# COMPARATIVE STUDY ON THE PRODUCTION CHARACTERISTICS OF WHITE LEGHORNS IN CAGES AND ON LITTER

By

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## THESIS

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# DECLARATION

I hereby declare that this thesis entitled COMPARATIVE STUDY ON THE PRODUCTION CHARACTERISTICS OF WHITE LEGHORNS IN CAGES AND ON LITTER is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship, or other similar title, of any other University or Society.

Signature:

Name: T.N. Balachandran

Place: Mannuthy

Date: 29-7-1978.

CERTIFICATE

Certified that this thesis, entitled "COMPARATIVE STUDY ON THE PRODUCTION CHARACTERISTICS OF WHITE LEGHORNS IN CAGES AND ON LITTER" is a record of research work done independently by Sri.T.N.Balachandran under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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# INTRODUCTION

# INTRODUCTION

India ranks among the world's fifteen leading countries in egg production (Anon 1975). Though egg production in 1974 has improved to about 8000 millions as compared to 2000 millions twenty years ago, the current egg output is less than 10% of the minimum potential demand. India's per capita annual consumption of eggs is about 15 compared to 200 to 250 in many developed countries (Anon 1977).

As a means of solving problems of under-employment, unemployment, fighting malnutrition and attaining rural prosperity, poultry is making significant contribution. The efficiency of chicken to convert low fibre feed stuffs, industrial wastes and agricultural by-products which are unfit for human consumption into highly nutritive animal protein, is very high. Inspite of many limitations like non-availability and price escalation of feed ingredients, Indian poultry industry has become the most progressive and leading agri-business.

During the last few years, there has been a phenomenal change in the housing of poultry. Recently, poultrymen have started to think of raising chicken in cages replacing the

conventional deep litter houses not only for brooding of chicks but also for raising broilers, layers and even for breeding purposes. Rearing methods and housing during the laying period are vitally related to the cost of egg production. The development of individual cage system, with attempts at modification to lower housing costs have led to the use of colony cages for rearing of replacement pullets. The use of wire cages for housing laying birds has gained widespread favour in recent years. Many poultry farmers in our country have adopted the practice of keeping laying hens in wire cages. Laying batteries housing a few thousand layers under a single roof are not uncommon. Four bird cages set up in single rows or in two tiers or more are popular. These cages are installed in houses of simple structure. Many old farmers who were raising poultry on deep litter have converted the conventional houses into cage houses.

Mere novelty of the idea of the laying batteries has in most of the cases outweighed all other advantages generally attributed to laying cages. Lowered mortality among birds, simplicity of the structure required for keeping the

laying batteries, economy in labour, fewer management problems like cannibalism etc. are some of the plus points for taking up rearing of layers in cages. But it is well to remember that laying cages cannot be universal substitute for the conventional deep litter poultry houses. One of the interesting findings in the management of cage layers is that there are marked differences between strains of fowls in their adaptability to close confinement in laying batteries (Gowe 1955). Started pullets, which have been raised on deep litter till they are put to confinment in cages, will have to adjust themselves to the cages. At times some birds in cages develop the habit of wasting feed. Some birds may not eat normally when compared to hens raised on deep litter.

One of the advantages for encouraging poultry rearing on deep litter is the production of ready made manure. Organic manure in abundance is required for our country, deep litter manure is suitable for improving the mulch of the soil.

In places like big cities, where space is very scarce, laying batteries are provided under the intensive system. Laying battery is a collection of cages used for housing

laying hens. These cages are becoming popular because the problems of caked or wet litter and parasites associated with deep litter system can be eliminated. Also the birds can be housed more densely and labour needs are less. It is also highly sanitary.

In the united States of America the use of metal or plastic cages for laying hens has increased rapidly in recent years and about two-thirds of all layers are now so handled (Card and Nesheim, 1972).

The influence of any type of housing system in poultry rearing is largely governed by the micro-environment. In a country like India where the climatic conditions are widly varying from region to region, the adoption of a particular type of housing needs detailed study before implementation by farmers. This is especially important to the state of Kerala which has high rainfall and humidity.

A survey of literature indicates that very little work has been carried out to evaluate the comparative merits of raising poultry in cages and on litter floor in our country. It was therefore thought relevent to judge the two systems of housing viz. deep litter floor and cage in terms of economic productive characteristics under conditions prevailing in this region of the country.

REVIEW OF LITERATURE

## REVIEW OF LITERATURE

As early as 1950 Halnfox reported that white Leghorn pullets housed in individual cages were significantly superior in egg production to those housed in wire floor laying pens.

When the egg sale records, relating to birds reared under semi-intensive system and to those kept in cages were examined over two years, viz., 1949 and 1950, Wilson (1951) could observe that the average number of eggs sold per bird was higher under the cage system.

Gowe (1955) compared the egg production of seven White Leghorn strains housed in floor pens and laying cages. He reported that the mean egg yield for one strain was 56 eggs lower in the cages than on floor pens. While another strain laid 11 eggs more in the cage than on floor pens. The mean mortality rate among birds on floor pens was 24% and the corresponding figure for birds in cages was 19%.

Mohner (1955) in a study to assess the effect of keeping hens in batteries for egg production concluded that the younger hens were better able to adapt themselves to battery conditions.

Lowery et al.(1955) reported that caged birds had significantly lower mortality (5.9%) and laid heavier eggs than the floor birds. Miller (1956) reported more eggs, better feed efficiency and lower mortality among birds housed in individual cages as compared to conventional floor housing. Francis (1957) compared five strains of commercially available S.C.White Leghorns and two hybrids for their economic traits in individual cages for a six month period. The results indicated that pure strain of Leghorns appeared to show better adaptability to cages than hybrids.

Froning and Funk (1958) studied the seasonal variation in quality of eggs laid by caged layers and their sisters on the floor. He found that eggs laid by caged layers had a higher height of thick albumen than that of the floor birds. The haugh unit values of eggs were 73.0 among caged layers and 71.7 in the floor layers. However, caged layers produced eggs with 3.8% more blood and meat spots. Egg weight was found to be higher in caged layers than those on floor.

Bailey et al.(1959) compared the performance of layers in cages and floor housing over a period of 308 days of egg production. A total of 873 birds representing four egg production stocks were used in the experiment. They observed that egg production in cage housed birds was 1.3% higher

than those housed on the floor. Average egg weight and body weight of caged birds were significantly higher than those for floor housed birds. They also reported that cage housed birds required 0.146 lb less feed to produce a lb of eggs and 0.118 lb less feed to produce a dozen of eggs than did the floor housed birds.

Miller and Quisenberry (1959) reported that birds housed in cages usually laid at a higher rate, exhibited lower mortality and required less feed per unit of eggs than identical birds housed on the floor.

Shupe and Quisenberry (1960) observed that pullets reared in Colony cages had heavier body weight at the end of the rearing period than those reared in floor pens. They also found that laying birds housed in floor pens had significantly lower body weight and laid smaller eggs than birds housed in cages.

Pingel (1961) reported that growth and food conversion were better in cages than in intensive floor management. He also opined that some groups of cage reared pullets had better egg yields than the floor reared pullets.

Heilbarz and McDonald (1961) concluded that birds in cages were heavier and laid more eggs than birds on litter

based on an experiment with 600 pullets comprising of White Leghorns, Australorps and their reciprocal crosses.

Francis and Robertson (1963) in a study with pullets of three strains of White Leghorns housed in single cages or floor pens at random in equal numbers found that the birds housed in cages gained significantly more weight during the experimental period than the floor housed birds.

Johnson and Zindel (1963) observed that average body weight of caged birds was significantly more than that of floor birds and that eggs of caged birds had significantly thicker shells than those from floor birds.

Harms et al.(1965) concluded from two experiments with laying hens maintained in cages and indicated that high levels of phosphorus depressed their performance. They reported that caged hens would tolerate a higher level of phosphorus than birds maintained on the litter. It was postulated that this difference was due to the higher phosphorus requirement of caged hens.

Logan (1965) opined that floor birds attained smaller body weight, laid smaller eggs with lower blood spot score and consumed less feed per dozen of eggs. Caged birds had 7.0% lower mortality than did birds housed on the floor.

Nakazawa et al.(1965) in an experiment on the effect of cage versus floor rearing on performance of egg type pullets reported that growth rate was higher in cages than in the floor reared birds.

Auxilia and Mastrorillo (1965) conducted an experiment with 20 White Leghorns in cages, 20 White Leghorns on litter, 20 cross breds in cages and 20 cross breds on litter. They observed that the average egg production to 500 days of age were 193.04, 177.29, 190.45 and 169.02 respectively. The percentage of eggs weighing55 grammes were 78.83, 65.03, 46.13 and 44.62 respectively. Final body weight of hens were 2072.5, 1879.31, 2004.37 and 1997.5 grammes respectively. Food consumption in kg per egg produced were 0.24, 0.25, 0.22 and 0.27 respectively.

Nakazawa and Furnta (1965) studied the effect of cage versus floor rearing on the performance of egg type pullets. They reported that age at first egg was earlier and initial egg weight was greater in cage birds than floor birds.

Guerner and Tullor (1966) observed that pullets showed better growth rate and food conversion when kept in cages. Caged hens laid significantly heavier eggs and consumed significantly less food per day ie. 13-17 grammes less than birds on the floor.

Kolstad (1967) compared production characteristics of four groups of birds (2 groups of hybrid layers and 2 groups of Norwegian White Leghorns) in cages and on floor. He reported that in group I number of eggs, kg egg mass per hen, average egg weight and mortality average were 224, 13.4 kg, 59.8 g and 13.4% respectively for caged birds versus 193, 11.4 kg, 59.1 g and 22.3% respectively for hens on deep litter. In group II the averages were 217, 12.7 kg 58.5 g and 21.1% in cage versus 216, 12.5 kg, 57.9 g and 25.7% on litter. In group III the averages were 257, 15.6 kg 60.7 g and 4.3% in cage versus 192, 11.6 kg 60.4 g and 23.6% on litter. In group IV the averages were 230, 13.7 kg, 59.6 g and 3.6% in cages versus 198, 11.9 kg, 60.1 g and 10.4% on litter floor. He also observed that food units required per kg eggs were 3.1, 3.0, 2.9 and 3.0 respectively in the four groups of caged birds versus 3.7, 3.5, 3.8 and 3.9 respectively in the groups on deep litter.

Rao et al. (1968) in a study with 280 chicks, 140 in battery and 140 in floor treatment reported that battery reared chicks were heavier than the floor reared chicks from two weeks.

Wegner (1968) reported that hens in cages laid more and heavier eggs, had lower food consumption and better feed

conversion, higher mortality, slightly heavier body weight at the end of the laying season and fewer dirty eggs than hens on litter.

Iocjus and Stele (1968) observed that average live weight at 75 days of age was significantly greater and food conversion was more efficient for battery reared chicks than for those on deep litter.

Nazarenko (1969) conducted a comparative study of the management of laying hens in cages and on deep litter. He reported that temperature in summer tended to be slightly lower in cages than in deep litter houses. From August to January, egg production of 1508 birds in cages and 1591 birds on deep litter, averaged 51.4 and 66.8 per cent and egg weight 47.0 and 47.3 g respectively. Food consumption per 10 eggs laid was 15-16% lower in cages than on deep litter.

Rauch and Vogt (1969) studied the quality traits of eggs obtained from cages and deep litter pens and observed that there were no significant differences in respect of odour, taste, breaking strength and thickness of the shell, yolk index or albumen index.

Stappers (1969) in an experiment with hens housed in battery and litter during the rearing and laying periods observed that by 18th week of age battery reared hens were heavier than those on deep litter (1504 Vs 1544 g) and had lower mortality (1.7 Vs 2.3%). He also reported that eggs laid by hens in batteries were approximately 0.5 g heavier than those laid by hens on deep litter. The daily food requirement of battery hens was 5-10 g less than for those on deep litter.

Popescu (1971) opined that egg production was better in caged hens than in hens kept on litter. This was attributed to less ammonia and dust in the air and greatly reduced bacterial count. He also found that a properly ventilated poultry house which can accommodate 2000 hens on litter can be used to house 6000 hens in cages.

Pal et al.(1974) in a study with 120 White Leghorns observed that 100 day egg production was higher (51 eggs) for battery reared hens than the floor reared hens (49 eggs).

Aleandri and Olivetti (1974) conducted an experiment with 2 groups of birds. One group (A) of birds was reared in batteries and other group (B) on deep litter. They observed that the hen housed egg production averaged 243.6 and 246.5, egg weights were 60.93 and 62.65 g and food consumption per kg egg produced were 2.73 and 2.67 kg respectively.

Helmy and Afifi (1974) experimented with two groups of birds and from each group half was reared on the floor and the other half in batteries. They observed that live weight at 12 weeks of age averaged 977 and 1064 g and for the other group 1583 and 1709 g respectively for the two treatments.

Stockberg and Wegner (1974) analysed data pertaining to random samples of 80-100 eggs from 320 hens on floor pens and 240 hens in cages. They reported that weight of all eggs examined increased during the first laying year and that of caged hens increasing earlier and more rapidly than that of hens on litter.

Luke et al.(1974) analysed data for 30 groups, each containing 180 hens, involving both cage and floor testing. They indicated a significant superiority in laying performance of birds in cages compared to those on the floor.

Sharma (1974) in a study with 20 week-old 50 White Leghorn pullets kept on deep litter and 50 in cages for 15 weeks observed that kg of feed consumed per kg egg produced averaged 6.83 in litter versus 4.74 in cages. He also reported that there were no significant differences between the groups in hen-housed or hen-day egg production, egg

weight, yolk index, shell thickness or incidence of blood and meat spots. But birds on litter had a longer laying pause, a lower Haugh unit score and a higher yolk colour index than caged birds.

Thiyaga Sundaram (1974) reported that a significant housing difference within strain was evident for body weight, egg production, egg mass and egg weight. He also observed that performance efficiency index was better and feed consumption per pullet per day was less in the cage system when compared to the deep litter housing in both the strains tested.

Christmas et al.(1974) reported that floor birds had better viability and higher hen-day production but caged birds laid larger eggs and utilised feed more efficiently.

Roland et al.(1975) reported that the floor housed birds produced more eggs with better shells, consumed more feed and produced smaller eggs than the cage housed birds.

Oluyemi and Roberts (1975) compared the performance of Rhode Island Reds and White Plymouth Rocks in deep litter house and two types of cages. They observed that birds in cages produced significantly at heavier rates (59.1, 61.4%) and laid heavier eggs (53.9, 54.5 g) than those on deep litter whose percentage production and average egg size were respectively 55.8% and 51.0 g.

Dawan Sugandi et al.(1975) opined that egg production and feed conversion were significantly better in floor pens than in cages.

Kaparkaleis et al.(1975) conducted a study with 6873 fowls kept in cages and 5374 fowls on deep litter. They observed that egg production per head averaged 256.6 in cages 238.7 in floor; egg weight 62.0 and 60.2 g; percentage of dirty eggs 1.6 and 7.7; percentage of cracked eggs 1.0 and 2.9; fertility 84.6 and 82.3%; hatchability of fertile eggs 88.8 and 86.4% and average body weight 1850 and 1800 g respectively in cages and floor.

Scholtyssek (1975) analysed egg samples of nine types of Leghorn hybrids during the 10th month of lay. Half of the birds kept in cages and half on the floor but otherwise they were under identical management practices. He observed that there were only small differences in egg quality due to management. He also observed that shell characters were better in birds on the floor and albumen height and yolk index were better in caged birds.

Hagger (1975) analysing the results for the five laying seasons observed that battery hens were significantly superior to hens on floor in egg production, egg weight, food conversion, shell thickness and albumen quality.

Kotiah et al.(1975) compared the quality characters of eggs laid by 50 caged White Leghorn pullets with those from 50 pullets kept on litter. They found that caged birds produced significantly heavier eggs with thicker shells than birds on deep litter.

Samalo and Sathe (1976) compared the performance of laying hens kept on the floor and in cages. He opined that there was no significant difference between the groups in the percentage of shell cracks. The birds housed in cages tended to have lower egg production. However the difference was not significant.

Yeldan and Gurocak (1976) conducted a study for a period of over 160 days with 48 White Leghorns housed in floor pens and 48 in individual cages. He observed that the hen-housed production averaged 69.5 and 68.7%, egg weight 59.02 and 59.05 g, food consumption per kg egg laid 4.31 and 4.36 kg, and mortality 12.5 and 8.33% respectively for the two groups. However the differences were not significant.

In an analysis of the data for 30 groups of hens containing 180 birds that took part in the 1973/1974 Random sample test at the Eickelborn testing station which involved both cage and floor testing, Luke et al. (1976) indicated a significant superiority in performance of birds in cages compared to those on the floor.

Zuev and Maidanyuk (1976) in a study on the effectiveness of cage management of the parent flock observed that cage housing increased chick production by 10.8% compared to pen housing.

Tripathi et al.(1977) reported that caged birds laid more eggs, had heavier egg weight and lower mortality during the 120 days study.

Chand et al.(1977) conducted a study pertaining to the effect of housing condition on the gross components of eggs and egg quality indices in White Leghorns. They reported that the eggs from caged birds were significantly superior than those from floor birds with respect to yolk and albumen indices.

Konovalov (1977) conducted an experiment with two groups of White Leghorns housed in battery cages and a third group housed on deep litter. He observed that for the two experimental groups on cages and the control group respectively egg production in 475 days of lay were 223.5, 223.7 and 226.3 eggs; Egg weight at 360 days of age were 57.5, 57.3 and 57.8 g; Egg fertility 91.23, 86.30 and 88.92%, hatchability 90.4, 91.4 and 89.5% and chick survival to maturity 82.52, 78.89 and 79.59% respectively.

Chand and Razdan (1977) conducted an experiment with White Leghorns maintained under three different housing systems with floor areas 0.28$m^2$ and 0.14$m^2$ per bird (group 1 and 2) in floor pens, 0.14$m^2$ per bird (group 3) in laying cages. They reported that incidence of blood spots were 5.33, 12.50 and 6.67% in groups one, two and three respectively, which indicates that restriction of movement in cages did not appreciably affect the incidence of blood spot and/or meat spots.

MATERIALS AND METHODS

## MATERIALS AND METHODS

An experiment was conducted at the University Poultry Farm, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy for comparing the production characteristics of 180 single comb White Leghorn pullets maintained in cages and on litter floor. All birds belonged to a single hatch and strain. They were 156 days of age and had attained an average production of 19% at the commencement of the trial.

Ninety birds were housed in 23 californea colony cages with 4 birds in each cage except in one cage which contained only two birds. The cages were 60 cm x 45 cm x 40 cm size providing 675 $cm^2$ area per bird.

Ninety birds were housed in a single deep litter pen of 450 cm x 450 cm size providing 2250 $cm^2$ of floor area per bird.

The birds were wing badged, weighed individually and were distributed to the two housing systems (treatments) (Fig. 1 and Fig. 2). The allotment of birds to two treatment groups as well as different colony cages were made at random.

The birds under each treatment were housed in well ventilated and well lighted rooms. They were fed a standard layer ration throughout the period of experimentation. The composition of the ration is set out in Table 1. Feed was provided ad libitum. Routine management practices were followed till the completion of the experiment in both cage and floor.

The whole experiment period was divided into six, 28-day periods, thus birds were 324 days of age at the close of experiment.

Individual body weights were taken at the beginning of the experiment and at the end of each 28 day period, to study the pattern of body weight maintenance in the two treatments.

Daily egg production under the two treatment groups was recorded during the entire experimental period. From this data hen-day production was calculated for each 28 day period. Hen-day production was calculated by dividing the total number of eggs laid by the flock during the experimental period by the sum of the number of hens alive on each day of the period (hen-days).

Feed consumption per bird was recorded at the end of each 28 day period in caged birds and per flock for birds

on deep litter. Feed efficiency was calculated using the data on egg production and feed consumption (kg feed/doz. of eggs).

The layer house mortality during each period was recorded and expressed as percentages. During the last three consecutive days of each period twelve eggs from each treatment were saved at random every day for egg quality studies. They were marked and stored in a refrigerator for internal quality studies at the end of each period. Eggs from each group were individually weighed, broken out and the weight of albumen and yolk were recorded. From these data the percentage composition of the individual components was arrived at.

The economics of the two types of housing birds was worked out.

The data obtained were subjected to statistical analysis as per methods outlined by Snedecor and Cochran (1967).

Table 1. Composition of layer mash

| Ingredients | Parts/100 kg |
|---|---|
| Maize yellow | 20.00 |
| Groundnut cake | 15.00 |
| Gingelly oil cake | 5.00 |
| Rice polish | 20.00 |
| Damaged food grains | 25.75 |
| Unsalted dried fish | 10.00 |
| Common salt | 0.25 |
| Starmin P.S.* | 2.00 |
| Oyster shell meal | 2.00 |
| Rovimix A+B2+D3** | 25 g |
| Aurofac 2A *** | 125 g |
| Crude protein percentage (Analysed) | 17 |
| Metabolic energy value K.Cal/kg feed (calculated) | 2764 |

* Starmin P.S. (Shaw Wallace) The mineral mixture contained 28% Calcium, 7% phosphorus, 0.5% iron, 0.008% iodine, 0.013% Copper, 0.25% Manganese, 0.005% Cobalt, 17% sodium chloride, 0.25% fluorine, Zinc and Magnesium trace, Moisture 7.0

** Rovimix A+B2+D3 (Roche products India Ltd.) contained vitamins A, B2 and D3 at levels of 40,000 IU, 20 mg and 5000 I.U. per g respectively.

*** Aurofac 2A supplement (cyanamid India Ltd.) contained 8 g of 'aureomycin' chlortetracycline per kg.

EXPERIMENTAL BIRDS

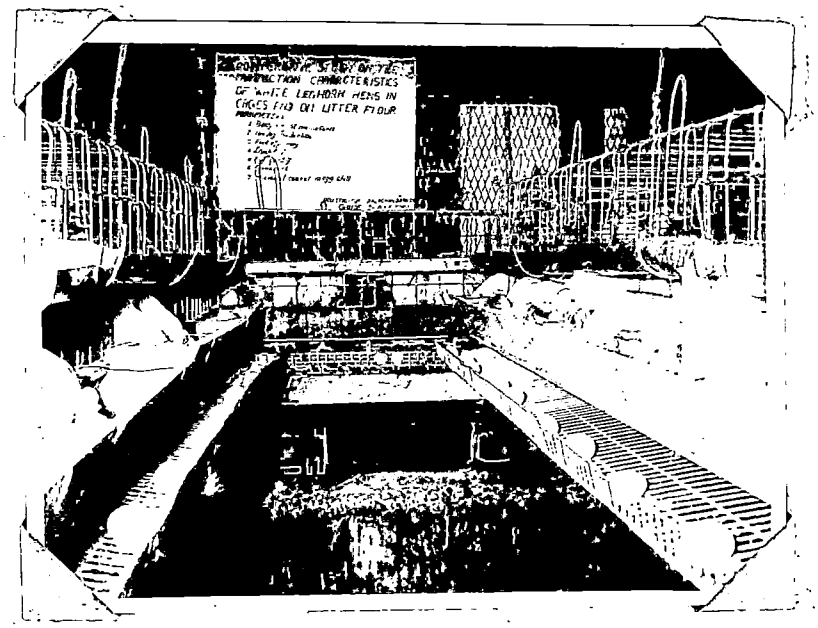

Fig. 1

Fig. 2

## RESULTS

### Egg production

The data pertaining to the per cent hen-day egg production of the birds in cages and floor and the chi-square value of the same are presented in Table 2. It can be seen that the mean hen-day production for floor and cage birds were 54.89% and 61.09% respectively. Statistical analysis of the data (Table 2) showed that the birds in cages had significantly higher percentage hen-day production than the floor birds ($P < 0.01$). It was also observed that birds in cages showed significantly higher hen-day egg production than the birds maintained on floor during all the periods except the 4th period.

### Feed consumption

The mean daily feed consumption periodwise as well as that computed based on the consumption during the entire period of experimentation in respect of birds under the two treatments are presented in Table 3. The data showed that mean daily feed consumption computed based on the entire experimental period was less (102 g) for the birds in cages than those raised on floor (109 g).

Statistical analysis of the data (Table 4) revealed that this difference was significant ($P < 0.01$).

The mean feed consumption data for the periods, irrespective of treatments, showed significant differences ($P < 0.05$) among periods which is a normal trend.

Feed efficiency

The data relating to feed efficiency for the six periods of the experiment are presented in Table 5 and the statistical analysis of the same are presented in Table 6. The mean feed efficiency for the birds in cages was 2.01 while the corresponding figure for the birds on floor was 2.38, indicating that the caged birds had better feed efficiency than the birds on floor. Statistical analysis of the data revealed that the difference in feed efficiency between the two treatments was significant ($P < 0.01$). It was also observed that there was a significant ($P < 0.01$) difference in feed efficiency (Table 6) among periods. The feed efficiency in the first period was significantly poorer in comparison to that in the rest of the periods. The periods second to the sixth were comparable as far as feed efficiency was concerned in both the treatments.

Body weight

Average body weight of birds in cages and on floor for the six periods are given in Table 7. Throughout the six periods the birds in the two treatments maintained the body weight at a satisfactory level. It was observed that the birds in cages maintained better body weight than those on floor. Pooled analysis of the data using students 't' test showed that the birds in cages had significantly ($P < 0.01$) higher body weight than the birds on floor.

When the data on body weight were analysed (Table 8) it was observed that during the first and second periods there was significantly higher body weight for birds in cages than those on floor. The differences observed during the third, fourth, fifth and sixth periods were not significant between treatments.

Egg weight

Average egg weight for the two treatments for the six periods are presented in Table 9. It can be seen from the table that the mean weights of eggs laid by birds in the cages and on floor were 50.25 and 49.81 g respectively.

On statistical analysis it was found that the difference was not significant (Table 13). The difference in egg weight observed among periods was statistically significant ($P < 0.01$). The lowest egg weights of 42.20 and 43.84 g for floor and cage birds respectively were recorded during the first period. Egg weight progressively increased upto the fifth period among floor birds then there was a decrease while in cage there was a gradual increase in egg weight from first to the sixth period. The maximum egg weight registered by the birds in cages was 54.55 g during the sixth period.

Internal Egg Quality

Mean values of weight of albumen, yolk and shell and their percentage contribution are set out in Table 10, 11 and 12.

The mean weight of albumen, for the birds reared on floor and in cages were 29.89 and 29.77 g respectively. Statistical analysis of the data on weight of albumen (Table 13) showed no significant difference due to treatment, but differences among periods were significant ($P < 0.01$). The lowest albumen weight was recorded during the first period. There was progressive increase in albumen weight upto 5th period in both the treatment groups except during the third period.

From table 11 it can be seen that the mean weight of yolk of eggs laid by birds on floor and in cages were 13.71 and 13.94 g respectively. Statistical analysis of the data on weight of yolk is presented in Table 13. It was revealed that there was no significant difference due to treatment. The yolk weight data showed a progressive increase in both the treatments during the periods from first to sixth. The differences among periods were significant ($P < 0.01$). The lowest yolk weight (11.02 g) was recorded in the first period and the highest yolk weight of 15.64 g during the 6th period.

From Table 12, it can be seen that the mean shell weight of eggs procured from birds on floor and in cages were 6.22 and 6.44 g respectively. Statistical analysis of the data are presented in Table 13. It was found that there was significant increase ($P < 0.05$) in shell weight in eggs laid by birds in cages. It was also observed that between periods there was a significant increase in shell weight. The lowest shell weight of 4.91 g in floor and 5.19 g in cages were observed during the first period and the highest shell weight (7.01 and 7.35 g) in the 6th period.

## Livability

The data pertaining to livability are tabulated in Table 14. During the course of the experimentation seven birds from floor and three birds from cage died. The deaths were due to oophoritis, peritonitis and internal laying. Statistical analysis of the data using Normal deviate test for proportion, indicated that the proportions of deaths in cage and floor were not significantly different.

## Economics

The economics were worked out based on the egg production and food consumption alone. The price of 7825 eggs from birds on floor and 9064 eggs from birds in cages were Rs 2378.75 and Rs 3172.40 respectively at the rate of Rs 35.00 per hundred eggs. The cost of 1550 kg feed consumed by birds on floor and 1520 kg feed by birds in cages during the experimental period were Rs 2015.00 and Rs 1976.00 respectively at the rate of Rs 1300/- per tonne of feed.

The net profit of Rs 723.75 from floor management and Rs 1196.40 from cage management shows that the cage system of rearing yielded Rs 472.65 more than the floor system of rearing.

Table 2. Per cent hen-day egg production for six periods

| Treatments | Periods 1 | 2 | 3 | 4 | 5 | 6 | Mean for treatment |
|---|---|---|---|---|---|---|---|
| FLOOR | 40.96[a] | 57.18[a] | 58.61[a] | 55.64[a] | 57.36[a] | 59.32[a] | 54.89[a] |
| CAGE | 43.89[b] | 71.18[b] | 66.00[b] | 54.36[b] | 61.96[b] | 63.50[b] | 61.09[b] |
| Chi-square value | 17.67** | 50.02** | 20.56** | 0.34 | 13.16** | 9.65** | 91.10** |

** Significant at $P < 0.01$

Figures carrying same superscript in a column did not differ significantly ($P < 0.01$)

Table 3. Mean daily feed consumption(g) in different periods as influenced by the housing system

| Treatments | Periods | | | | | | Mean for treatment |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| FLOOR | 108 | 102 | 111 | 102 | 111 | 117 | $109^{a}$ |
| CAGE | 104 | 97 | 106 | 95 | 104 | 107 | $102^{b}$ |
| Mean | $106^{a}$ | $95.5^{b}$ | $108.5^{ac}$ | $98.5^{b}$ | $107.5^{ac}$ | $112^{c}$ | |

C.D. 3.923 ($P < 0.05$)

Means carrying the same superscript in a row and in a column did not differ significantly ($P < 0.05$)

Table 4. Analysis of variance of data pertaining to feed consumption

| Source | d.f | SS | MSS | F |
|---|---|---|---|---|
| Treatments | 1 | 120.36 | 120.36 | 51.55** |
| Periods | 5 | 280.67 | 56.134 | 24.08** |
| Error | 5 | 11.66 | 2.33 | |
| Total | 11 | 412.67 | | |

** Significant at $P < 0.01$

Table 5. Feed efficiency (kg feed/dozen eggs) in different periods as influenced by the housing system

| Treatments | periods | | | | | | Mean for treatment |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| FLOOR | 3.17 | 2.14 | 2.27 | 2.19 | 2.31 | 2.35 | $2.38^{a}$ |
| CAGE | 2.56 | 1.64 | 1.93 | 2.09 | 2.01 | 2.02 | $2.01^{b}$ |
| Mean | $2.87^{a}$ | $1.89^{b}$ | $2.10^{b}$ | $2.14^{b}$ | $2.16^{b}$ | $2.19^{b}$ | |

C.D. 0.314 ($P < 0.05$)

Means carrying the same superscript in a column and in a row did not differ significantly ($P < 0.05$)

Table 6. Analysis of variance data pertaining to feed efficiency

| Source | d.f. | SS | MSS | F |
|---|---|---|---|---|
| Treatment | 1 | 0.403 | 0.403 | 26.867** |
| Periods | 5 | 0.103 | 0.221 | 14.733* |
| Error | 5 | 0.075 | 0.015 | |
| Total | 11 | 1.581 | | |

** Significant at P $<$ 0.01

Table 7. Body weight maintenance of pullets (g) as influenced by the housing system

| Treatment | Initial | Periods | | | | | | Mean for treatment |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | |
| FLOOR | 1202 | 1359 | 1354 | 1355 | 1428 | 1434 | 1495 | 1404[a] |
| CAGE | 1238 | 1417 | 1473 | 1345 | 1422 | 1482 | 1509 | 1461[b] |

t value = 4.707

Means carrying the same superscript in a column were not significant (P < 0.01)

Table 8. Analysis of variance of data pertaining to body weight for different periods in the two housing system

| Period | Source | d.f | SS | MSS | F |
|---|---|---|---|---|---|
| | Treatments | 1 | 183778.2 | 183778.2 | 4.48* |
| 1 | Error | 177 | 7268845.4 | 41066.92 | |
| | Total | 178 | 7452623.6 | | |
| | Treatments | 1 | 436326.79 | 436326.79 | 36.72** |
| 2 | Error | 171 | 2031548.65 | 11880.40 | |
| | Total | 178 | 2467875.44 | | |
| | Treatments | 1 | 24178.69 | 24178.69 | 2.29$^{ns}$ |
| 3 | Error | 168 | 1766611.60 | 10515.54 | |
| | Total | 169 | 1790790.29 | | |
| | Treatments | 1 | 15741.39 | 15741.39 | 1.06$^{ns}$ |
| 4 | Error | 168 | 2492101.67 | 14833.93 | |
| | Total | 169 | 2507843.06 | | |
| | Treatments | 1 | 38080.37 | 38080.37 | 2.55$^{ns}$ |
| 5 | Error | 167 | 2401735.01 | 114920.57 | |
| | Total | 168 | 2529816.38 | | |
| | Treatments | 1 | 976.90 | 976.90 | 0.04$^{ns}$ |
| 6 | Error | 167 | 3644488.38 | 21823.3 | |
| | Total | 168 | 3645365.28 | | |

* Significant at $P < 0.05$

** Significant at $P < 0.01$

ns Non significat

Table 9. Average egg weight (g) as influenced by the two systems of Housing in different periods

| Treatments | Periods | | | | | | Mean for treatment |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| FLOOR | 42.20 | 47.02 | 48.78 | 50.96 | 55.26 | 54.62 | 49.81[a] |
| CAGE | 43.84 | 48.65 | 48.75 | 51.72 | 53.96 | 54.55 | 50.25[a] |

Means carrying the same superscript in a column did not differ significantly ($P < 0.05$)

Table 10. Mean weight of albumen (g) and percent of albumen as influenced by the housing system

| Treatments | Periods | | | | | | | | | | | | Mean for treatment | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | | |
| | wt. | % | wt. | % | wt | % | wt. | % | wt. | % | wt. | % | Wt. | % |
| FLOOR | 26.23 | 62.15 | 29.15 | 61.98 | 28.65 | 59.35 | 30.17 | 59.25 | 33.15 | 60.28 | 31.93 | 58.56 | 29.88[a] | 59.99[a] |
| CAGE | 27227 | 62.21 | 29.02 | 59.66 | 28.40 | 59.43 | 30.23 | 58.92 | 32.55 | 60.40 | 31.13 | 57.21 | 29.77[a] | 59.25[a] |

Means carrying same superscript in a column were not significantly differe (P ∠ o.05)

Table 11. Mean weight of yolk (g) and percent of yolk as influenced by the two types of housing

| Treatments | Periods | | | | | | | | | | | | Mean for treatment | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | | |
| | wt. | % | wt. | % | wt. | % | wt. | % | wt. | % | wt. | % | wt. | % |
| FLOOR | 11.02 | 26.20 | 12.11 | 25.76 | 13.62 | 27.92 | 14.40 | 28.28 | 15.48 | 28.15 | 15.64 | 28.62 | 13.71[a] | 27.52 |
| CAGE | 11.38 | 25.95 | 13.08 | 26.89 | 13.80 | 28.28 | 14.54 | 28.02 | 14.84 | 27.54 | 15.99 | 29.32 | 13.94[a] | 27.74 |

Means carrying same superscript in a column were not significantly different ($P < 0.05$)

Table 12. Mean weight of shell (g) and per cent shell as influenced by the two types of housing

| Treatments | Period 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | Means for treatment | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | wt. | % | wt. | % | wt. | % | wt. | % | wt. | % | wt. | % | wt. | % |
| FLOOR | 4.91 | 11.65 | 5.76 | 12.26 | 6.21 | 12.73 | 6.42 | 12.47 | 6.36 | 11.57 | 7.01 | 12.82 | 6.22[a] | 12.49 |
| CAGE | 5.19 | 11.84 | 6.54 | 13.45 | 5.97 | 12.23 | 6.79 | 13.06 | 6.50 | 12.06 | 7.35 | 13.47 | 6.39[a] | 13.01 |

Means carrying same superscript in a column were not significantly different ($P < 0.05$)

Table 13. Analysis of variance for various egg quality traits studied.

| Factors | Source of variation | d.f | SS | MSS | F |
|---|---|---|---|---|---|
| Egg Weight | Treatments | 1 | 0.681 | 0.681 | 0.323$^{ns}$ |
| | Periods | 10 | 381.159 | 38.116 | 18.09** |
| | Error | 20 | 42.138 | 2.107 | |
| | Total | 31 | 423.978 | 40.904 | |
| Albumen weight | Treatments | 1 | 0.520 | 0.520 | 0.374$^{ns}$ |
| | Periods | 10 | 102.520 | 10.252 | 7.37** |
| | Error | 20 | 27.823 | 1.391 | |
| | Total | 31 | 140.343 | | |
| Yolk Weight | Treatments | 1 | 0.352 | 0.352 | 0.659$^{ns}$ |
| | Periods | 10 | 58.439 | 5.844 | 10.944** |
| | Error | 20 | 10.670 | 0.534 | |
| | Total | 31 | 69.461 | | |
| Shell Weight | Treatments | 1 | 0.612 | 0.612 | 6.511* |
| | Periods | 10 | 9.340 | 0.934 | 9.36** |
| | Error | 20 | 1.872 | 0.094 | |
| | Total | 31 | 11.924 | | |

* Significant ($P < 0.05$)

** Significant ($P < 0.01$)

ns Non significant

Table 14. Data pertaining to livability with two housing systems

| Type of housing | No. of birds died | No. of birds survived | Total | Percentage livability |
|---|---|---|---|---|
| FLOOR | 7 | 83 | 90 | 92.22[a] |
| CAGE | 3 | 87 | 90 | 96.66[a] |

Means carrying the same superscript in a column were not significantly different ($P < 0.05$)

Table 13. Analysis of variance for various egg quality traits studied.

| Factors | Source of variation | d.f | SS | MSS | F |
|---|---|---|---|---|---|
| Egg Weight | Treatments | 1 | 0.681 | 0.681 | 0.323$^{ns}$ |
| | Periods | 10 | 381.159 | 38.116 | 18.09** |
| | Error | 20 | 42.138 | 2.107 | |
| | Total | 31 | 423.978 | 40.904 | |
| Albumen weight | Treatments | 1 | 0.520 | 0.520 | 0.374$^{ns}$ |
| | Periods | 10 | 102.520 | 10.252 | 7.37** |
| | Error | 20 | 27.823 | 1.391 | |
| | Total | 31 | 140.343 | | |
| Yolk Weight | Treatments | 1 | 0.352 | 0.352 | 0.659$^{ns}$ |
| | Periods | 10 | 58.439 | 5.844 | 10.944** |
| | Error | 20 | 10.670 | 0.534 | |
| | Total | 31 | 69.461 | | |
| Shell Weight | Treatments | 1 | 0.612 | 0.612 | 6.511* |
| | Periods | 10 | 9.340 | 0.934 | 9.36** |
| | Error | 20 | 1.872 | 0.094 | |
| | Total | 31 | 11.924 | | |

* Significant ($P < 0.05$)

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| CAGE | 3 | 87 | 90 | 96.66[a] |

Means carryin; the same superscript in a column were not significantly different ($P < 0.05$)

Table 15. Comparison of performance in cages and on floor housing

| Housing | Average body weight (g) | Average egg weight (g) | Per cent production (Hen-day) | Kg feed/ dozen of eggs | Feed consumption per day (g) | Mortality percentage |
|---|---|---|---|---|---|---|
| FLOOR | 1404 | 49.81 | 54.89 | 2.38 | 109 | 7.77 |
| CAGE | 1461 | 50.25 | 61.09 | 2.01 | 102 | 3.33 |
| difference | 57** | 0.44 | 6.20** | 0.37** | 7** | 4.44 |

** significant at 0.01 level of probability

# DISCUSSION

# DISCUSSION

## Egg production

In the present study hen-day egg production was found to be significantly higher for birds in cages than those obtained from the birds on floor. This finding is in agreement with those of Palafox (1950), Bailey et al.(1959), Miller and Guisenberry (1959), Auxilia and Mastrorillo (1968), Popescu (1971) and Oluyemi and Roberts (1975). Hagger et al (1975) and Andrews (1977) also observed superior hen-day egg production for birds maintained in cages over those maintained on floor. However Nazarenko (1968), Dawan et al. (1975) and Bhagwat and Craig (1975) reported superior hen-day egg production for birds maintained on floor pens compared to those in colony cages. This difference might have been possibly due to the difference in strains employed in these studies. Interaction between strains and housing systems has been recorded by Gowe (1955) and Bhagwat and Craig (1975).

It could also be seen that the birds maintained in cages showed higher rate of production in all the periods except period 4, substantiating that the performance in respect of egg production of the birds maintained in cages is superior to those maintained on litter.

Feed consumption

The overall daily feed consumption of 109 and 102 g per bird for the birds maintained on floor and in cages respectively are within the normal range set for the birds of superior performance. The mean feed consumption per bird for the whole experimental period was found to be less in caged birds when compared to the birds on floor. The significantly lower feed consumption of birds maintained in cages over those maintained on floor recorded in this study indicates that it is economical to maintain birds in cages.

Lower feed consumption by laying birds maintained in cages has been reported by many workers, Bailey et al. (1959), Shupe and Quisenberry (1960), Auxilia and Mastrorilli (1965), Quarner and Tuller (1966), Nazarenko (1968), Stappers (1969) and Sharma (1974).

Feed efficiency

Significant difference in feed efficiency between the cage and floor systems of housing was observed. The mean feed efficiency of 2.38 and 2.01 recorded during the course of this investigation for birds maintained on floor and in cages respectively are within the normal range. The better feed efficiency registered in the cage system is essentially due to increased production and lowered feed consumption.

Similar observations in favour of birds maintained in cages have been reported by Bailey et al.(1959), Miller and Quisenberry (1959), Auxilia and Mastrorilla (1965), Stappers (1969), Dewan et al. (1975) and Hagger et al (1975).

Body weight

The body weight data of birds maintained in the two systems of housing showed that the birds maintained in cages were heavier than those maintained on floor. Gowe (1956), Bailey et al.(1959), Shupe and Quisenberry (1960), Auxilia and Mastrorillo (1965), Stappers (1969) and Keparkaleis et al. (1975) have observed higher body weights for cage housed birds than floor housed birds.

This difference in body weight in favour of birds in cages might be due to their lesser activity and better efficiency compared to those on floor. That the higher body weight was not due to additional fat deposition was ascertained by physical examination of the birds in the region of keel bone and abdomen during routine weighing.

Egg weight

Mean egg weights in cage management and floor management were 50.25 and 49.81 g respectively. The difference observed was not significant. The absence of any significant

difference in egg weight between the two treatments suggests that the housing systems as is employed in the present study do not influence this trait. The data in the present study are in accordance with the data presented by Kolstad (1967), Nazarenko (1968), Steppers (1969) and Aleandri and Olivetti (1974).

It is of interest to note that though the birds in cages had a significantly heavier body weight in comparison to those on floor, its effect was not fully reflected on the egg weight. The birds on both the systems were of the same age. Ewing (1963) has indicated that the egg weight is primarily controlled by the chronological age of the birds.

However, Bailey *et al* (1959), Oluyemi and Roberts (1975) and Hagger *et al* (1975) reported that the eggs of cage housed birds were significantly heavier than those from the floor housed birds.

Internal egg quality

The data relating to the various internal quality traits suggested that the system of housing had no significant effect on the albumen weight and yolk weight. Similar observations were reported by Guerner and Tuller (1966), Stockberg and Wegner (1974) and Schottyssek (1975).

However, the eggs procured from birds maintained in cages showed significantly better shell weight than those on the floor. Johnson and Zindel (1963), Hagger *et al* (1975) and Kotiah (1976) also reported that eggs from birds reared in cages showed significantly thicker shells than the birds on litter.

Livability

The absence of any significant difference in mortality pattern between the two housing systems indicated that the housing system employed had no influence on laying house livability. However the birds maintained in cages showed an apparently better livability than those housed on floor. Better livability for cage housed birds has been reported by Gowe (1955), Lowery *et al*.(1955), Miller and Quisenberry (1959), Logan (1965) and Stappers (1969).

Economics

The overall economics of the two systems of housing has been worked out and the results are in favour of housing birds in cages. The higher profit margin from birds maintained in cages is essentially due to lesser cost of feeding and an increased return from eggs when compared to birds on floor.

SUMMARY

## SUMMARY

The results of an experiment designed to study the effect of housing system (cage and floor) on the productive performance of White Leghorns is reported in this thesis.

One hundred and eighty S.C.White Leghorn pullets were assigned to two treatments (cage and floor) of ninety birds each at random.

The whole experimental period was divided into six 28 day periods for the purpose of recording the data.

Data on egg production, feed consumption, body weight, egg quality traits such as egg weight, weight of albumen, weight of yolk and weight of shell and its percentages were collected and analysed.

The overall performance of the birds in the two treatment groups is presented in Table 16. The following conclusions were drawn from this study.

1. Percent hen-day egg production of birds in cages was significantly ($P < 0.01$) more than the birds on the floor.

2. The feed consumption was significantly less ($P < 0.01$) in caged birds than those on the floor.

3. Birds in cages had significantly ($P < 0.01$) better feed efficiency.

4. Body weight of caged birds was significantly ($P < 0.01$) higher than that of the birds on the floor.

5. The mean egg weight was 0.44 g more in caged birds than the birds on the floor. This difference was not significant.

6. The quality of albumen and yolk was not affected by the housing system.

7. The percent shell was significantly ($P < 0.05$) better for eggs of caged birds than those of birds on floor.

8. The birds on floor showed 4% more mortality than the birds in cages. This difference was not significant.

On the basis of the results of this study it appears reasonable to surmise that housing layers in cages is superior to housing them on floor in respect of major economic productive traits.

Table 16. Overall performance of the birds in the two treatments

| Attributes | Floor | Cage |
|---|---|---|
| 1. Egg production (%)** (Hen-day basis) | 54.89 | 61.09 |
| 2. Feed consumption (g)** | 109 | 102 |
| 3. Feed efficiency** (kg feed/dozen eggs) | 2.38 | 2.01 |
| 4. Initial body weight (kg) | 1.202 | 1.238 |
| 5. Final body weight (kg)** | 1.404 | 1.461 |
| 6. Egg weight (g)$^{ns}$ | 49.81 | 50.25 |
| 7. Albumen (%)$^{ns}$ | 59.99 | 50.25 |
| 8. Yolk (%)$^{ns}$ | 27.52 | 27.74 |
| 9. Shell (%)* | 12.42 | 13.01 |
| 10. Mortality (%)$^{ns}$ | 7.77 | 3.33 |
| 11. Economics (profit based on the egg production & feed consumption) | Rs 723.75 | Rs 1196.50 |

ns Non significant
* Significant at 5% level
** Significant at 1% level

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# ABSTRACT

# COMPARATIVE STUDY ON THE PRODUCTION CHARACTERISTICS OF WHITE LEGHORNS IN CAGES AND ON LITTER

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ABSTRACT OF A THESIS

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## ABSTRACT

This thesis embodies the results of an investigation carried out to study the productive traits of White Leghorn hens under the two housing systems. Single comb White Leghorn pullets formed the experimental subjects and the systems of housing employed were cage and deep litter management.

The results revealed that rearing birds in cages significantly improved per cent hen-day production, body weight and feed efficiency. Feed consumption was more in floor reared birds. Birds in the two treatments maintained normal body weight, throughout the experimental period. The albumen and yolk quality showed no change attributable to treatments, but shell weight showed significant increase in the eggs from caged birds than on the floor. There was no significant difference in livability.

It was concluded that the cage system of management of layers could be employed as a means for better returns.