infra-red and incandescent lamp brooders

System of brooding	Feed efficiency*	
	0-8 weeks	0-12 weeks
Infra-red	2.52±0.116	3.00±0.045
Incandescent	2.65±0.116	2.89±0.045

*Mortality has been adjusted

Table 21. Analysis of variance showing the effect of two brooding systems (infra-red and incandescent) on feed efficiency (0-8 and 0-12 week ages)

Source of variation	df	0-8 week MS	0-12 week MS
Between brooding systems	1	0.0338	0.0231
Between hatches	3	0.1191	0.2236*
Error	3	0.0536	0.0081

*$p \leq 0.05$

The average per cent survivability in turkey poults during different ages have been presented in Table 22. No significant difference in mortality was observed between these two treatments when tested by X^2-test. On a cumulative basis (Table 23) significant differences were obtained only for the birds of 2nd hatch whereas the birds hatched in 1st, 3rd and 4th hatches did not show significant differences. Comparable reports in turkeys were not available during review of literature.

Griffin and Vardaman (1971), Kostin and Sersunova (1968), Lysenko (1970), Singh (1976), Ramappa et al.(1978), Pruthi (1981) and Verma (1982) studied the effect of these two types of brooding systems on chicks and reported their findings for feed consumption, feed efficiency and mortality. The reports of these workers were contradictory. Therefore, it is hard to draw definite conclusion from the above study unless a few more trials are made on this aspect.

To compare the performance of turkey poults in battery or under infrared brooding systems, the 4th experiment was conducted. The birds were hatched in four hatches as usual and each hatch served as a replicate. The birds were weighed at bi-weekly intervals during 2 to 12 weeks of age. The average body weights between the birds of the two groups are presented in Table 24. No difference was observed in body weights of poults of the two brooding systems (Table 25). However, highly significant difference in hatches was observed at all ages. Verma (1982) found a significant preference of battery brooding over infrared brooding for growth in chickens.

Table 22. Average per cent survivability in turkey poults raised under infra-red (IR) and incandescent lamp (I) brooders during different periods

Hatch No.	Age (weeks)											
	0-2		2-4		4-6		6-8		8-10		10-12	
	IR	I	IR	I	IR	I	IR	I	IR	I	IR	I
1	93.6	94.7	91.4	94.4	98.1	100.0	100.0	100.0	98.1	97.1	100.0	100.0
	(0.059)		(0.303)		(0.649)		(0.00)		(0.094)		(0.00)	
2	92.0	89.9	<u>96.3</u>	<u>83.8</u>	97.4	98.5	100.0	97.0	96.4	93.8	98.6	98.3
	(0.227)		(6.944)		(0.214)		(2.305)		(0.366)		(0.017)	
3	92.3	93.8	91.7	96.7	95.5	96.6	100.0	98.2	100.0	98.2	100.0	100.0
	(0.112)		(1.437)		(0.096)		(1.135)		(1.155)		(0.00)	
4	92.3	96.1	100.0	100.0	100.0	100.0	100.0	98.0	95.8	93.9	97.8	95.7
	(2.122)		(0.00)		(0.00)		(0.970)		(0.190)		(0.845)	

The figures scored by a line differed significantly at $P \leq 0.05$.

Figures in parentheses are X^2 values.

Table 23. Average per cent cumulative survivability in turkey poults raised under infra-red (IR) and incandescent lamp (I) brooders during different periods

Hatch No.	Age (weeks)											
	0-2		0-4		0-6		0-8		0-10		0-12	
	IR	I	IR	I	IR	I	IR	I	IR	I	IR	I
1	93.6	94.7	85.5	89.5	83.9	89.5	83.9	89.5	82.3	89.5	82.3	89.5
	(0.059)		(0.332)		(0.614)		(0.614)		(0.368)		(0.368)	
2	92.0	89.9	88.5	76.3	86.2	74.2	86.2	71.9	82.8	67.4	81.6	66.3
	(0.227)		(5.122)		(4.009)		(5.416)		(5.523)		(5.347)	
3	92.3	93.8	84.6	80.6	80.8	87.5	80.8	85.9	80.3	84.4	80.8	84.4
	(0.112)		(1.147)		(1.173)		(0.669)		(0.315)		(0.315)	
4	92.3	96.1	92.3	96.1	92.3	96.1	92.3	94.2	88.4	88.4	86.5	84.6
	(2.122)		(2.122)		(2.122)		(0.513)		(0.00)		(0.078)	

The figures scored by a line below differed significantly at $P \leq 0.05$.
Figures in parentheses are X^2 values.

Table 24. Least squares means and standard errors for body weight(g) of turkey poults raised in battery and infra-red brooding systems

Brooding systems	Age (weeks)					
	2	4	6	8	10	12
Battery	92.85±0.798 (467)	201.80±2.557 (437)	377.63±5.123 (420)	682.62±8.617 (417)	1012.58±25.057 (412)	1349.44±17.074 (398)
Infra-red	92.88±0.848 (444)	203.58±2.804 (391)	384.06±5.587 (379)	677.55±8.648 (374)	1005.96±27.487 (368)	1349.20±18.631 (360)

Figures in parentheses are number of observations

Table 25. Mean squares from analysis of variance to compare the difference in performance of turkeys raised in battery or infra-red light

Source of variation	Age (weeks)											
	2		4		6		8		10		12	
	df	MS	df	MS	df	MS	df	MS	df	MS	df	MS
Between brooding systems	1	0.35	1	627.52	1	7829.33	1	6853.10	1	8043.01	1	1.44
Between hatches	3	12039.41**	3	118354.99**	3	457217.56**	3	843720.29**	3	1412245.20**	3	2716185.80**
Error	903	307.48	820	2955.44	791	11391.86	783	32001.60	772	267464.98	750	120105.00

$^{**}p \leq 0.01$

Other studies to make comparisons with ours were not available. Therefore, there is need to repeat the experiment in different seasons before adoption of the results in the field.

The feed consumption and feed efficiency along with analysis of variance have been tabulated in Tables 26 to 29. The differences in these traits were also non-significant. Feed consumption and feed efficiency are generally dependent on growth.

Table 30 presents the survivability of turkey poults of two groups. The differences in general were non-significant when tested by X^2-test. The per cent cumulative mortality (Table 31) varied significantly in 1st and 4th hatch but no general difference was observed in the 2nd and 3rd hatches. This may be the reason of hatch differences. It appeared that hatch had a greater influence on growth feed consumption and mortality in turkeys compared to brooding systems. Sharma (1986) has also reported that hatching season has significant effect on the performance of turkeys. Similar observation was found by Singh (1986). Turkeys are seasonal birds in the sense that demand for turkey meat is high during December and April. Therefore, a package of practices should be developed to popularize this enterprise.

On the basis of 2nd, 3rd and 4th experiment the cost of producing one kg weight of 12 week old turkey poults by raising them in batteries, infrared and incandescent lamps was calculated and has been presented in Table 32. The cost of raising birds in batteries vs incandescent lamp brooding was found to be Rs.16.59 and 16.88 respectively. When the

Table 26. Mean and standard errors for feed consumption (g) of turkey poults raised in infra-red and battery brooding systems

Brooding systems	Feed consumption/bird/day during the age of (weeks)						
	0-2	2-4	4-6	6-8	8-10	10-12	0-12
Infra-red	10.80±0.25	23.46±0.60	34.55±1.52	44.81±0.92	58.84±1.09	82.85±1.03	40.41±0.65
Battery	10.49±0.25	23.23±0.60	32.08±1.52	42.55±0.92	57.75±1.09	82.88±1.03	40.12±0.65

Table 27. Mean squares from analysis of variance to compare the difference in feed consumption of turkeys raised in infra-red and battery light

Source of variation	df	Age (weeks)						
		2	4	6	8	10	12	0-12
Between brooding systems	1	0.192	0.106	12.202	10.283	2.409	0.003	0.162
Between hatches	3	2.722*	79.436**	34.743	10.734	48.876*	16.207	31.986*
Error	3	0.246	1.461	9.282	3.394	4.755	4.222	1.667

*P $\leq$ 0.05 **P $\leq$ 0.01

Table 28. Feed efficiency (g of feed consumed per g weight gain) in birds raised in battery and under infra-red lamp brooders

System of brooding	Feed efficiency*	
	0-8 weeks age	0-12 weeks age
Battery	2.35±0.053	2.59±0.045
Infra-red	2.42±0.053	2.62±0.045

*Mortality has been adjusted.

Table 29. Analysis of variance showing the effect of two brooding systems battery vs infra-red on feed efficiency (0-8 week and 0-12 week ages)

Source of variation	df	0-8 week age MS	0-12 week age MS
Between brooding systems	1	0.0105	0.001
Between hatches	3	0.2392*	0.032
Error	3	0.0113	0.008

*P $\leq$ 0.05

Table 30. Average per cent survivability in turkey poults raised in battery (B) and under infra-red lamp brooders (IR) during different periods

Hatch No.	Age (weeks)											
	0-2		2-4		4-6		6-8		8-10		10-12	
	B	IR	B	IR	B	IR	B	IR	B	IR	B	IR
1	95.1	85.9	96.4	86.9	98.5	97.2	100.0	100.0	97.7	96.1	96.9	94.9
	(7.114)		(0.213)		(0.494)		(0.00)		(0.490)		(0.526)	
2	96.3	94.3	97.7	90.5	95.3	100.0	100.0	100.0	99.2	99.0	97.5	99.0
	(0.966)		(5.880)		(5.092)		(0.00)		(0.010)		(0.752)	
3	92.1	91.7	89.7	91.8	98.1	97.0	100.0	98.0	99.0	100.0	93.1	99.0
	(0.013)		(0.313)		(0.236)		(2.103)		(0.946)		(4.738)	
4	93.5	86.0	89.0	80.0	91.0	92.2	97.5	94.9	100.0	98.2	98.7	98.2
	(3.057)		(2.824)		(0.066)		(0.678)		(1.421)		(0.067)	

The figures scored by a line differed significantly ($P \leq 0.05$). Figures in parentheses are X^2 values.

Table 31. Average per cent cumulative survivability in turkey poults raised in battery (B) and under infra-red lamp brooders(IR) during different periods

Hatch No.	Age (weeks)											
	0-2		0-4		0-6		0-8		0-10		0-12	
	B	IR	B	IR	B	IR	B	IR	B	IR	B	IR
1	95.1	85.9	91.7	74.7	90.3	72.5	90.3	72.5	90.3	69.7	85.4	66.2
	(7.114)		(14.827)		(26.117)		(26.117)		(29.358)		(14.428)	
2	96.3	94.3	94.1	84.5	89.6	85.4	89.6	85.4	88.9	84.5	86.7	83.7
	(0.966)		(9.466)		(1.932)		(1.932)		(1.058)		(0.439)	
3	92.1	91.7	84.9	84.2	82.5	81.7	80.9	80.0	80.2	80.0	74.6	79.2
	(0.013)		(0.117)		(0.021)		(0.036)		(0.001)		(0.719)	
4	93.5	86.0	83.2	68.8	73.7	63.4	73.8	60.2	73.8	59.1	72.9	58.1
	(3.057)		(5.707)		(3.561)		(4.205)		(4.857)		(4.878)	

The figures scored by a line differed significantly ($P \leq 0.05$).

Figures in parentheses are X^2 values.

Table 32. Effect of three brooding systems on cost of production of a 12 week old poult

Hatch No.	Total cost	Cost/kg weight gain	Total cost	Cost/kg weight gain
<u>Experiment 2</u>				
	<u>Battery</u>		<u>Incandescent</u>	
1	21.71	16.37	22.25	14.49
2	20.63	15.78	31.33	21.69
3	21.58	18.13	19.90	14.87
4	17.63	16.08	20.17	16.45
Overall	20.39	16.59	23.41	16.88
<u>Experiment 3</u>				
	<u>Infra-red</u>		<u>Incandescent</u>	
1	17.25	16.37	16.76	14.59
2	16.55	19.47	17.57	18.42
3	16.81	18.99	15.30	15.70
4	16.85	22.88	15.45	17.76
Overall	16.87	19.43	16.27	16.62
<u>Experiment 4</u>				
	<u>Battery</u>		<u>Infra-red</u>	
1	18.11	13.85	21.55	14.98
2	19.05	13.46	19.29	13.34
3	20.62	15.67	18.94	15.55
4	19.62	16.79	22.52	20.38
Overall	19.35	14.94	20.58	16.06

incandescent lamp and infrared brooding was compared, the cost was Rs.16.62 and 19.43. Infrared brooded birds were costly by more than one rupee per kg weight gain compared to battery brooded birds.

The results based on 2nd, 3rd and 4th experiment lead to a conclusion that the effect of brooding systems on growth, feed consumption and mortality on turkey poults is not significant under optimum conditions. Some of the earlier workers have said that the effect of infrared brooding is better during mild weather. Therefore, to reach at a definite conclusion experiments should be repeated during different seasons.

The eggs produced during the conduct of experiment 1 were weighed and their shape index was calculated. These eggs were subjected to individual hatching and the weight of the poults hatched from individual eggs was recorded. The correlation coefficients of poult weight with egg weight and shape index were calculated. These have been presented in Table 33. The correlations were highly significant between egg and poult weight. Scott and Phillips (1936) in turkeys found that egg weight was highly correlated with day-old weight, but not with subsequent weight, except the 2 week weight of the males. Sergeeva (1986) reported that poult weight and egg weight had a correlation coefficient (0.93). Many other workers have reported relationship between egg weight and chick weight (Sharma and Bora, 1966; Rao, 1970; Gurung and Taylor, 1981; Agarwal et al., 1974; Kumar and Shingari, 1969; Georgiev, 1972; Kumar et al., 1975; Misra and

Table 33. Correlation coefficients (r) of poult weight with egg weight and shape index

Hatch No.	Egg weight			Shape index		
	Floor space per bird(sq.cm)			Floor space per bird (sq.cm)		
1	0.6292±0.066** (141)	0.4192±0.097** (90)	0.7166±0.074** (92)	-0.0093±0.085 (141)	-0.1500±0.105 (90)	-0.0468±0.105 (92)
2	0.6931±0.066** (123)	0.7051±0.076** (88)	0.5926±0.082** (98)	-0.1957±0.089* (123)	0.0875±0.107 (88)	0.0787±0.102 (98)
3	0.6920±0.059** (154)	0.6437±0.089** (76)	0.7161±0.072** (97)	-0.0209±0.081 (154)	-0.0868±0.116 (76)	-0.0334±0.103 (97)
4	0.3061±0.092** (108)	0.6451±0.109** (51)	0.7548±0.080** (69)	0.0884±0.097 (108)	0.0968±0.142 (51)	-0.0124±0.122 (69)
Overall	0.5750±0.036** (526)	0.5088±0.049** (305)	0.6813±0.039** (356)	-0.0386±0.044 (526)	-0.0059±0.057 (305)	-0.0211±0.053 (356)

Figures in parentheses are number of observations

$*p \leq 0.05$ $**p \leq 0.01$

Reddy, 1976; Son and Sarda, 1978; Narkhede et al., 1981; Costantini and Panella, 1982; Shanawany, 1984; Sergeeva, 1986; Tserveni-Gousi, 1987; and Yannakopoulos and Tserveni-Gousi, 1987).

The correlation coefficients between shape index and poult weight were non significant. Relationship of shape index with poult or chick weight of eggs has not been sufficiently reported in the literature. From Table 34 it can be seen that the number of abnormal sized eggs was very small. Naturally the number of eggs of different shape indices might also be small and the differences in correlations between shape index and poult weight could not reach statistical level.

The effect of size of the egg on per cent hatchability was also studied (Table 34). In this case the relationship was different in different hatches indicating a hatch x egg size interactions. If we plot the eggs on the basis of size to make normal distribution than it can be seen that the maximum number of eggs fall between 61-80 g. In nature the intermediates are preferred than the extremes. Therefore, the eggs of this size may be selected for hatching. Limaye et al. (1983) has also reported that very large or very small eggs have a different rate of drying down as compared to normal eggs and hence there is reduction in hatching percentage. Tikk (1973) reported that hatchability of very large eggs ($\gg$ 90 g) was lower than the other groups falling between 76-90 g. Cramer (1974) on the other hand, reported that consistent correlations could not be found between egg

Table 34. Per cent hatchability of eggs of different sizes in four different hatches

Hatch No.	Egg weight range	Total eggs	Fertile eggs	Poults hatched	Per cent hatch-ability
1	Below 60	39	34	28	82.35
	61-65	128	98	67	68.37
	66-70	226	172	135	78.49
	71-75	150	106	88	83.02
	76-80	19	9	5	55.56
	Above 80	1	-	-	-
2	Below 60	3	2	1	50.00
	61-65	98	63	48	76.19
	66-70	202	133	95	71.43
	71-75	233	155	137	88.39
	76-80	52	31	27	87.10
	Above 80	6	2	1	50.00
3	Below 60	6	3	3	100.00
	61-65	68	57	38	66.67
	66-70	232	168	132	78.57
	71-75	199	145	106	73.10
	76-80	89	59	45	76.27
	Above 80	8	3	3	100.00
4	Below 60	5	1	1	100.00
	61-65	80	56	32	57.14
	66-70	198	130	81	62.31
	71-75	190	137	86	62.77
	76-80	71	47	27	57.45
	Above 80	2	2	1	50.00

Table 35. Per cent hatchability of eggs of different shape indices in four different hatches

Hatch No.	Shape index range	Total eggs	Fertile eggs	Poults hatched	Per cent hatch-ability
1	Below 65	7	6	5	83.33
	66-70	113	81	65	80.25
	71-75	370	270	208	77.04
	Above 75	73	62	45	72.58
2	Below 65	6	5	5	100.00
	66-70	112	74	56	75.68
	71-75	426	276	225	81.52
	Above 75	50	31	23	74.19
3	Below 65	-	-	-	-
	66-70	116	84	60	71.43
	71-75	418	304	225	74.01
	Above 75	68	47	42	89.36
4	Below 65	4	2	2	100.00
	66-70	114	72	35	48.61
	71-75	357	241	156	64.73
	Above 75	71	58	35	60.34

weight and hatchability. Cherms and MacIlraith (1974) found that the turkey hatching eggs weighing 80-100 g had higher hatchability than those either above or below this range. Menge <u>et al</u>. (1979) reported that fertile turkey egg weighing $>$ 100 g had a significantly lower hatchability than those weighing $<$ 100 g.

Large number of studies of relationship of egg size with hatchability are available in chickens but the results cannot be directly applied to turkeys.

The per cent hatchability on eggs of different shape indices has been presented in Table 35. In the 1st, 2nd and 4th hatches shape index presented a negative relationship with per cent hatchability. The group having average shape index of 71-75 in the 2nd hatch and 66-70 per cent in the 4th hatch was an exception. The eggs with a shape index of $>$ 75 per cent had highest hatchability in the 3rd hatch. The data thus, indicated the presence of hatch x shape index interactions for hatchability. Tsarenko (1974) also studied the relationship of shape index with hatchability of fertile eggs and found that eggs between 69 to 80 per cent shape index had highest hatchability. From these results definite conclusion could not be drawn for this relationship.

C H A P T E R – V

SUMMARY AND CONCLUSIONS

To popularise turkey raising in India, a detailed study of managemental practices like amount of floor space that should be provided, the type of brooding system that should be adopted, best marketing age, dressing yield and quality of meat etc. need to be studied with respect to this species. The objectives of the present investigation were to find answer to some of such questions.

Four experiments were conducted to find the effect of floor space (3600, 4500 and 5400 cm^2/adult bird) and type of brooding systems on the performance of turkeys and turkey poults. The salient findings are given below:

1. The effect of floor space on number of eggs per bird was non significant suggesting that provision of 3600 cm^2 of floor space was as good as 4500 and 5400 cm^2 per bird.
2. The egg size of turkeys provided 3600 cm^2 floor space was higher than those provided with 4500 and 5400 cm^2 per bird with no significant difference amongst the later two.
3. The per cent shape index was significantly higher for the birds provided 5400 cm^2 of floor space, but the day-old poult weight was significantly higher for the group provided 3600 cm^2 of floor space per bird.
4. The birds kept in higher density pens had the highest fertility in three out of four hatches. This was also true for per cent fertility on overall hatch average.
5. Barring a few exceptions the per cent hatchability was highest for the birds provided minimum floor space.

6. On comparing the growth, feed consumption and mortality of birds raised in battery or incandescent lamp, it was found that the performance in terms of growth and feed efficiency of birds raised under incandescent lamp brooding was better than those raised in battery brooders. The results regarding mortality percentage were so variable within hatches that it was difficult to draw valid conclusions.

The brooding refers to control of environment (heat and over crowding) therefore it was suggested that the experiment should be conducted in different seasons and under different climatic conditions to draw valid conclusions.

7. The 3rd experiment aimed at the comparison of infra-red and incandescent brooding systems on various traits. The infra-red system produced heavier birds than those reared under incandescent lamp brooding systems at 2 weeks age but the reverse was true later on. Feed consumption and feed efficiency were not significant. However, the hatch effects were significant for growth, feed consumption and feed efficiency. No significant differences were observed in per cent mortality of poults of these two groups.

8. It appeared that hatch had a greater influence on growth, feed consumption and mortality than brooding systems.

9. During the conduct of 4th experiment, the performance of turkey poults raised under battery or infra-red brooding system were studied. No difference was observed in body weights, feed consumption and feed efficiency of poults

hatched during this study. The survivability of turkey poults was also studied and no significant difference was observed when tested by X^2 test.

10. The cost of producing one kg weight of 12 weeks old turkey poult was calculated. The cost was Rs.16.59 and 16.88 for battery and incandescent brooded birds; Rs.16.62 and 19.43 for incandescent and infra-red brooded birds; and Rs.14.94 and 16.06 for battery vs infra-red brooded birds, respectively.

11. The correlation between egg weight and poult weight were highly significant but the effect of shape index on poult weight was non significant.

12. The effect of size and shape index of the egg on per cent hatchability showed the existence of hatch x egg size interaction.

13. The maximum number of eggs laid by birds of different hatches ranged between 61-80 g.

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EFFECT OF FLOOR SPACE AND BROODING SYSTEMS ON THE PERFORMANCE OF TURKEYS

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To popularise turkey raising in India, a detailed study of managemental practices like amount of floor space that should be provided, the type of brooding system that should be adopted, best marketing age, dressing yield and quality of meat etc. need to be studied with respect to this species. The objectives of the present investigation were to find answer to some of such questions.

Four experiments were conducted to find the effect of floor space (3600, 4500 and 5400 cm^2/adult bird) and type of brooding systems on the performance of turkeys and turkey poults. The salient findings are given below:

1. The effect of floor space on number of eggs per bird was non significant suggesting that provision of 3600 cm^2 of floor space was as good as 4500 and 5400 cm^2 per bird.

2. The egg size of turkeys provided 3600 cm^2 floor space was higher than those provided with 4500 and 5400 cm^2 per bird with no significant difference amongst the later two.

3. The per cent shape index was significantly higher for the birds provided 5400 cm^2 of floor space, but the day-old poult weight was significantly higher for the group provided 3600 cm^2 of floor space per bird.

4. The birds kept in higher density pens had the highest fertility in three out of four hatches. This was also true for per cent fertility on overall hatch average.

5. Barring a few exceptions the per cent hatchability was highest for the birds provided minimum floor space.

6. On comparing the growth, feed consumption and mortality of birds raised in battery or incandescent lamp, it was found that the performance in terms of growth and feed efficiency of birds raised under incandescent lamp brooding was better than those raised in battery brooders. The results regarding mortality percentage were so variable within hatches that it was difficult to draw valid conclusions.

The brooding refers to control of environment (heat and over crowding) therefore it was suggested that the experiment should be conducted in different seasons and under different climatic conditions to draw valid conclusions.

7. The 3rd experiment aimed at the comparison of infra-red and incandescent brooding systems on various traits. The infra-red system produced heavier birds than those reared under incandescent lamp brooding systems at 2 weeks age but the reverse was true later on. Feed consumption and feed efficiency were not significant. However, the hatch effects were significant for growth, feed consumption and feed efficiency. No significant differences were observed in per cent mortality of poults of these two groups.

8. It appeared that hatch had a greater influence on growth, feed consumption and mortality than brooding systems.

9. During the conduct of 4th experiment, the performance of turkey poults raised under battery or infra-red brooding system were studied. No difference was observed in body weights, feed consumption and feed efficiency of poults hatched during this study. The survivability of turkey poults was also studied and no significant difference was observed when tested by X^2 test.

10. The cost of producing one kg weight of 12 weeks old turkey poult was calculated. The cost was Rs.16.59 and 16.88 for battery and incandescent brooded birds; Rs.16.62 and 19.43 for incandescent and infra-red brooded birds; and Rs.14.94 and 16.06 for battery vs infra-red brooded birds, respectively.

11. The correlation between egg weight and poult weight were highly significant but the effect of shape index on poult weight was non significant.

12. The effect of size and shape index of the egg on per cent hatchability showed the existence of hatch x egg size interaction.

13. The maximum number of eggs laid by birds of different hatches ranged between 61-80 g.