EFFECT OF HOUSING SYSTEMS ON PERFORMANCE OF BROILERS IN SUMMER

By

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "EFFECT OF HOUSING SYSTEMS ON PERFORMANCE OF BROILERS IN SUMMER" 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.

Mannuthy
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E. JOHN JACOB

CERTIFICATE

Certified that this thesis, entitled "EFFECT OF HOUSING SYSTEMS ON PERFORMANCE OF BROILERS IN SUMMER" is a record of research work done independently by Sri. E. JOHN JACOB under my guidence 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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Dedicated to My,

Parents, Kith and Kin

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E. JOHN JACOB

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

Introduction

INTRODUCTION

Poultry production in India has been making rapid strides during the past decades. Population of poultry which was 70 millions in 1951 rose to over 245 millions in 1988-89. Egg production in the country rose to 20,200 millions in the year 1989. Broiler production which was barely four millions in 1971 has risen to 168 millions in 1989. The gross value of poultry production has crossed Rs 2,561 crores in the year 1988. By the turn of the century, annual egg production in our country is likely to touch 30,300 millions; and broiler production by 400 million mark. The value of poultry products per year would touch Rs 35,000 million by 2000 AD (Anon., 1990). Thus, the Indian Poultry scenario is poised with spectacular changes.

Production and productivity of poultry depend on two major factors, namely the genotype and environment. In a climatically adverse environment, birds of good genotype, no matter how well fed, will not return maximum profit unless housed ideally. Among the environmental factors,micro-environment has more impact in India since it is designated as hot and humid. Therefore, housing of poultry assumes significance for better production. Further, one of the major capital costs in poultry enterprise is the cost of housing.

Broilers reared in conventional houses with open-sided walls and non-insulated roofing are exposed to high temperature and are subjected to heat stress due to radiation from roof, floor and surroundings. The house environment can rarely be maintained constant without elaborate control systems. Under ordinary housing, the inside environment vary within wide ranges of temperature limits. Other factors that contribute to environment are relative humidity and ventilation inside the poultry house. Extreme changes in these factors are experienced in all parts of our country. High temperature and relative humidity inside the houses during summer affect growth both at starting as well as at finishing stages. Therefore, it is necessary to investigate the effects of house environment in order to arrive at proper design and /or to suggest effective modifications in houses for obtaining economic returns.

Every part of the house, namely the roof, the walls, the overhang, the roofing materials and the openness of side walls etc. influence the micro-environment in the house. Among the commonly used roofing materials, Asbestos cement concerete (ACC) is more popular in broiler industry because of its desirable qualities like cheapness, rigidity and moisture resisting power. However, the poor heat-insulation capacity of ACC contributes the greatest disadvantage with this roofing material. The removal of excess heat from broiler house is a major bottleneck in hot-humid climate. Since the moisture given off by broilers through droppings is high, its removal becomes difficult in deep litter system especially in houses with dwarf side walls which prevent ventilation at the bird level. In order to overcome this situation, raised floors with wire, wood or plastic may be advantageous for rearing broilers.

Increasing the air movement inside the house in summer will be of some value to facilitate thermolysis. Forced ventilation of outisde air through the building will remove excess moisture, when outside humidity is lower than that of inside air, at same temperature. But if the relative humidity of outside and inside air is the same, no amount of air change will do good. In summer, the chances for heat stress will be high. The respiratory rate and volume of air breathed in by broilers will be higher during summer than those in other seasons. Therefore, supply of fresh air into the house in summer has to be necessarily increased mechanically for efficient production.

It has been proved that environmentally controlled poultry house is by far the best solution in providing optimum micro-environment for the best production. Nonetheless, in developing countries, acceptance of this concept in large scale will take a several years due to economic considerations. Therefore, it is essential that research efforts be directed for identifying methodologies that are comparatively cheaper for fair degree of productivity. It is in this direction that the present experiment was conceived with the following objectives:-

1. To quantamise the impact of deep litter and wire floor rearing systems on broiler performance.

2. To study the effects of two roofing materials in poultry houses viz., Asbestos cement concrete (ACC) and earthern tiles on broiler performance, and

3. To assess the effect of fanned environment in deep litter system under Asbestos cement concrete roofing on broiler performance.

Review of Literature

REVIEW OF LITERATURE

The literature pertaining to the impact of housing systems on the performance of broilers under various environmental conditions are reviewed in this chapter.

Growth

Seasons of the year have proved to influence the economic factors involved in broiler production (Hammond, 1950). Likewise, environmental factors such as temperature, humidity, ventilation and nutrition also influenced the post-hatching life of birds (Hafeez, 1955). Naidu (1959) reported that cold months of November to February were most suitable for growth of broilers in North India and June to September in South India.

Huston and Edwards (1961) in their study on the relationship between environmental temperature and body weight observed decrease in body weight with increase of ambient temperature. Roberts et al. (1961) studied the performance of broilers during different seasons viz., spring, summer, fall and winter and found that broilers reared on 900 sq. cm per bird performed well during all seasons except summer. In summer, a floor space of 1125 sq.cm per bird showed better performance.

Adams et al. (1962) reported that high environmental temperatures reduced growth and feed intake. However, they observed improvement in growth on increasing the energy levels of the ration. They opined that high temperature especially during the last week of brooding interfered with optimal growth of broilers.

Payne (1962) obtained an average live weight of 1.52 and 1.45 kg in broilers reared during winter and summer respectively. The average environmental temperatures in summer ranged from 18.3 to 21.1°C and were approximately -12°C higher than winter temperature. The author also reported that from two to six weeks of age, chicks reared at 21.7°C were significantly lighter than those reared at other temperatures of 12.8, 14.4 and 17.8°C. Osbaldiston and Sainsbury (1963) found faster growth rates in broilers reared at constant temperature of 21°C.

Huston (1965) stated that birds grown in an environmental temperature of 19°C were larger than comparable groups of birds reared in other environments of 8°C and 30°C. He opined that the ambient temperature was an important factor in influencing growth of young birds. Mickelberry et al. (1966) reported higher body weight in broilers reared at 21°C than those grown at 29°C.

Sainsbury (1966) observed the highest live weight gain in broilers reared at 21.1 to 23.9°C house temperature and poorer growth rates were noticed below and above this range. An air velocity ranging from 5.5 to 8 cfm at brooding period was reported by the author as satisfactory for growth of chicks.

Deaton et al. (1967) conducted two experiments in a climatic chamber and in an environmentally controlled unit. The housing density levels used were 929 and 650 sq. cm per bird. Results from both the experiments indicated that temperature regimes above 21.1°C reduced the body weight significantly especially during the later part of the growing period.

Parkhust (1967) stated that the temperature inside the house from 29.4°C to 35°C did not markedly affect growth response in broilers upto six weeks of age. At sixth week of age and beyond that,temperatures of 29.4°C and above adversly affected growth of broilers.

Deaton et al. (1968) tested the social and environmental aspects of rearing broilers and reported that broilers reared for five weeks in temperature regimes above 26.7°C showed significant reduction in body weight gain as compared to temperature regimes below 26.7°C. A significant density effect on body weight gain was also evident in broilers reared for five weeks at temperature below 21.2°C. With temperatures between 21.1 and 37.8°C, density effect on body weight gain was eliminated at five per cent levels when density levels of 650 and 929 sq.cm per bird, were compared.

Griffin et al. (1969) raised broiler chicks in a cyclic temperature environment between 4.4 to 15.6°C and on daily constant ambient temperature of 35.0, 32.2, 26.7, 21.1 and 15.6°C during weekly periods from first to fifth, respectively. The chicks grown in non-cyclic condition had the highest eighth week body weight and in cyclic temperature condition had the lowest body weights.

Deaton et al. (1970) investigated the effects of bird density on broiler performance in winter and summer conditions in an environmentally controlled house. The results indicated that a density of 279 sq.cm per bird significantly depressed body weight in both sexes during winter as well as in summer.

Griffin and Vardaman (1971a) conducted three experiments to study the effects of air temperature and relative humidity on broiler performance. In one experiment, the chicks were grown at the ambient temperature cycling between 22.2 and 34°C with a lower relative humidity of 42.0 $\pm$ 2.0 per cent subjected to additional radiant heat energy had shown significantly lower weight and feed conversion than the control groups reared without additional radiant heat load. In the second experiment, the daily cyclic temperature was 22.2° to 34°C with additional radiant heat and the relative humidity was higher (60 ± 2 per cent) than the first experiment. It was reported that the peak temperature caused greater adverse effect on body weight. In the third experiment, with a daily cyclic temperature between 24.2 and 37.2°C at a relative humidity of 35 ± 2 per cent, with additional radiant heat energy resulted in significantly lower weight gain than the control groups in the same temperature and humidity without additional heat load.

Griffin and Vardaman (1971b) in another study observed that the broiler chicks grown at an environmental temperature between 24.0 to 35.5°C showed an average body weight gain of 479 g during four to six weeks of age. At six to eight and four to eight week periods the values for body weight gains were 386 and 865 g respectively in mixed sex group of broilers. Male broiler chicks grown in wide cyclic (15.6°C to 35.5°C)temperature environments had shown a significantly higher body weight gain during the period from six to eight weeks of age indicating that lowering the minimum daily temperature improved the weight gian of male chicks that too during six to eight week periods only.

Reece and Deaton (1971a) conducted experiments to study the effects of evaporative cooling on performance of broilers in areas of high relative humidity and reported that the body weight of broilers were influenced by dry bulb temperature of the environment. In these studies, the wet bulb temperature was maintained constant at 23.3°C and dry bulb temperatures varied as 26.7, 29.4,32.2 and 35.5°C. The eighth week body weight at these temperatures averaged 1615, 1560, 1460 and 1344 g respectively, showing a decline in body weight with increase in dry bulb temperature.

Deaton et al. (1972) observed that rearing commercial broilers from four to eight weeks of age under a constant temperature of 23.9°C increased eight week male body weight by 170 g and female body weight by 111 g when compared to those reared in a cyclic diurnal temperature environment varying from 23.9 to 35°C. Broilers reared in a constant ambient temperature of 29.4°C responded to body weight and feed utilization similar to those under a diurnaly varying temperature of 23.9 to 35°C.

Kubena et al. (1972) conducted an experiment to study the sex-wise performance of broilers during high ambient temperature and found that at higher temperatures body weights were reduced both in males and females.

Reece et al. (1976) studied the effect of roof insulation on the growth rate of broiler chicks under high temperature condition. They reported that body weight of chicks grown at ambient air temperature ranging from 24 to 35°C with and without additional radiation were ranged from 1858 to 1828 g respectively. Environmental chambers were used for the above study to simulate the infra red radiation from a solar heated roof of an insulated poultry house in summer. The results of their study also indicated that the body weight was adversely affected in broilers with diurnal temperature of 24 to 38°C with radiation in comparison to 24 to 35°C without radiation. The study also revealed that the radiation from a hot roof alone had no apparent effect on body weight.

Parkhust <u>et al</u>. (1977) evaluated the economic feasibility of rearing broilers in conventional and environmentally modified houses at different population densities. The environmentally modified house was enclosed with metal siding and thermostatically operated, fixed and variable speed fans were used. Significant improvement in body weights had been reported in environmentally modified houses.

Husseiny and Creger (1980) in their studies on the effect of ambient temperature on carcass energy gain in chicken reported that the body weights of chicks grown in a room temperature of 22 and 32°C averaged 1234.61 and 1106.14 g respectively at six weeks of age.

Aggarwal *et al.* (1981) in their studies with broilers in summer (May,June,July) reported that the birds hatched in spring and fall performed better than those hatched in summer and winter. The body weights of broilers at sixth and eighth weeks of age during summer averaged 640 and 1077 g respectively.

Wathes *et al.* (1981) opined that the body weight of broilers was influenced by the effect of post-brooding temperature, age and dietary nutrient concentration.

Reece and Lott (1982b) reported that the growth rate of broiler from four to seven weeks of age were linear for all environmental temperatures (15.6, 21.1 and 26.7°C) tested.

Nair (1983) reported eighth week body weight range in New Hampshire breed of chicken from 703.85 to 851.31 g during summer season.

Linyu (1985) conducted studies on bird density of broiler reared on deep litter system in summer season (April to May) and Monsoon season (June to July) under three housing densities namely 743, 929 and 1114 sq. cm per broiler. The seventh week body weights during summer with these densities averaged 859, 850 and 857 g respectively. At eighth week of age, the values reported were 1013, 1014 and 1054 g respectively. The author also reported that birds reared during summer exhibited significantly lower body weights than those reared during monsoon. During monsoon the eighth week body weights were 1589, 1631 and 1656 g respectively for densities of 743, 929 and 1114 sq.cm per broiler. The monsoon season reared birds showed significantly better body weights.

Pone et al. (1985) studied the effect of maternal age on performance of broilers reared on deep litter system and raised perforated floor. The body weights of broilers reared on deep litter system were 1669, 1764 and 2091 g resperctively at 44, 47 and 52 days of age. The body weights of broilers reared on perforated floor averaged 1715, 1814 and 2109 g, respectively at the above ages. The authors also reported that broilers kept on slat floor had greater body weights and were significant at all ages studied.

Sharma and Gangwar (1985) studied the efficiency of cooling methods using cooler, fogger and exhaust fans in broiler production in hot weather where the temperature ranged from 27.3 ± 1.29 to 30.58 ± 1.58°C and found that broilers under cooler and foggers had significantly higher body weight gain over the control without any cooling methods. The overall efficiency with cooler, fogger and exhaust fans were found better in hot - dry season than that in hot-humid season. It was observed that the broilers attained average body weights of 1150, 1100, 950 and 900 g at eight weeks of age when reared in houses provided with cooler, fogger, exhaust fan and without any cooling device respectively.

Seriff and Kothandaraman (1987) studied the efficiency of stocking density and floor type on performance of broilers. They had reported a body weight of 1526 ± 19.4 g for broilers reared with a density of 900 sq.cm per bird under deep litter system and 1449.8 ± 33 g for broiler reared on welded mesh floor with a floor space of 630 sq.cm per broiler.

Simpson and Nakaue (1987) studied the performance of broilers reared on different type of raised floors namely wire, wooden slats, plastic inserts over wire and plastic coated expanded metal each with and without padded roosts and found that the mean body weights were not significantly different among floor types.

Yausef and singh (1989) studied the effect of protein level and stocking density on broiler performance in different seasons. They found maximum body weight gain in cold seaso followed by hot-humid and hot-dry seasons.

Andrews et al. (1990) studied the performance of broilers grown on raised floor Vs. litter floor and found that the eighth week body weights were significantly heavier for broilers grown in litter than those reared on raised floors.

Feed Consumption and Feed Efficiency

Trials with New Hampshire chicks had shown that high temperature of 37.2°C significantly depressed growth and feed intake with increased water consumption (squibb et al., 1959). The depressed growth was found to be due to lowered feed intake.

Huston and Edwards (1961) reported better feed efficiency at high ambient temperature.

A significant linear decrease in feed consumption with increase of environmental temperature from 7.1 to 23.8°C in broiler from four to eight weeks of age and a highly linear effect of temperature and feed efficiency were reported by Prince et al. (1961). The decrease in feed intake during four to eight weeks period was about 0.21 kg per bird. These authors also reported that lowering the ventilation rate from 2 cfm to 3/4 cfm per bird significantly decreased feed consumption by 0.06 kg per bird during the period of four weeks.

Adams <u>et</u> <u>al</u>. (1962) reported that higher environmental temperatures reduced voluntary intake of feed. Increasing the energy level of the ration improved growth rate and efficency of feed utilization.

In a field survey on results of broiler production in winter and summer for the period 1958-1959 Payne(1962) reported average feed conversions of 2.73 and 2.68 respectively for winter and summer seasons. The author also reported an average feed consumption of 4.15 and 3.89 kg per bird respectively for winter and summer. The average house temperatures in summer was 65 to 70°F which was approximately 10°F higher than the house temperature recorded in the house during winter.

The best feed efficiency for broilers was reported by Sainsbury (1966) at 21.1 to 23.9°C house temperature.

Deaton <u>et</u> <u>al</u> (1967) studied the effect of temperature and density on broiler performance in commercial type of houses under environmentally controlled and uncontrolled condition and found that the feed efficiency was better at higher temperatures in both conditions.

Parkhust (1967) stated that the temperature of 29.4 to 35°C did not markedly affect feed efficiency in broilers upto six weeks of age. At sixth week and beyond that age 29.4°C and above adversely affected the feed efficiency.

Adams and Rogler (1968) reported that growth depression at 29°C compared to 21°C was greater in fast growing chicks and feed conversion was consistently better for the slow growing chick compared to fast growing chicks.

Deaton et al. (1968) in their studies with broilers reported that there was a trend for better feed efficiency at high temperature of 37.8°C.

Increased feed consumption and loweer feed efficiency were reported by Olson et al (1970) with chicks kept under cooler regimes of 13 to 24°C than chicks kept at temperatures varying from 26.5 to 40.5°C.

Siegel and Drury (1970) observed that feed efficiency in broilers were affected by diurnally cycling temperature. The amplitudes of variation studied were 5.5, 11.1 and 16.6°C with constant temperature of 29.4°C at first week and reduced weekly by 2.8°C to fourth week. The feed efficiency was found poorer at 16.6°C compared to the temperature amplitudes of 5.5 and 11.1°C.

Reece and Deaton (1971a) observed range of feed efficiencies from 2.10 to 2.18 which were not significant for broilers grown at dry bulb temperatures varying from 26.7 to 35°C with a constant wet bulb temperature of 23.3°C. It was also reported that feed efficiencies which ranged from 2.08 to 2.25 were non-significant in broilers grown at a constant wet bulb temperature of 24.9°C with dry bulb temperature varying from 26.7 to 35°C.

Reece and Deaton (1971b) reported that temperature of 21°C with a relative humidity of 60 per cent were optimum for better feed utilization during the growing period of broilers reared on deep litter system.

Harris et al. (1974) noted highest body weight gain and feed consumption in broilers grown at minimum temperatures of 18.3 and 23.9°C non-cyclic or with a cycle of least variation. A linear decrease in feed consumption was observed for these two minimum temperature as maximum temperatures increased to 40.6°C. No significant effect.on feed efficiency were noted by the authors.

According to Swain and Farrell (1975) feed consumption and growth rate declined with high temperature and a significant increase in fat content of the carcass were noticed.

Reece *et al*. (1976) in their experiment with broilers reported a feed efficiency of 2.22 for broilers housed at ambient temperatures ranging from 24 to 35°C with and without radiation from the solar heat during four to eight weeks of age.

Vo *et al*. (1977) in their studies with broilers found that feed efficiency was best at 29.4°C and significantly poor at 37.8°C.

Husseiny and Creger (1980) carried out experiments with broilers reared from day old to six weeks of age in two groups, one at 32°C and other at 22°C, observed that the mean cumulative feed consumption at these temperatures averaged 1.98 and 2.88 kg respectively. The reported feed efficiencies averaged 1.86 and 1.91 respectively for the two groups of broilers reared at 32°C and 22°C.

Timmons and Baughman (1981) found that the feed efficiencies averaged 2.11 and 2.02 for broilers reared in uninsulated houses and in insulated curtain sided houses respectively.

Reece and Lott (1983) studied the effects of temperature and age on feed efficiency of broilers grown in three different environmental temperatures viz. 15.6, 21.1 and 26.7°C. They observed that there was no difference in feed conversion at 21.1

and 26.7°C. Whereas, broilers grown at 15.6°C consumed more feed per unit of weight than those at other temperatures at 49 days of age. These workers noted that the heat output decreased in birds smaller than 1200 g indicating that the metabolic heat associated with growth was predominant. For larger birds in cooler and warmer temperatures (15.6°C and 26.7°C)the heat output was higher indicating more heat requirement to maintain body temperature and growth in the cool environment.

In an experiment with broilers on deep litter it was reported that cumulative feed consumption averaged 3.21, 3.30 and 3.36 kg per bird reared on 743, 929 and 1114 sq.cm per bird respectively (Linyu, 1985). The feed consumption was not influenced by the different density levels but there was seasonal influence on feed consumption during monsoon. Birds in above density levels consumed 3940, 3997 and 4048 g bird respectively during monsoon indicated higher feed consumption.

Sharma and Gangwar (1985) observed that the feed efficiency was not influenced significantly in broilers reared in houses provided with coolers, foggers and exhaust fans in comparison with houses without any cooling devices.

Wo (1985) conducted research using broilers and compared two rearing systems viz., deep litter and wire floor during four to eight weeks of age and reported that the type of floor showed no significant effect on feed consumption.

Howldier and Rose (1987) conducted experiments using broilers and reported that growth, feed intake, feed conversion ratio and body composition of the birds were not influenced significantly by temperature.

Seriff and Kothandaraman (1987) in their studies with broilers observed that those reared with lower densities (900 sq.cm per bird) had higher feed consumption (3.83 kg) upto eight weeks of age. The authors also reported that broilers reared on deep litter floor having 720 sq.cm per bird (floor space) had the best feed efficency (2.16). Increased floor space also resulted in increased feed consumption. The feed efficiency was better for crowded groups provided with less floor space. Broilers reared on welded mesh floor with a space of 630, 720 and 810 sq.cm per bird exhibited conversion efficiency of 2.27, 2.36 and 2.50 respectively.

Simpson and Nakaue (1987) reported that floor types viz., wire, plastic coated expanded metal and plastic inserts did not influence the feed conversion significantly among the broilers. The feed conversion efficiency was 2.02 on wire floor with or without padded roost at seventh week of age. At this age, feed efficiency of 2.03 and 1.96 in broilers reared on plastic coated expanded metal with and without padded roosts respectively, were also reported by these workers.

Chambers and Lin (1988) reported that much of the variation (85-90 per cent) in feed consumption and feed efficiency among broilers were due to age and body weight.

Madelin and Wathes (1989) studied the effect of floor types by comparing deep litter with raised netted floors and found that birds on litter floor had a slightly betterr feed gain ratios.

Andrews et al. (1990) reported that the feed conversion was significantly superior for broilers grown on litter floor than for broilers grown on the raised floors. Feed conversion was 2.02, 1.95, 1.96 and 1.93 for broilers housed on Black plastic coated expanded metal, white plastic floor, white plastic coated expanded metal with square openings and litter floor respectively.

Environment

Roberts et al. (1961) studied the relationship of floor space and factors influencing broiler growth and indicated that broilers reared during summer months required more floor space per bird for efficient growth.

Huston (1965) opined that broilers grown at high environmental temperature especially during the finishing periods had poorer growth rates and poor feed conversion efficiency than those grown at moderate temperatures.

Deaton et al. (1967) observed that body weight gain was significantly reduced when temperature regimes especially during the latter part of the growing period were above 21.1°C. A significant effect of housing density on body weight gain was evident at temperatures below 21.1°C. It was also reported that feed efficiency was better at high temperatures but mortality and condemnation of carcass were not significantly affected.

Deaton et al. (1970) obtained results pertaini ; to sex wise performance of broilers reared under winter and summer conditions in an environmentally controlled house. Males had shown leg weakness and breast blisters more than that of females, with higher mortality rates at high temperature and humidity. A housing density of 279 sq.cm per bird significantly depressed body weight in both sexes. They further observed higher mortality rates during high temperature conditions since bird density also influenced the micro-environment adversely.

Reece and Deaton (1971b) observed that the ideal house temperature be near 21°C with a relative humidity of about 60 per cent for providing optimum comfortable environment for broilers on litter floor. A multiple fan-ventilation control system may be used to modulate the ventilation rate over a wide range with ± 1°C change in house temperature. In another study Reece and Deaton (1971c) determined the time required for development of stress conditions in environmentally controlled houses after loss of mechanical ventilation under summer conditions. They have determined the environmental parameters namely temperature, relative humidity,ammonia and carbondioxide which are responsible for development of stress conditions. High temperature in combination with extremely high relative humidity appeared as a critical stress factor. These workers found that natural convection through the ventilation system be sufficient to prevent carbondioxide or Ammonia gases reaching dangerous levels.

Reece et al. (1976) reported that when the ventilation rate is zero, the ambient air temperature tends to approach the roof temperature. With high ventilation rate, the increase in ambient air temperature due to radiation would be negligible.

Parkhurst et al (1977) investigated the effects of growing broilers in environmentally modified and conventional houses at different population densities. It was revealed that body weight and feed conversions were significantly improved and mortality rates significantly decreased in the environmentally modified houses.

Somanathan (1980) classified climate in Kerala as hot and dry during Feb. to April; and warm - wet during May to Sept. These authors recorded a maximum temperature of 35.3°C with mean relative humidity of 72.5 per cent during the month of March.

Reece and Lott (1982a) in their studies on broilers found that supplemental heat prevented the increase of humidity beyond 70 per cent inside the poultry house.

Morrison and McMillan (1986) studied the response of broiler chicks to various environmental temperatures and stated that the requirement of supplementary heat was low with increasing environmental temperature from 10 to 24°C.

Sykes and Fataftah (1986) studied the acclimatization of birds on exposure to ambient temperature of 38°C and observed that acclimatization was characterised by a progressive reduction in the rate of increase in cloacal temperature.

Arfona et al. (1988) investigated the effects of heat stress on broiler chicks at five days of age and found that the exposure to high environmental temperature from 35 to 37.8°C resulted in significantly loweer mortality rate when subsequently exposed to high environmental temperature than those birds exposed to high environmental temperature at later periods only.

Livability

Hartung (1955) while reporting the effect of floor space on broiler performance observed high livability with floor space of 450, 675, 900 and 1125 sq. cm per bird. Siegel and Coles (1958) observed that the floor space allowance of 450, 675 and 900 and 1125 sq.cm per bird had little effect on livability upto nine weeks of age. Deaton et al. (1967) reported that the density levels of 650 and 929 sq.cm per bird did not affect livability significantly. The above authors have not reported the micro-environment status in their studies. Deaton et al. (1968) reported that mortality and contamination were not significantly affected by temperatures and density level.

Deaton et al. (1970) found that floor allowances of 279, 465 and 743 sq.cm per bird affected livability during high temperature conditions and opined that bird density affected the micro-environment.

Siegel and Drury (1970) in their studies with broilers reported that mortality was higher for the birds cycled at temperature amplitude of 16.6°C compared to other temperature amplitudes of 5.5 and 11.1°C.

Mathur and Reddy (1975) observed that the floor space of 450, 700 and 950 sq.cm per bird did not affect livability.

Parkhust et al. (1977) observed significant improvement in livability in the environmentally modified house where the densities were 0.07 and 0.06 sq.m per bird.

Reece et al. (1980) in a study found that broiler chicks exposed to 0, 50, 100 and 200 ppm of ammonia in the atmosphere during zero to twenty eight days brooding period increased the mortality rate in chicks.

Stanley (1981) reported that livability was markedly depressed in the groups with the highest stocking density of 360 sq.cm/bird. Vo (1982) observed that birds reared at high densities exhibited a significant decrease in livability percentage.

Arfona et al (1988) investigated the effects of heat stress at five days of age and found that the exposure to high environmental temperature ranging from 35 to 37.8°C resulted in significantly low mortality in comparison with the birds exposed to high environmental temperature at the later periods.

Processing Yields and Losses

The processing yield of poultry is related to a variety of factors in birds such as the body conformation (Jaap and Penquite, 1938), the previous nutritional status (Harking et al., 1960) and sex, age and strain (Fry et al., 1962). The processing yields and losses of chicken reported by Jull (1951) showed that the per cent yield in broilers ranged from 66 to 71.

Hartung (1955) graded the individual carcass of each treatment into the colorado grades and found that as the floor space increased there was an increase in per cent grade A carcasses.

Deaton et al. (1961) observed that there was significant change in percentage of grade A carcass of birds allowed more space at the time of rearing compared to birds reared on high density.

Deaton et al. (1967) reported carcass condemnation was not significantly affected by the density levels of 650 and 929 sq.cm per bird.

Mathur and Ahmed (1968) reported that the processing yields of Arbor Acre broilers averaged 71.08 and 71.13 per cent in male and female broilers respectively.

Haynes and Marion (1973) in their studies with broilers at eight weeks of age observed that the mean per cent edible yields were 72.04 and 70.08 in males and females respectively.

Singh and Essary (1975) reported that the processing yields averaged 77.1 and 76.3 per cent respectively in broilers at eight and ten weeks of age. Hubbard broilers at 10 weeks of age had resulted in edible per cent yields ranging from 69.80 to 70.80 (Tan et al., 1975).

Sethuraman and Kothandaraman (1978) investigated the effect of pre-slaughter fasting and population density on dressing yield of broilers and found that floor space given during rearing period had no effect on dressing yield. However, a reduction in dressing yield was reported by these authors in birds reared with increased floor space of 1080 sq.cm per bird and slaughtered after prolonged fasting time.

Proudfoot et al. (1979) reported that increased bird density was affected carcass quality adversely. Silaev et al. (1981) measured the carcass weight per sq.m. floor area at six, seven and eight weeks of age and found that increasing the housing density from 34.52 to 44 birds per sq.m. floor area increased the yield of poultry meat by thirty per cent without any fall in quality.

Huggins and Lewis (1980) studied the effect of controlled environmental temperatures (4.4, 12.7,23.9 and 32.2°C) on the per cent edible yield of broilers reared from four to nine weeks of age and reported that the high temperatures (23.9 and 32.2°C) caused a reduction in edible yield in broiler stock.

Narayanankutty et al. (1982) conducted studies on the processing yields and losses in broiler spent hens of White Rock and White Cornish aged between 18 and 24 months and reported that the per cent ready-to-cook yield ranged from 71.13 $\pm$ 1.20 to 76.92 $\pm$ 0.18.

A quality comparison of meat from different types of chickens was carried out and data on meat yield and yield of different cut-up parts of spent hens, cocks, broilers and White Leghorn male chicks grown upto 12 and 14 weeks of age were reported (Naraynankutty et al., 1983). In the above study it was observed that the per cent ready-to-cook yield of broilers averaged 67.0 and eviscerated yield averaged 62.0 per cent.

Mohapatra et al. (1984) reported that the total per cent meat yield was not affected by housing systems viz., cage and floor.

Syam Sunder *et al* (1988) studied the conformation, carcass characteristics and yield in pure bred broilers. They have reported the eviscerated yield range from 65.74 to 67.94 per cent and the ready-to-took yields from 70.80 to 73.64 per cent. The mean per cent blood, feather, offal and total loss ranged in their study were 3.94 to 4.88, 6.82 to 8.58, 13.51 to 16.78 and 16.80 to 29.20 respectively, in pure bred broilers.

Materials and Methods

MATERIALS AND METHODS

An experiment was carried out at the Department of Poultry Science, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy to study the effects of four housing systems on the performance of broilers in summer. The study was conducted during the period from tenth March to fifth May'1990.

Six hundred, one-day old commercial broiler chicks were received and vaccinated against Ranikhet disease using RDF vaccine on the same day. The chicks were wing banded, weighed individually and were brooded for a period of two weeks in four groups of 150 chicks each, in a clean well ventilated poultry house with ACC roofing. The chicks were provided with a floor space of 100 sq.cm/chick and were fed with broiler starter mash, *ad libitum*. Fresh, clean drinking water was made available at all times. The body weights at the end of first and second weeks were recorded individually.

At the end of second week of age, five hundred and sixty (560) healthy chicks were selected and divided into four experimental groups of 140 each. Each experimental group consisted of five replicates of 28 chicks each. The allotment of chicks to groups and replicates were made in such a way that the mean body weights between replicates varied within ± 10 g, at the commencement of the experiment. The variation in body weights within replicates was kept minimum. The chicks were distributed to groups at random. Each group was reared under one of the following housing systems:

a) Asbestos cement concrete (ACC) roofing.

i. Deep litter floor (DL)

ii. Deep litter floor with fanned environment (DLF)

iii. Wire floor (WF)

b) Tiled roofing

iv. Deep litter floor with Earthern tile roofing (DLT)

In deep litter systems, dried wood shavings were used as litter materials. In wire floor system, a raised floor kept at a height of 60 cm fitted with Netlon polymer plastic meshes of hexagonal shape fixed using metal frames were used. All replicates in systems i to iii listed above were located in a house with ACC roofing. The replicates under the fourth treatment were located in a separate house having earthen tile roofing.

In experimental houses separate individual pen units were used as replicates. They were thoroughly cleaned and disinfected before housing the chicks. A floor space of 900 sq.cm/chick was provided in all experimental groups except in wire floor system where 675 sq.cm/chick was provided. In treatment ii, pedastal fans working at a speed of 800 rpm provided for each replicate, were kept outside the pens at a height of 90 cm from floor level, so as to provide more air movement.

Standard managemental practices were followed routinely in all treatment groups identically. Broiler starter ration was fed to all chicks until sixth week of age and thereafter a finisher ration until eight week of age. Feed and water to the experimental birds were provided ad libitum throughout the experiment. The starter and finisher rations were prepared as per ISI specification (1979). The ingredient composition (per cent) of diets, values of per cent crude protein, analysed as per A.O.A.C. (1970) and calculated values of metabolisable energy (K cal/kg) of diets are presented in Table 1.

The following observations were made during the period of experimentation.

1. Weekly body weight.
2. Feed consumption
3. Feed efficiency
4. Cloacal temperature
5. Maximum and minimum temperature inside the house.
6. Relative humidity inside the house
7. Relative humidity at the level of birds
8. Ammonia concentration inside the house
9. Livability
10. Processing yields and losses
11. Economics of rearing broilers in summer.

Table 1. The ingredient composition of experimental diets

Ingredients	Starter (0-6 week)	Finisher (7-8 week)
	(Parts)	(Parts)
1. Yellow Maize	45	55
2. Groundnut cake	28	28
3. Rice polish	15	10
4. Fish Meal	10	5
5. Mineral mixture*	1.75	1.75
6. Salt	0.25	0.25
For every 100 kg feed added		
i) Merivite** (g)	10	10
ii) Coccidiostat (g)	50	50
iii) Choline chloride (g)	140	100
iv) Lysine hydro chloride (g)	90	90
v) DL Methionine (g)	57	57
vi) Animal Protein Factor (g)	100	100
Chemical composition		
1. Crude protein (%) (Analysed value)	22.3	19
2. Metabolisable energy K cal/kg (calculated value)	2910	3020
3. Cost of feed/kg (Rs.)	3.90	3.80

* Mineral Mixture (Poultrymin) (Aries Agro-Vet Industries Pvt. Ltd). Each g contained (Min) Calcium 32%, Phosphorous 6.002, Copper 100 ppm Cobalt 60 ppm, Manganese 2700 ppm, Iodine 100 ppm, Zinc 2600 ppm, Iron 071% and Magnesium 100 ppm

** Merivite AB_2D_3 and K (Merivet, a division of Merind Ltd.) Each g contained Vitamin A 82,500 I.U, B_2 52mg, D_3 12,000 I.U. and K 10mg.

At the end of every week, chicks were weighed individually and mean weekly body weights in each of the rearing systems were calculated. The weekly feed consumption was recorded replicatewise. For this, an approximate quantity of feed required in a week for each replicate was weighed out at the beginning of every week and kept aside in feed bins. From this, feed was issued ad libitum and balance feed at the end of every week was weighed back and the actual intake in that week was worked out. From this data, the daily feed consumption per bird in each week was arrived at, for each rearing system. The feed efficiencies were worked out on the basis of cumulative feed intake and live body weights in the respective system of housing.

The cloacal temperature of three birds at random from each replicate was recorded in the morning on alternate days, using clinical thermometer. From this data the mean cloacal temperature at every week was determined to represent the body temperature.

The maximum and minimum temperature (°C) in the housing systems were recorded daily using Zeal Maximum-minimum thermometers and the weekly mean values were calculated. The per cent relative humidity inside the house was estimated every day in different systems using Mason's Dry and Wet bulb thermometers and the respective weekly means were worked out. The per cent relative humidity at the level of birds was estimated every day around 7.25 A.M. and 2.25 P.M. using whirling psychrometer. For this purpose, the psychrometer was whirled several times at the bird level until two consecutive readings were obtained. The same was recorded in all housing systems separately and the corresponding weekly means were arrived at.

Ammonia concentration in each housing system was evaluated qualitatively twice in a week using multi-coloured litmas papers as described by Mourn et al. (1969). The paper strips were dipped in water and were hung at the bird level for 15 seconds, and the corresponding pH values were scored at every week in each of the rearing systems.

The air velocity prevailing in the locality, during the season was obtained from the meteorological division of the University.

Mortality among birds was recorded weekwise and replicatewise to study the survivability of broilers in summer under different rearing systems.

The processing yields and losses were estimated after conducting slaughter studies at the end of eighth week. Three birds, at random from each replicate, were slaughtered as per procedure described by Indian Standards Institution (ISI, 1973). The edible and non-edible yields were estimated under each system of housing. The per cent blood feather, and total offals were determined separately in each of the housing systems. The giblet yield and eviscerated yields were also calculated to find out the ready-to-cook yield from broilers reared under various systems of housing.

The data collected in respect of each parameter were analysed statistically using appropriate techniques as per Snedecor and Cochran (1967).

The economics of rearing broilers under different housing systems in summer were calculated on the basis of margin of profit over feeding cost alone; without taking into account other cost items. The production performance and carcass yields also were taken into consideration in determining the economics of broiler production in summer under the different systems of rearing studied.

Results

RESULTS

Body Weight

The overall mean body weight of day-old broiler chicks was 38.40 ± 0.51 g and at the end of first week was 69.82 ± 2.02 g. At the end of second week mean weight was 132.11 g (Table 2).

The mean body weight of chicks at the time of housing in different groups at the end of second week; and subsequent weekly body weights as influenced by different housing systems are presented in Table 3. Statistical analysis of the data showed that the variations among mean body weights of chicks in different housing systems were non-significant at commencement of the experiment. The mean body weights of chicks housed on the floor types viz. deep litter, litter floor with fan ventilation and wire floor in the house with Asbestos Cement Concrete (ACC) roofing were 132.36, 131.58 and 132.47 g respectively. The mean body weight of chicks housed on deep litter floor in the house with earthern tile roofing was 131.85 g, at the end of second week.

The mean body weights of chicks at the end of third week were statistically comparable among the rearing systems in the house with ACC roofing. At this age, the mean body weights recorded were 215.81, 213.09 and 215.52 g with litter floor, deep litter with fan ventilation and wire floor systems

Table 2. The performance of broiler chicks during initial two weeks of brooding (on litter floor) in a house with asbestos roofing

	First week	Second week
1. Mean body weight (g)	69.82	132.11
2. Mean weekly weight gain (g)	31.44	62.29
3. Mean daily feed consumption (g)	12.38	23.43
4. Mean cumulative feed consumption (g)	89.81	257.81
5. Cumulative feed efficiency	1.35	1.28
6. Per cent mortality	1.0	1.3
House Environment		
a) Maximum temperature (°C)	33.0	35.1
b) Minimum temperature (°C)	25.2	25.4
c) Relative humidity (%) F.N.	86.8	87.2
d) Relative humidity (%) A.N.	47.8	48.2

Mean body weight of day-old chicks was 38.4 g.

Table 3. Mean weekly body weights (g) as influenced by different housing systems

Housing systems	Age in weeks						
	2	3	4	5	6	7	8
<u>Asbestos Roofing</u>							
Deep litter floor	132.36± 3.11	215.81±^{a} 3.11	332.49± 5.02	436.49±^{a} 7.05	566.94± 11.84	742.22± 14.92	811.15± 13.66
Litter floor with fan ventilation	131.58± 3.08	213.09±^{a} 3.46	322.17± 6.36	431.89±^{a} 8.53	549.48± 14.12	680.31± 25.64	753.85± 31.69
Wire floor	132.47± 2.99	215.52±^{a} 5.54	330.72± 4.37	469.07±^{b} 6.31	568.38± 4.11	706.13± 12.56	830.05± 26.93
<u>Tile Roofing</u>							
Deep litter floor	131.85± 3.14	230.34±^{b} 2.17	342.92± 7.50	433.94±^{a} 10.83	542.44± 10.36	681.96± 11.79	843.65± 11.96
Overall Mean	132.11± 3.08	218.69± 3.9	332.08± 4.25	442.85± 8.79	556.81± 6.4	702.66± 14.43	809.66± 19.76

Means bearing same superscripts within the columns did not differ significantly ($P<0.05$)

respectively. The chicks had uniform weights with these systems. However, the third week mean body weight of chicks reared on litter floor under tile roofing was 230.34 g and they were significantly heavier than those reared with all the three systems under ACC roofing ($P < 0.05$).

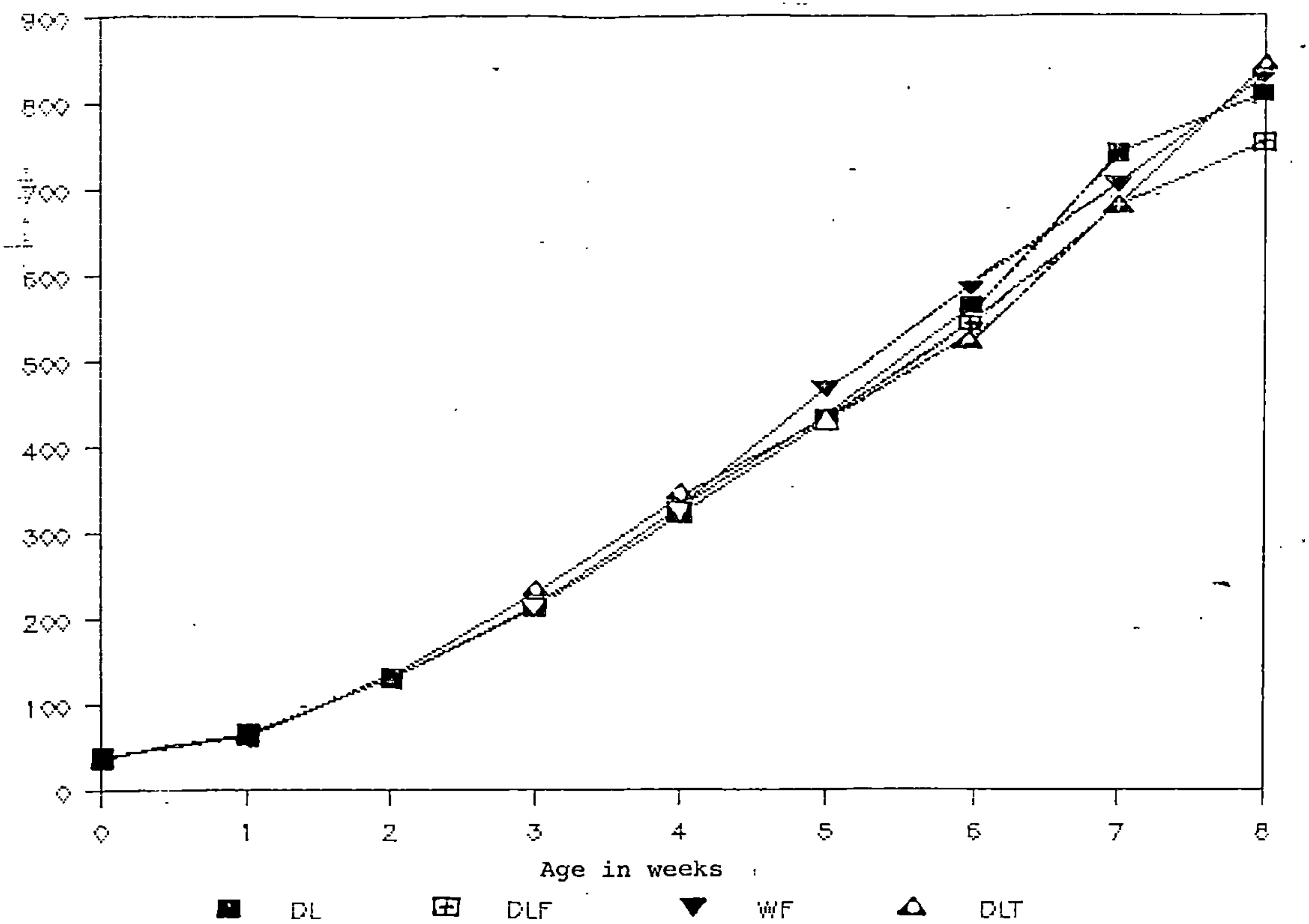
Among the four systems, the corresponding mean body weights of chicks at fourth week were 322.17, 322.49,330.72 g in the house with ACC roofing; and 342.92 g for chicks reared on litter floor in tiled roof house. The body weights in all systems under ACC roofing as well as that under tile roofing were statistically comparable among themselves. However, the body weight of chicks grown under tile roofing was numerically higher than those reared under ACC roofing.

The trend of results showed a change at fifth week. The mean body weight of 469.07 g recorded with chicks reared on wire floor in the house with ACC roofing was significantly high in comparison with those reared in all other systems, at the end of fifth week. The mean body weights of broilers grown on deep litter, litter floor with fan ventilation under ACC roofing and that reared on deep litter system under tile roofing were 436.49, 431.89 and 433.94 g respectively. The differences among these mean values were non-significant. The variation in weights among these systems were very low.

The housing systems did not influence the body weights significantly during the latter periods of growth at sixth, seventh and eighth week of age. The body weights recorded at sixth week averaged 566.94, 549.48 and 568.38 g for birds reared on deep litter floor, the same with fan ventilation and wire floor systems in the house with ACC roofing, respectively; and 542.44 g with those reared on deep litter floor under tile roofing. The corresponding body weights in the above systems averaged 742.22, 680.31, 706.13 and 681.96g at seventh week and 811.15, 753.85, 830.05 and 843.65 g at the end of eighth week.

At sixth week, it was revealed that the mean weights of broilers with deep litter and wire floor systems under ACC roofing were almost similar. At the same time, they were numerically higher than the weights of birds reared in the other two systems. The body weight of birds reared on litter floor with fanned environment under ACC roofing and that with litter floor under tile roofing had almost equal weights, at the end of sixth and seventh week as well showing similar cumulative effects with these systems. Whereas, the numerically higher body weight at seventh week was observed only with broilers grown on deep litter system under ACC roofing. The wire floor system recorded intermediary weights. At eighth week, the highest body weight obtained was with broilers reared on deep litter floor under tile roofing.

Fig. 1. WEEKLY BODY WEIGHT



The impact of different housing systems on weekly body weights of broilers at various ages is depicted in figurel.

Weight Gain

The mean weekly weight gain of chicks during first and second weeks of age were 31.44 and 62.29 g respectively (Table 2).

The mean weekly weight gain of chicks reared in each of the housing systems is presented in Table 4 and graphically represented in figure 2, for the period from 3 to 8 weeks of age.

Statistical analysis of the data pertaining to the weight gains at third week revealed that it was significantly higher with chicks reared on litter floor in the house with tile roofing where in the mean weight gain was 98.48g ($P < 0.05$). In the house with ACC roofing, the mean weekly weight gains resulted were 82.24, 81.63 and 83.07 g with those chicks reared on litter floor, litter floor with fan ventilation and that with wire floor systems respectively showing uniform gain in weight with all systems in that house. The differences among mean values were found non-significant. Similar trend of results were also obtained in rerspect of live body weights recorded at the end of third week (Table 3).

Table 4. Mean weekly weight gain (g) from three to eight weeks of age as influenced by different housing systems

Housing systems	Age in weeks					
	3	4	5	6	7	8
<u>Asbestos Roofing</u>						
Deep litter floor	$83.24\pm^{a}$ 2.69	$116.69\pm$ 2.99	$103.99\pm^{ab}$ 4.95	$130.44\pm$ 5.80	$175.22\pm$ 5.72	$73.54^{a}\pm$ 11.93
Litter floor with fan ventilation	$81.63\pm^{a}$ 3.05	$108.95\pm$ 3.22	$109.72\pm^{b}$ 2.96	$117.59\pm$ 13.63	$130.83\pm$ 13.24	$68.98\pm^{a}$ 3.13
Wire floor	$83.07\pm^{a}$ 4.72	$115.19\pm$ 2.03	$138.34\pm^{c}$ 2.63	$99.31\pm$ 6.94	$137.69\pm$ 10.35	$123.96\pm^{b}$ 17.19
<u>Tile Roofing</u>						
Deep litter floor	$98.48\pm^{b}$ 2.25	$112.58\pm$ 7.89	$91.02\pm^{a}$ 5.06	$108.5\pm$ 11.50	$139.52\pm$ 11.09	$161.69\pm^{c}$ 9.05
Overall Mean	$86.61\pm$ 3.97	$113.35\pm$ 1.69	$110.77\pm$ 9.98	$113.96\pm$ 6.64	$145.83\pm$ 9.97	$107.03\pm$ 22.06

Means bearing same superscripts in columns did not differ significantly ($P<0.05$)

None of the housing systems significantly influenced the weight gains during fourth week. At this age, the weight gains per chick in the house with ACC roofing were 108.95 g in respect of chicks reared on deep litter system, 116.69 g due to litter floor with fan ventilation and 115.19 g with wire floor system of rearing. The weight gain of chicks grown on litter floor in the house with tile roofing averaged 112.58 g. The weight gains with respect to all systems were more or less uniform without exhibiting great variations in growth rate during fourth week of age.

The weekly gain was found significant at fifth week of age with chicks reared on wire floor system. The mean weight gain of 138.34 g registered with those chicks on the wire floor system under ACC roofing was significantly higher in comparison with those birds reared in all other systems (P <0.01). Likewise, significantly better weekly body weight was also observed with wire floor reared birds at this age (Table 3). In the house with ACC roofing the mean weekly weight gains recorded with birds grown on litter floor (103.99 g) and those on litter floor with fan ventilation (109.72 g) were statistically comparable to each other during fifth week. Whereas, the weight gain of chicks recorded with litter floor under tile roofing was only 91.02 g and was significantly lower (P < 0.01) in comparison to litter floor with fan ventilation under ACC roofing. With all systems of rearing except wire floor under ACC roofing, the birds registered lower gain in weight during fifth week in comparison with fourth week weight gains.

The rearing systems did not show significant influence on weekly weight gains of broilers during six and seven weeks of age. At both these ages, the gains observed with litter floor reared birds under ACC roofing were numerically higher than those of other systems. The mean weight gain during sixth week were 130.44, 117.59 and 99.31 g with litter floor, litter floor with fan ventilation and wire floor systems under ACC roofing respectively. The birds grown on litter floor under tile roofing registered a gain of 108.50g. The corresponding weight gains per bird in the above systems were 175.22, 130.83 and 137.69 and 139.52 g during seventh week.

The gains of weight observed during eighth week showed statistical significance among the birds reared on different housing systems ($P < 0.01$). The weight gain of 161.69 g registered with birds reared on litter floor in the house with tile roofing was significiantly higher in comparison with birds reared in the house with ACC roofing. Among the various sytems of rearing under ACC roofing, the weight gain of 123.96 g recorded with broilers grown on wire fllor was found significantly higher than the weight gains of birds reared on litter floor (73.54 g), and litter floor with fan ventilation (68.98 g). However, the difference in weight gain between birds reared on litter floor with and without fan ventilation was non-significant.

The growth pattern in broilers at different ages revealed that the mean weekly weight gains recorded were maximum during seventh week with all rearing systems under ACC roofing. A higher gain of same magnitude as that of seventh week also obtained at an early age during fifth week with those broilers reared on wire floor system under ACC roofing. The maximum weekly gain in birds reared on litter floor in the house with tile roofing was delayed and was observed during eighth week of age only.

Cumulative weight gains

The mean cumulative weight gain during first week was 31.44 g and 93.73 g at the end of second week (Table 2).

The cumulative weight gain per chick at third week (Table 5) was significantly higher with chicks reared on litter floor in the house with tiled roof (192.77 g) in comparison with the chicks reared in the house with asbestos roof. In this house, the cumulative weight gains averaged 176.08 g with birds reared on deep litter system, 174.51 g for birds grown on litter floor with fan ventilation and 177.07 g for wire floor system of

Table 5. Mean cumulative weight gains (g) from three to eight weeks of age as influenced by different housing systems

Housing systems	Age in weeks					
	3	4	5	6	7	8
<u>Asbestos Roofing</u>						
Deep litter floor	176.80 ± 3.02[a]	293.20 ± 4.97	397.19 ± 7.04[a]	527.64 ± 11.78	702.86 ± 14.84	770.49 ± 13.91
Litter floor with fan ventilation	174.51 ± 3.35[a]	283.89 ± 6.18	393.56 ± 8.42[a]	511.15 13.96	641.98 ± 25.48	715.51 ± 31.53
Wire floor	177.07 ± 5.79[a]	292.97 ± 4.31	430.71 ± 6.39[b]	530.02 ± 4.39	667.79 ± 12.53	791.70 ± 27.0
<u>Tile Roofing</u>						
Deep litter floor	192.77 ± 2.31[b]	305.35 ± 7.54	396.38 ± 10.86[a]	504.87 ± 10.24	644.38 ± 11.84	806.07 ± 12.02
Overall Mean	180.34 ± 4.18	293.84 ± 4.41	404.46 ± 8.78	518.42 ± 6.16	664.25 ± 14.12	770.94 ± 19.87

Means bearing same superscripts in columns did not differ significantly ($P<0.05$)

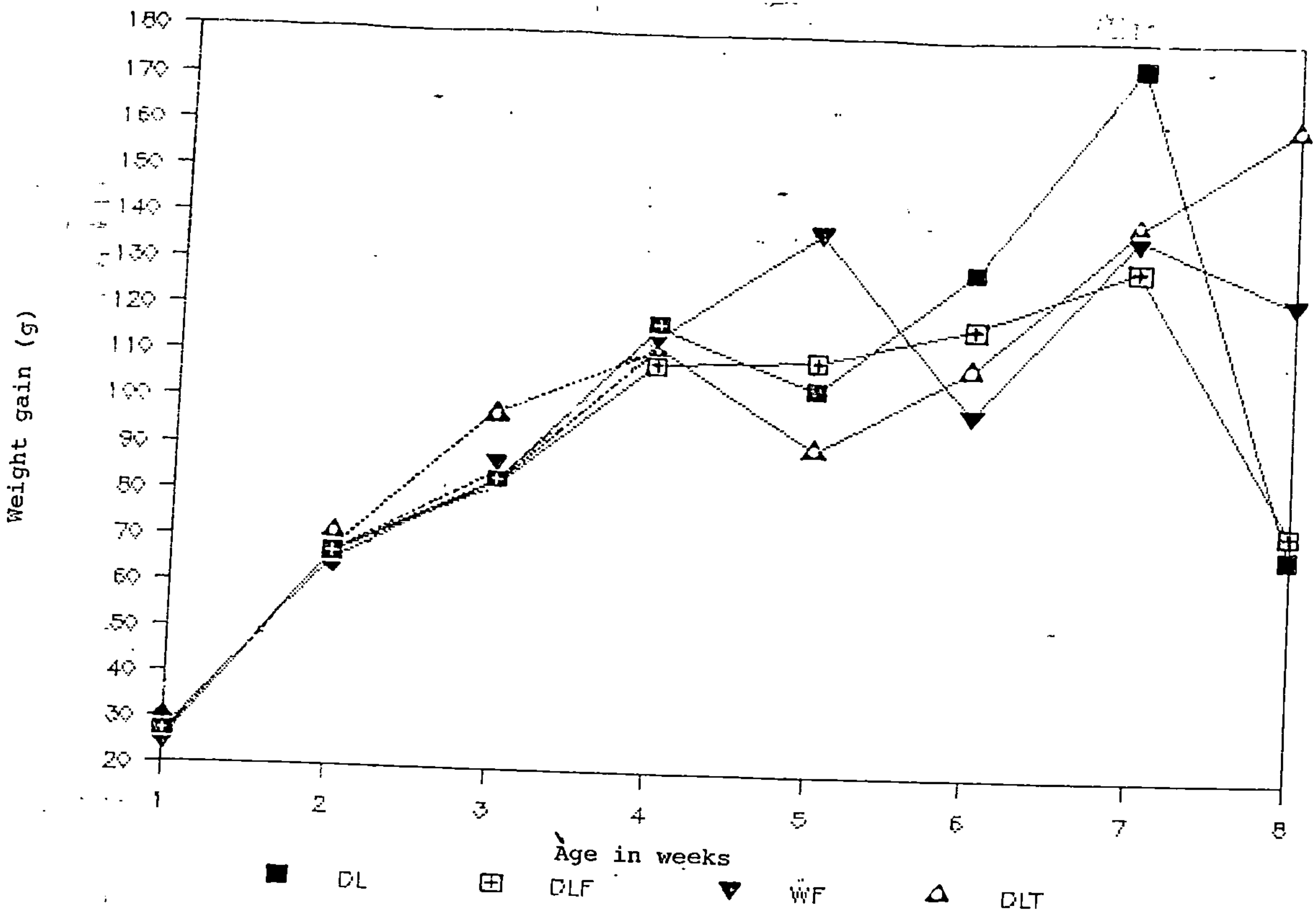
rearing. The differences among these groups were statistically non-significant.

The cumulative weight gains at fourth week were ranged from 283.89 to 305.35 g among various groups and were statistically non-significant among themselves. However, at fifth week the mean cumulative weight gain of chicks reared on wire floor system in the house with ACC roofing (430.71 g) was significantly higher than those reared with other systems in the same house and deep litter system in the tiled roof house. In the house with asbestos roof, the weight gains were 397.19 g with birds reared on litter floor and 393.56 in birds reared with fanned environment. The birds reared on deep litter system in the house with tiled roof showed cumulative weight gains of 396.38 g. The differences among the above groups were non-significant.

From sixth week onwards the cumulative weight gains per chick were not significantly influenced by any of the housing systems. The range of cumulative weight gains averaged 504.87 to 530.02 g at sixth week, 641.98 to 702.86 g at seventh week and 715.51 to 806.07 g at eighth week.

The effect of different housing systems on weekly body weight gains of broilers is depicted in figure 2.

Fig. 2. WEEKLY BODY WEIGHT GAIN



Feed Consumption

Mean daily feed consumption

The overall mean daily feed consumption of chicks during first and second weeks were 12.33 g and 23.43 g respectively (Table 2.).

The mean daily feed consumption per broiler in each week as influenced by housing systems are presented in Table 6 and the same is represented graphically in figure 3a. Statistical analysis showed that no significant influences exist due to any of the housing system at any age until seventh week, in respect of mean daily feed consumption as well as weekly feed consumption. Apparently, it appears that the chicks reared on litter floor under tile roofing (39.79g) consumed more feed during third week in comparison with those chicks reared in other systems under ACC roofing. The daily feed consumption in chicks reared on litter floor with and without fan ventilation were 37.04 g and 37.14 g respectively and with wire floor system under ACC roofing being the lowest was 33.48 g during third week.

The corresponding feed intake in the above systems under ACC roofing during fourth week were 65.13, 65.30 and 63.26 g. With litter floor under tile roofing, the feed intake was found to be the lowest and 58.18 g per broiler.

Table 6. Mean daily feed consumption (g/bird) as influenced by different housing systems

Housing systems	Age in weeks					
	3	4	5	6	7	8
<u>Asbestos Roofing</u>						
Deep litter floor	37.14	65.30	57.55	58.82	62.12	62.94[b]
Litter floor with fan ventilation	37.04	65.13	60.66	69.22	67.38	67.46[a]
Wire floor	34.38	63.26	61.32	68.73	70.89	68.58[a]
<u>Tile Roofing</u>						
Deep litter floor	39.79	58.18	54.42	65.49	68.56	68.72[a]
Overall Mean	37.09	62.97	58.49	65.56	67.24	66.93

Means bearing same superscripts in columns did not differ significantly ($P<0.05$)

At the end of fifth week, the mean cumulative feed intake of chicks with litter floor having fanned environment under ACC roofing registered the highest intake of 1390.49 g. The second highest feed intake was with chicks reared on litter floor (1370.58 g) followed by wire floor (1363.45 g). Both these systems were in the house with ACC roofing. The lowest feed intake (1317.36 g) recorded were in chicks with litter floor under tile roofing at fifth week.

At sixth week, the feed intake observed with litter floor reared chicks in the fanned environment under ACC roofing (1875.08 g) was the highest and next below as 1844.81 g recorded with wire floor reared chicks. The chicks reared on litter floor under ACC roofing showed the lowest cumulative feed intake (1784.34 g) at the end of sixth week. The feed intake registered with litter floor under tile roofing (1785.84 g) appeared close to that recorded with litter floor under ACC roofing.

The cumulative feed intake at seventh week also showed the same trend as observed at sixth week with various systems under ACC roofing. The corresponding feed intake with the three systems Viz. wire floor, with and without fan ventilation were 2346.79, 2341.09 and 2216.32 g. With litter floor under tile roofing the mean cumulative feed intake was 2255.82 g per bird which appeared to be slightly higher than that recorded with litter floor under ACC roofing.

At fifth week also the feed consumption recorded with litter floor under tile roofing was the lowest and found to be 54.42 g per bird. This was 3.76 g lesser than the fourth week feed intake under this sytem. Whereas, in the house with ACC roofing the feed intake in birds reared on litter floor, litter floor with fan ventilation and that with wire floor systems averaged 57.55 g, 60.66 g and 61.32 g respectively. Further a decline in feed intake during fifth week was observed in all systems of rearing in comparison with feed intake of fourth week. The overall mean daily feed intake with all systems put together averaged 62.97 g at fourth week and 58.49 g at fifth week.

At sixth week, the mean daily feed consumption in birds reared on litter floor, litter floor with fan ventilation and wire floor systems under ACC roofing were 58.82, 69.22 and 68.73 g respectively. The birds reared on litter floor under tile roofing consumed 65.49 g per day. In the above systems, the corresponding feed intake during seventh week were 62.12, 67.38, 70.89 and 68.56 g per day. The trend of results observed at sixth and seventh weeks showed that the feed intake was lower with chicks reared on deep litter system under ACC roofing.

The mean daily feed intake during eighth week was significantly low with birds reared on deep litter system under ACC roofing (62.94 g). With other systems, the feed intake of birds per day were almost equal. The mean values were 67.46g and 68.58 g in respect of litter floor with fan ventilation and wire floor systems under ACC roofing respectively. The birds grown on litter floor under tile roofing had consumed 68.72 g per day.

Mean cumulative feed consumption.

The mean cumultive feed consumption inclusive of the overall mean feed intake for the initial two weeks recorded for each system were presented in Table 7. Statistical analysis of the data revealed that the housing systems did not influence the mean cumulative feed consumption at any age until eighth week.

At the end of third week, the mean cumulative feed intake of chicks reared on litter floor under tile roofing was the highest and was 529.19 g. The feed intake recorded with chicks grown on wire floor under ACC roofing was the lowest with a mean of 491.36 g. The mean feed intake of chicks reared on deep litter system with and without fan ventilation under ACC roofing were almost equal (509.92 and 510.64 g). This trend of equal feed intake with and without fan ventilation was also exhibited at the end of fourth week (965.86 and 967.76 g). At the same time, the feed consumption of chicks reared on wire floor under ACC roofing was almost same as that of litter floor reared birds under tile roofing (935.18 and 936.42 g).

Table 7. Mean cumulative feed consumption (g/bird) until eight weeks of age as influenced by different housing systems

Housing systems	Age in weeks					
	3	4	5	6	7	8
<u>Asbestos Roofing</u>						
Deep litter floor	510.64± 7.75	967.76± 13.96	1370.58± 18.50	1782.34± 21.0	2216.32± 28.36	2656.32± 30.0
Litter floor with fan ventilation	509.92± 18.08	965.86± 23.64	1390.49± 32.26	1875.08± 48.5	2346.79± 28.2	2819.79± 67.13
Wire floor	491.36± 9.54	935.18± 18.25	1363.48± 30.88	1844.81± 39.10	2341.09± 42.5	2821.20± 44.63
<u>Tile Roofing</u>						
Deep litter floor	529.19± 14.43	936.42± 6.69	1317.36± 4.12	1785.84± 30.86	2255.82± 34.58	2736.90± 40.5
Overall Mean	510.28± 6.89	951.30± 8.96	1360.47± 15.46	1822.02± 22.76	2290.00± 32.18	2758.56± 39.36

At the end of fifth week, the mean cumulative feed intake of chicks with litter floor having fanned environment under ACC roofing registered the highest intake of 1390.49 g. The second highest feed intake was with chicks reared on litter floor (1370.58 g) followed by wire floor (1363.45 g). Both these systems were in the house with ACC roofing. The lowest feed intake (1317.36 g) recorded were in chicks with litter floor under tile roofing at fifth week.

At sixth week, the feed intake observed with litter floor reared chicks in the fanned environment under ACC roofing (1875.08 g) was the highest and next below as 1844.81 g recorded with wire floor reared chicks. The chicks reared on litter floor under ACC roofing showed the lowest cumulative feed intake (1784.34 g) at the end of sixth week. The feed intake registered with litter floor under tile roofing (1785.84 g) appeared close to that recorded with litter floor under ACC roofing.

The cumulative feed intake at seventh week also showed the same trend as observed at sixth week with various systems under ACC roofing. The corresponding feed intake with the three systems Viz. wire floor, with and without fan ventilation were 2346.79, 2341.09 and 2216.32 g. With litter floor under tile roofing the mean cumulative feed intake was 2255.82 g per bird which appeared to be slightly higher than that recorded with litter floor under ACC roofing.

At the end of eighth week, the cumulative feed intake registered per broiler was the highest with wire floor (2821.20g). A mean value very close to this was also recorded with litter floor having fan ventilation under ACC roofing (2819.79 g). The cumulative feed intake with litter floor systems showed that the numerically higher feed intake was with broilers under tile roofing (2736.90g) than that recorded with ACC roofing (2656.32g).

Feed Efficiency

The cumulative feed efficiencies worked out on the basis of live body weights at the end of each week (from 3 to 8 week) with various housing systems are presented in Table 8. Statistical analysis showed that the housing systems significantly influenced the cumulative feed efficiencies at all ages except at and fifth week.

At the end of third week the cumulative feed efficiencies recorded with litter floor, litter floor with fan ventilation and wire floor systems having ACC roofing were 2.36, 2.39 and 2.28 respectively. On litter floor with tile roofing, the cumulative efficiency recorded was 2.25. The differences between the mean values of various systems were non-significant among themselves.

Table 8. Mean cumulative feed efficiency as influenced by different housing systems

Housing systems	Age in weeks					
	3	4	5	6	7	8
<u>Asbestos Roofing</u>						
Deep litter floor	2.36 ± 0.04	2.91 ± 0.04^{ab}	3.14 ± 0.04	3.14 ± 0.03^{b}	2.98 ± 0.04^{b}	3.27 ± 0.11^{b}
Litter floor with fan ventilation	2.39 ± 0.07	2.99 ± 0.01^{a}	3.22 ± 0.02	3.41 ± 0.04^{a}	3.46 ± 0.09^{a}	3.75 ± 0.11^{a}
Wire floor	2.28 ± 0.05	2.82 ± 0.03^{b}	2.90 ± 0.06	3.25 ± 0.09^{ab}	3.32 ± 0.09^{a}	3.41 ± 0.11^{b}
<u>Tile Roofing</u>						
Deep litter floor	2.25 ± 0.05	2.70 ± 0.04^{c}	3.02 ± 0.05	3.25 ± 0.06^{ab}	3.31 ± 0.08^{a}	3.21 ± 0.11^{b}
Overall Mean	2.32 ± 0.03	2.86 ± 0.06	3.07 ± 0.07	3.26 ± 0.05	3.27 ± 0.07	3.41 ± 0.11

Means bearing same superscripts in columns did not differ significantly ($P<0.05$)

At the end of fourth week, the feed efficiency recorded with litter floor having tile roofing (2.70) was significantly lower than those recorded with all rearing systems under ACC roofing ($P<0.05$). Among the various systems under ACC roofing, the feed efficiency of 2.82 recorded with wire floor was significantly lower than that recorded with litter floor having fan ventilation (2.99). However, in the house with ACC roofing the feed efficiency of 2.91 observed with litter floor was intermediary and comparable with that of wire floor as well as litter floor with fan ventilation

Significant differences in mean feed efficiencies among various systems could not be noticed at fifth week. The mean values recorded with various rearing systems under ACC roofing were 3.22, 3.14 and 2.90 on litter floor with and without fan ventilation and wire floor respectively. On litter floor with tile roofing the feed efficiency was 3.02.

The corresponding mean values in various systems as described above were 3.41, 3.14, 3.25 and 3.25 at the end of sixth week. Of these, the statistical significance observed was only between litter floor with fan ventilation (3.41) and that without fan ventilation (3.14) both having ACC roofing. The efficiency with the other systems were equal (3.25) and comparable with all systems of rearing.

Fig. 3a. DAILY FEED CONSUMPTION

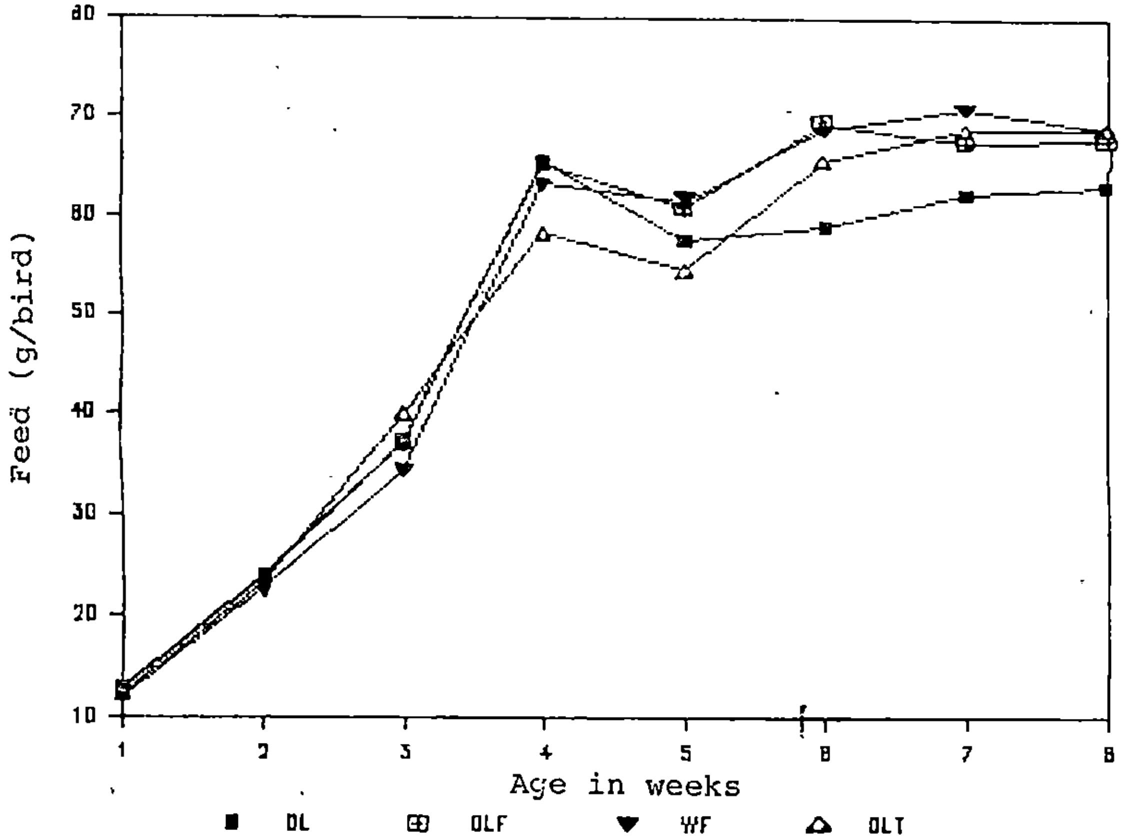
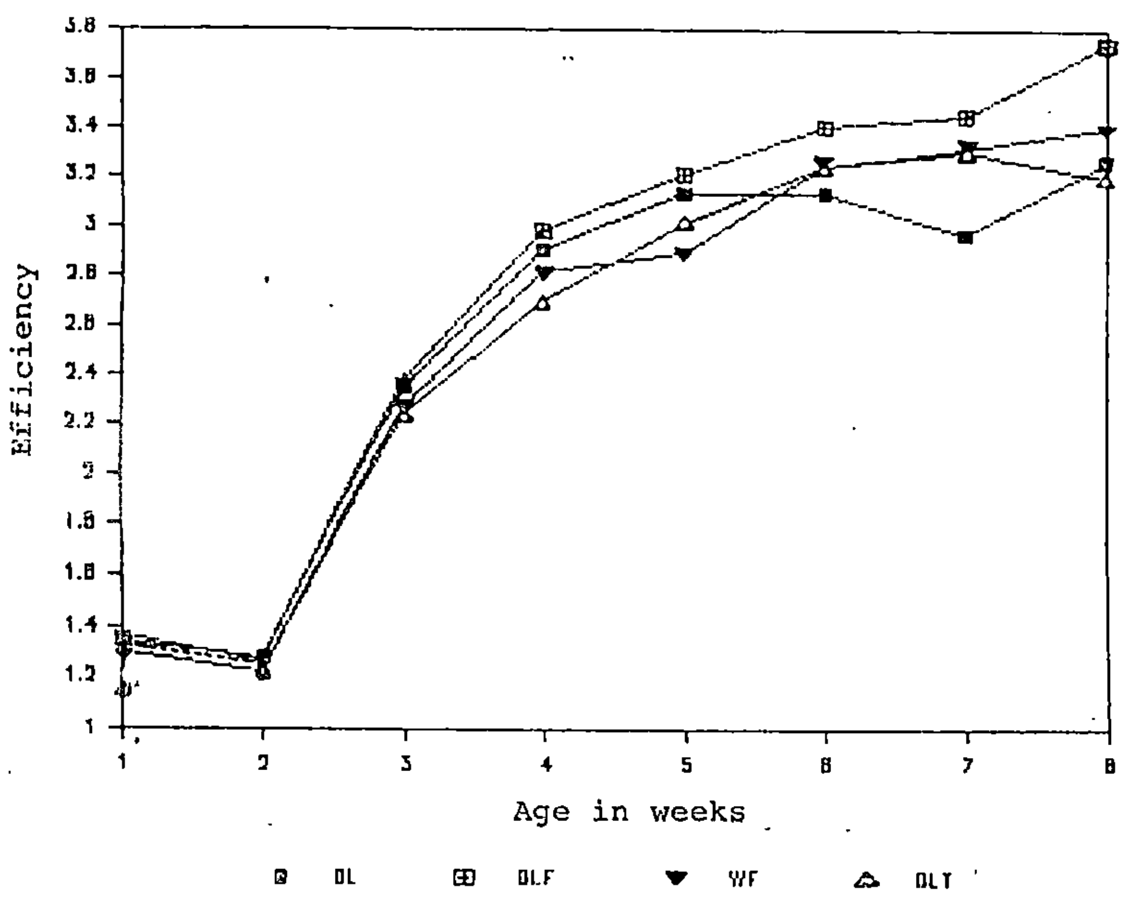


Fig. 3b. WEEKLY FEED EFFICIENCY



At the end of seventh week, the cumulative efficiency of 2.98 recorded with litter floor having ACC roofing was significantly superior over those of other systems. Here the mean values recorded in respect of litter floor with fan ventilation and that with wire floor under ACC roofing were 3.46 and 3.32 respectively. The feed efficiency with litter floor having tile roofing was 3.31. The differences between the above mean values were not statistically significant.

The cumulative feed efficiency at the end of eighth week averaged 3.75 with litter floor having fan ventilation under ACC roofing and was significantly inferior to all other systems ($P<0.05$). The mean values recorded with litter floor and wire floor systems (3.27 and 3.41) under ACC roofing were comparable among each other and with litter floor having tile roofing (3.21) as well. (Fig 3).

Cloacal Temperature

The cloacal temperature of birds housed under various rearing systems are presented in Table 9. Statistical analysis of the week-wise data revealed that the housing systems significantly influenced the cloacal temperature from fifth week onwards until seventh week of age.

Table 9. Mean weekly cloacal temperature (°C) of broilers as influenced by different housing systems

Housing Systems	Age in weeks						Overall Mean
	3	4	5	6	7	8	
<u>Asbestos Roofing</u>							
Deep litter floor	42.3	42.2	42.3^{a}	42.1^{a}	41.8^{ab}	42.0	42.1
Litter floor with fan ventilation	42.4	42.2	42.3^{a}	42.1^{a}	42.0^{a}	42.1	42.2
Wire floor	42.3	42.1	42.2^{ab}	42.0^{a}	41.6^{b}	42.0	42.0
<u>Tile Roofing</u>							
Deep litter floor	42.2	42.0	41.9^{b}	41.6^{b}	41.6^{b}	41.9	41.9
Overall Mean	42.3	42.1	42.2	42.0	41.8	42.0	42.1

Means bearing same superscripts within the columns did not differ significantly ($P<0.01$)

At third and fourth weeks of age, variations in cloacal temperature of birds observed among various housing systems were low and statistically non-significant. The third week mean temperature ranged from 42.2 to 42.4°C with an overal mean of 42.3°C and that of fourth week ranged from 42.0 to 42.2°C with an overall mean of 42.1°C.

The mean cloacal temperature of birds recorded with various rearing systems under ACC roofing were statistically comparable among each other, at fifth week. The mean values recorded with litter floor, litter floor with fan ventilation and wire floor were 42.3, 42.3 and 42.2°C respectively. The mean temperature recorded with litter floor having tile roofing was 41.9°C. This was comparable with wire floor but diffrent from other two systems under ACC roofing ($P<0.05$).

Similar trend of results with various systems in the house with ACC roofing were observed during sixth week of age. No appreciable difference between the mean values could be observed between different floor types under ACC roofing. The mean value recorded on litter floor with and without fan ventilation was found to be the same ie; 42.1°C and that with wire floor system was 42.0°C. However the mean termperature of 41.6°C recorded with birds reared on litter floor under tile roofing was significantly low in comparison with systems under ACC roofing ($P<0.05$).

The overall mean of cloacal temperature with various rearing systems were statistically similar and were 42.1, 42.2 and 42.0°C with litter floor, litter floor with fan ventilation and wire floor systems under ACC roofing respectively. With litter floor having tile roofing it was found to be 41.9°C and statistically comparable with other systems.

Ambient Temperature

Maximum and minimum temperature

The maximum and minimum temperature recorded every day and the mean of these values for weekly intervals wer subjected to statistical analysis and the results are presented in Table 10. The overall mean of maximum temperature over the period of eight weeks in each housing system differed significantly from one another (P <0.01). In the house with ACC roofing, the mean maximum temperature recorded in pens with litter floor was 36.8°C, litter floor with fan ventilation was 36.5°C and with wire floor was 36.1°C. The maximum temperature observed with litter floor under tile roofing was 35.5°C, being the lowest among rearing systems. The same trend of results observed during fourth and seventh weeks of age were statistically significant (P <0.01).

The overall mean of maximum temperature for weekly periods revealed that it was significantly lowe during third week

Table 10. Weekly averages of maximum, minimum and mean temperature (°C) in the house as influenced by different housing systems

Housing Systems	3			4			5			6			7			8			Overall Mean		
	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
<u>Asbestos Roofing</u>																					
Deep litter floor	35.1	24.6	29.9	37.9^{d}	26.2	32.1	37.1	27.4	32.3	36.1	26.5	31.3	36.6^{d}	25.2	30.9	37.7	26.4	32.1	36.8^{d}	26.1	31.5
Litter floor with fan ventilation	35.1	24.4	29.8	37.5^{c}	26.0	31.8	36.9	27.4	32.2	35.9	26.6	31.3	36.1^{c}	25.5	30.8	37.5	26.4	32.0	36.5^{c}	26.0	31.3
Wire floor	35.4	24.7	30.1	36.6^{b}	26.3	31.5	36.9	27.3	32.1	35.1	26.9	31.0	34.9^{b}	25.2	30.1	37.7	26.3	32.0	36.1^{b}	26.1	31.1
<u>Tile Roofing</u> Deep litter floor	35.0	26.6	30.7	35.5^{a}	26.6	31.1	36.6	27.4	32.0	34.4	26.9	30.7	34.5^{a}	25.9	30.2	36.9	26.3	31.6	35.5^{a}	26.6	31.1
Overall mean	35.2^{a}	25.0	30.1	36.9^{c}	26.3	31.6	36.9^{c}	27.4	32.2	35.4^{b}	26.7	31.1	35.5^{b}	25.5	30.5	37.5^{d}	26.4	31.9	36.2	26.2	31.3

Values bearing same superscripts within the columns as well as overall means in the row did not differ significantly ($P < 0.05$)

(35.2°C) in comparison with other ages. The temperatures recorded during fourth and fifth week were similar (36.9°C) and that during sixth and seventh week were also similar statistically (35.4 and 35.5°C). But the sixth and seventh week temperatures were significantly lower than that of fourth and fifth week. The overall mean temperature recorded during eighth week was 37.5°C and was found to be the highest among the periods of experimentation.

The mean daily minimum temperature over the period of eight weeks averaged 26.1, 26.0 and 26.1 with litter floor, litter floor with fan ventilation and wire floor systems in the house with ACC roofing respectively, and were comparable among each other. With litter floor under tile roofing, the minimum temperature was 26.6°C and were found statistically similar to among other housing systems. The overall mean minimum temperature for weekly periods were statistically comparable among each other from three to eight weeks of age. During these periods the mean values ranged from 25.0 to 27.4°C with an overall mean of 26.2°C. The variations in mean daily temperature were non-significant.

Relative Humidity

The mean R.H. per cent calculated on the basis of Dry and Wet bulb temperatures in morning and evening were presented in Table 11. None of the values showed statistical significance.

Table 11. Mean Per cent relative humidity inside the house as influenced by different housing systems

Housing Systems	Ages in weeks 3			4			5			6			7			8			Overall Mean		
	MOR	AN	MEAN	MOR	AN	MEAN	MOR	AN	MEAN	MOR	AN	MEAN	MOR	AN	MEAN	MOR	AN	MEAN	MOR	AN	MEAN
Asbestos Roofing																					
Deep litter floor	84	46	65	85	46	65.5	79	49	64	85	52	68.5	79	53	66	83	51	67	82.5	49.5	66
Litter floor with fan ventilation	84	46	65	85	45	65.0	79	49	64	84	51	67.5	80	56	68	85	48	66.5	82.8	49.2	66
Wire floor	81	47	64	82	45	63.5	86	50	68	82	54	68.0	81	51	66	83	44	63.5	82.5	48.5	65.5
Tile Roofing Deep litter floor	80	48	64	78	45	61.5	89	49	69	85	52	68.5	80	51	65.5	80	51	65.5	82.0	49.3	65.7
Overall mean	82.3	46.8	64.5	82.5	45.3	63.9	83.3	49.3	66.3	84	52.3	68.1	80	52.8	66.4	82.8	48.5	65.6	82.5	49.1	65.8

The bird level R.H. per cent recorded using whirling psychrometer are presented in Table 12. This revealed that the overall morning relative humidity per cent at the bird level were not significantly influenced among the rearing systems in the house with ACC roofing. During the entire period of experiment, the overall mean per cent R.H. recorded with litter flor, litter floor with fan ventilation and wire floor systems were 85.2, 85.3 and 84.7 respectively. Whereas, the per cent R.H. of 82.6 recorded with litter floor under tile roofing was significantly low in comparison with those of other systems under ACC roofing ($P < 0.05$). Howerver, the overall mean weekly per cent R.H at the bird level in the morning from three to eight weeks did not differ among themselves. The mean values were ranged from 83.8 to 85.8 per cent with an overall mean of 84.4 per cent in the morning.

The per cent R.H. at the bird level in the afternoon averaged 51.8, 50.5 , 48.3 and 47.8 in litter floor, with fan ventilation, wire floor systems and under ACC roofing and that with litter floor under tile roofing, respectively. Among the various systems, the R.H. recorded with litter floor under ACC roofing was significantly higher than that of wire floor system under the same roofing and litter floor under tile roofing ($P < 0.01$). The weekly mean per cent R.H. during sixth and seventh week (53.0 and 54.3) were comparable each other. Both the

Table 12. Mean per cent relative humidity at the bird level as influenced by different housing systems

Housing Systems	Ages in weeks																				
	3			4			5			6			7			8			Overall Mean		
	MOR	AN	MEAN	MOR	AN	MEAN	MOR	AN	MEAN	MOR	AN	MEAN	MOR	AN	MEAN	MOR	AN	MEAN	MOR	AN	MEAN
Asbestos Roofing																					
Deep litter floor	85.0	48.0	66.5	84.7	48.0	66.4	83.7	51.0	67.4	88.3	55.0	71.7	83.1	57.0	70.1	86.6	52.0	69.3	85.2[a]	51.8[b]	68.5
Litter floor with fan ventilation	85.4	48.0	66.7	83.0	47.0	65.0	83.7	48.0	65.9	87.0	54.0	70.5	86.4	56.0	71.2	86.1	50.0	68.1	85.3[a]	50.5[ab]	67.9
Wire floor	83.4	47.0	65.2	86.1	44.0	65.1	84.9	46.0	65.5	85.3	52.0	68.7	84.1	54.0	69.1	84.3	47.0	65.6	84.7[a]	48.3[a]	66.5
Tile Roofing																					
Deep litter floor	81.7	49.0	65.4	81.3	48.0	64.7	84.4	46.0	65.2	82.4	51.0	66.7	83.0	50.0	66.5	82.4	43.0	62.7	82.6[b]	47.8[a]	65.2
Overall mean	83.9	48.0[a]	66.0	83.8	46.8[a]	65.3	84.2	47.8[a]	66.0	85.8	53.0[b]	69.4	84.2	54.3[b]	69.2	84.9	48.0[a]	66.4	84.4	49.6	67.0

Overall means bearing same superscripts within the columns and in the row did not differ significantly ($P < 0.05$)

values were significantly higher in comparison with those recorded during other ages. However the mean values recorded during third, fourth, fifth and eighth weeks were not significantly different from one another and were 48.0, 46.8, 47.8 and 48.0 per cent respectively during this ages.

Livability

The overall mean per cent livability recorded with litter floor, litter floor with fan ventilation and wire floor systems under ACC roofing were 99.3, 95.0 and 97.9 respectively. The livability per cent with litter floor rearing under tile roofing was 95.7. None of these values were statistically different among each other (Table 13).

Ammonia level

The pH values were ranged from 7 to 8 and the corresponding ammonia levels were from 20 to 50 ppm in various systems of rearing and are presented in Table 14. The ammonia level in each of the housing system was estimated after determining the pH levels using multi-coloured litmas paper. The ammonia levels to the corresponding pH indicated that none of the housing conditions significantly influenced the ammonia concentration inside the houses.

Table 13. Mean weekly per cent livability (from three to eight weeks) as influenced by different housing systems

Housing systems	Age in weeks						Overall Mean
	3	4	5	6	7	8	
<u>Asbestos Roofing</u>							
Deep litter floor	100	100	100	100	99.3 (1)	100	99.3 (1)
Litter floor with fan ventilation	100	99.3 (1)	100	97.1 (4)	99.3 (1)	99.3 (1)	95.0 (7)
Wire floor	100	100	100	99.3 (1)	98.6 (2)	100	97.9 (3)
<u>Tile Roofing</u> Deep litter floor	100	99.3 (1)	98.6 (2)	99.3 (1)	98.5 (2)	100	95.7 (6)
Overall mean	100	99.6 (2)	99.6 (2)	98.9 (6)	98.9 (6)	99.3 (1)	96.7 (17)

Numbers in paranthesis indicate the number of deaths

Table 14. The pH ranges and corresponding levels of ammonia in different housing systems

Housing systems	Age in weeks					
	3	4	5	6	7	8
<u>Asbestos Roofing</u>						
Deep litter floor	7.5 (35)	7.5 (35)	7.5 (35)	8.0 (50)	8.0 (50)	8.0 (50)
Litter floor with fan ventilation	7.0 (20)	7.5 (35)	8.0 (50)	7.5 (35)	8.0 (50)	7.5 (35)
Wire floor	7.0 (20)	7.0 (20)	7.5 (35)	7.5 (35)	7.5 (35)	7.5 (35)
<u>Tile Roofing</u> Deep litter floor	8.0 (50)	7.5 (35)	7.5 (35)	8.0 (50)	7.5 (35)	8.0 (50)

The figures in parenthesis indicate the levels of ammonia in ppm.

Carcass Yields and Losses

The processing yields and losses as influenced by housing systems were recorded after carrying out slaughter studies at the end of eighth week. The data collected in respect of per cent yields and losses are presented in Table 15. Statistical analysis of the data revealed that the loss due to shrinkage on fasting were 4.22, 4.82, 4.38 and 3.88 per cent with litter floor, litter floor with fan ventilation and wire floor under ACC roofing, and that with litter floor under tile roofing, respectively. None of these mean values were significant. The overall mean shrinkage loss was found to be 4.31 per cent.

The per cent blood with the above systems were 2.46, 3.00, 3.30 and 3.86 respectively with an overall mean of 3.2 per cent. The per cent feather was 2.62, 3.00, 2.99 and 2.86 among various systems respectively with an overall mean of 2.89 per cent. The housing systems did not significantly influence the per cent blood and feather. The dressed yield averaged from 93.28 to 94.92 per cent with an overall mean of 93.90 per cent did not differ significantly among rearing systems.

The total losses including head, shank viscera, blood and feather when analysed statistically found that the total loss was significantly high with litter floor rearing in the house with

Table 15. Mean per cent yields and losses of broilers at eight week of age as influenced by housing systems

Characters	Housing systems				Overall Mean
	Asbestos roofing			Tile roofing	
	Deep litter floor	Litter floor with fan ventilation	Wire floor	Litter flloor	
Shrinkage	4.22 ± 0.27	4.82 ± 0.56	4.33 ± 0.42	3.88 ± 0.59	4.31 ± 0.19
Blood	2.46 ± 0.35	3.00 ± 0.41	3.30 ± 0.33	3.86 ± 0.11	3.21 ± 0.29
Feather	2.62 ± 0.34	3.00 ± 0.72	2.99 ± 0.36	2.86 ± 0.55	2.89 ± 0.09
Dressed yield	94.92 ± 0.39	94.00 ± 0.50	93.71 ± 0.43	93.28 ± 0.63	93.90 ± 0.38
Eviscerated yield	66.83 ± 0.82	68.95 ± 0.10	68.89 ± 0.78	67.77 ± 1.08	68.03 ± 0.94
Total loss	27.82 ± 0.84^{b}	25.86 ± 0.70^{a}	26.02 ± 0.67^{a}	26.73 ± 0.76^{ab}	26.69 ± 0.46
Giblets	5.35 ± 0.18	5.19 ± 0.23	5.09 ± 0.20	5.50 ± 0.15	5.28 ± 0.09
Ready-to-cook yield	72.18 ± 0.80^{b}	74.14 ± 0.14^{a}	73.98 ± 0.60^{a}	73.27 ± 0.63^{ab}	73.31 ± 0.46

Means bearing same superscript within the rows did not differ significantly ($P<0.05$)

ACC roofing (27.82 per cent). Litter floor with fan ventilation and wire floor systems under ACC roofing recorded a total loss of 25.86 and 26.02 per cent and were comparable each other. With litter floor having tile roofing, the percent total loss (26.73) was comparable with other systems.

The eviscerated yield with various systems were found statistically non-significant. Under ACC roofing, birds on litter floor, litter floor with fan ventilation and wire floor systems averaged an yield of 66.83, 68.95 and 68.89 per cent respectively. The litter floor under tiled roof yielded 67.77 per cent. The per cent Giblet yield in the above systems were 5.35, 5.19, 5.09 and 5.50 respectively and were non-significant among each other. The housing systems significantly influenced, the per cent ready-to-cook yield (R to C) at eighth week. Among the systems in the house with ACC roofing, the mean R to C yield of 72.18 per cent recorded with litter floor reared birds was significantly lower than those recorded on litter floor with fan ventilation and wire floor systems where in the mean values recorded were 74.14 and 73.98 per cent respectively. The R to C yield of 73.27 per cent registered with litter floor under tile roofing was comparable with the yields in all other systems or rearing in the house with ACC roofing.

Economics

The economics of broiler production under various rearing systems were estimated based on feed cost and return over feeding cost and data are presented in Table 16. This revealed that the value of broilers at eighth week were lowest with broilers reared on deep litter system with fan ventilation (Rs. 16.58) and the highest with broilers reared on litter floor in the house with tile roof (Rs. 18.56). The similar trend of results were observed in respect of returns over feeding cost in the above two systems. The value of broilers reared in the house with asbestos roof were Rs. 17.84 and 18.26 per bird with deep litter and wire floor systems respectively.

The feeding cost inclusive of cost of starter and finisher diets were equal (Rs. 10.90) for birds reared on wire floor system and deep litter system with fan ventilation in the house with asbestos roof. The feeding cost of broilers reared on deep litter system in the houses with asbestos roof and tiled roof were Rs. 10.27 and 10.57 respectively. The returns over feeding cost ranged from Rs. 5.68 to 7.99 among various systems of housing. The lowest return was with birds reared in fanned environment in the house with asbestos roof (Rs. 5.68) and highest with birds reared on deep litter system in the house with tiled roof (Rs. 7.99). The reurns from birds reared on deep litter and wire floor systems were Rs. 7.57 and 7.36 respectively in the house with asbestos roof.

Table 16. Cost of feeding and returns over feed cost (Rs.) of broilers at eigth week as influenced by housing systems

Housing system	Eigth week body weight (g)	Broiler value (Rs.)	Cost of feeding (Rs.)	Returns over feed cost (Rs.)
<u>Asbestos Roofing</u>				
Deep litter floor	811.15	17.84	10.27	7.57
Litter floor with fan ventilation	753.85	16.58	10.90	5.68
Wire floor	830.05	18.26	10.90	7.36
<u>Tile Roofing</u>				
Deep litter floor	843.65	18.56	10.57	7.99

Discussion

DISCUSSION

Body weight

The overall mean body weight of day-old chick was 38.4 ± 0.5g and that at the end of first week was 69.82 ± 2.02g. The maginitude of increase in body weight was only 31.42 g during first week. Commercial broilers normally have an increase of around 80 g from their hatch weight during first week of their life. During first week of the study the relative humidity in the house was 86.8 per cent in the morning and 47.8 per cent in the afternoon (Table 2). The brooding temperature of 35°C with the high relative humidity would have contributed for the poorer weight gain. Reece and Deaton (1971 c) observed high temperature and high relative humidity as an initial stress factor.

The mean body weight of chicks at the end of second week averaged 132.11 g. The weight gain during second week was 62.29 g with a cumulative weight gain of 93.73 g. The relative humidity in the house during second week of age was 87.2 per cent in the morning and 48.2 per cent in the afternoon (Table 2). The poorer gains in weight during these periods could be due to the higher humidity coupled with higher brooder temperatures. The thermal environment in the house simulate to the summer climate classified for Kerala during the month of March (Somanathan 1980). Yausef et al. (1989) reported lower body weights in chicks exposed to hot-dry and hot-humid seasons of the year. The observations made in this study upto second week is in agreement with the results obtained by the above authors.

At the commencement of the experiment, that is at the end of second week, the mean body weights of chicks alloted to various housing systems were statistically comparable among themselves indicating homogenity and uniformity among experimental groups.

At the end of third week, the mean body weights of broiler chicks were 215.81 g with deep litter system of rearing, 213.09 g with litter floor rearing having fan ventilation and 215.52 g with wire floor system of rearing in the house with asbestos roof. Statistical analysis (Table 3) revealed that the differences in body weights among the groups under asbestos roofing were non-significant. Whereas, the chicks reared in the tiled roof house (deep litter floor) showed significantly higher body weights (230.34 g) than the other systems of rearing in the house with ACC roofing ($P < 0.05$). The data on weekly gains in weight (Table 4) also revealed similar trend during third week. Significantly higher weight gain (98.48 g) was obtained in chicks reared with deep litter system in the tiled roof house than other groups reared in the house with asbestos roof ($P < 0.05$). The quantum of gain in body weights at the end of third week among the chicks of various rearing systems under asbestos roofing were statistically similar, eventhough numerically different.

At third week, the relative humidity in the house with tile roof was 80 per cent in the morning and 48 per cent in the afternoon. Whereas, the values of relative humidity for deep litter system with and without fanned environment in the house with asbestos roof were equal and averaged 84 per cent in the morning and 46 per cent in the afternoon. For asbestos roofing with wire floor, it was 81 and 47 per cent in the forenoon and afternoon respectively. In as such as the brooding temperature for all the treatment groups being uniform, the environmental variable affecting the growth rate was the relative humidity. Thus, at third week the birds in the house under tile roofing has been subjected to less humidity stress. Possibly, this factor has contributed for greater growth response and added more weight in chicks reared under tile roof than those chicks reared in the house under asbestos roof. The differences in radiation from the heated ACC and tiles, the higher evaporation from the porous tiles keep the environment cooler in the house with tiled roof reduced heat stress. Griffin and Vardaman (1971) reported adverse effects on the body weight gain of chicks in cyclic temperature due to increased relative humidity in the house.

At the end of fourth week of age, the birds averaged a body weight of 332.08 $\pm$ 4.25 g for all the groups put together. The magnitude of differences among different treatment groups were statistically non-significant. However, the birds reared under tiled roof with deep litter system showed numerically higher body weights (342.92 g) than other groups reared in the asbestos roofed house. During fourth week relative humidity in the house with tile roofing was lower (78 per cent) than those of other treatment groups in the house with asbestos roofing wherein the relative humidity ranged from 82 to 85 per cent in the morning.

The broilers averaged a body weight of 442.85 g at fifth week for all the groups put together. Significantly better body weight (469.07 g) was obtained in birds reared on wire floor system in the house with asbestos roof. Pone et al. (1985) also reported significantly greater body weights in broilers reared on raised floor than those kept on deep litter floor, is in agreement with the results of the present study. The differences in body weights deep litter systems in the house with asbestos roof as well as that with tiled roof were inferior but statistically comprable among each other. The gain in weight during this period also revealed the same trend (Table 4). It is interesting to note that the birds under tile roofing with deep litter system had numerically least weight gain during fifth week. In as much as the brooding has been dispensed with at this age, the results have to be viewed in relation to the environmental temperature as well as relative humidity in the house. Seriff and Kothandaraman (1987) who reported better body weights in broilers reared on weld mesh floor agreas with results of present study.

The ambient temperature, maximum ranged from 36.6 to 37.1°C and minimum ranged from 27.3 to 27.4 °C during fifth week, among the various systems of rearing. Likewise, the relative humidity ranged from 79 to 89 per cent in the morning and 49 to 50 per cent in the afternoon. It was seen (Table 11) that fifth week humidity recorded in the morning in the house with tile roof was the highest (89 per cent). It could be possible that this high humidity has imposed a most stressful environment on these birds limiting faster growth rate which were exhibited by this group at earlier ages.

The overall mean body weights of broilers irrespective of housing systems were 556.81±6.4 g and 702±14.43 g respectively at sixth and seventh week of age. The magnitude of differences among the four treatment groups were statistically non-significant at both these ages. Aggarwal et al. (1981) also reported lower body weights in broilers during summer season. The body weight gains during these ages did not vary significantly among the four treatment groups. However, numerically higher weight gains were recorded with birds reared on deep litter floor in the house with ACC roof during sixth and seventh week.

The micro-environment in the various rearing systems during sixth and seventh weeks of study revealed that the maximum and minimum temperatures were ranged from 34.4 to 36.1°C and 26.5 to 26.9°C during sixth week and 34.9 to 36.6°C and 25.2 to 25.5°C during seventh week respectively. Likewise, the ranges of relative humidity were 82 to 85 per cent in the morning and 51 to 54 per cent in the afternoon during sixth week. The corresponding values of relative humidity during seventh week were 79 to 81 per cent (F.N.) and 51 to 56 per cent (A.N.) among the various housing systems studied. High temperature and high humidity during these periods made the environment extremely stressful and uncomfortable for the birds. This resulted in lower weight gains and consequently poor weekly body weights in broilers reared under all systems of rearing. These results are in agreement with the low body weights reported by Linyu (1985) and Yausef et al. (1989) for broilers reared in summer and hot-humid seasons.

In the present study, the eighth week body weights of all experimental groups put together averaged 809.66 ± 19.76 g. The differences in body weights among treatment groups were statistically non-significant. Nair (1983) had obtained low body weights at eighth week in New Hampshire breed of chicken reared during summer season is in partial agreement with the results of this study. The weekly weight gain registered during eighth week showed statistical difference among groups. Significantly higher weight gain (161.69 g) was recorded in birds reared on deep litter floor in the house with tiled roof. In this system, the peak gain was delayed by one week in comparison with those birds reared in the house with asbestos roof. The eighth week weight gain in birds reared on wire floor was intermediary (123.96 g) and statistically different from other groups reared in the same house with asbestos roofing. The weight gain during eighth week was lowest in birds reared on litter floor with fanned environment (68.98 g) but was statistically comparable with that of litter reared birds (73.5 g) in the same house with asbestos roof. However, these differences in weekly weight gains did not reflect significantly in the cumulative weight gains at the end of eighth week. The final body weights of birds reared under various systems were non-significant. Simpson and Nakaue (1987) also found that the mean body weights of broilers were not significantly different among different floor types studied.

During eighth week the diurnal cyclic temperature ranged from a minimum of 26.3 to a maximum of 36.9°C with deep litter system in the house with tiled roof and 26.3 to 37.7°C with wire floor system under asbestos roofing. In the above systems of rearing, the relative humidity ranged from 51 to 80 per cent and

44 to 83 per cent respectively. The mean daily humidity was 65.5 per cent with litter floor under tile roofing and 63.5 per cent with wire floor under asbestos roofing. The deep litter system with and without fanned environment showed a mean daily relative humidity of 66.5 and 67 per cent with maximum temperature of 37.5 and 37.7°C respectively. Both these systems registered daily minimum temperature of 26.4°C during eighth week.

Thus, analysing the data on body weight (Table 3) it could be seen that birds under tiled roof had better or comparable body weights throughout the experiment. But the initial significant quantum of improvement observed at third week was seen retarded subsequently from fifth week onwards. These birds showed better growth response during eighth week when the peak gain was recorded. Looking at the data on weekly weight gain (Table 4) it was observed that the quantum of weight gained by the chicks reared on litter floor in the house with tile roof during seventh and eighth week put together was the highest (301.21 g) in comparison with other systems of rearing.

The peak gains in broilers reared with all systems in the house with asbestos roofing were observed by seventh week of age. With litter floor system under tile roofing, the peak gain was at eighth week of age. The birds reared on wire floor in the house with ACC roofing showed higher gains in weight during fifth and seventh week of age when the amplitude of variation between maximum and minimum temperature was almost similar. In spite of better gains at two stages of growth the cumulative gain with chicks reared on wire floor was lower than those reared on litter floor under tile roofing indicating that the environment under the asbestos roofing was not favourable for better growth response.

Feed consumption and efficiency

The mean feed consumption per chick per day was 13.33 g during first week and 24.43 g during second week of age. The mean daily feed consumption per bird (Table 5) at different ages from third to seventh week revealed no statistical significance due to any of the housing system studied. Hence, only the numerical differences in feed consumption and efficiency in different housing, systems are discussed. The feed conversion efficiency with chicks during first week was 1.35. At second week, the cumulative efficiency was 2.28. At third week, chicks reared on litter floor under tile roofing showed a non-significant increase in feed intake (39.8 g per bird) with numerically better conversion efficiency (2.25). These chicks showed significantly higher gains as well as higher weekly body weights, at the end of third week (Table 4). This also indicated that the house environment during this period was more conducive for higher feed intake and better growth of broilers in the house with tile roofing.

In the poultry house with asbestos roof, the feed intake with chicks reared on litter floor and that with fanned environment were equal and intermediary (37.1 g) during this week. The conversion efficiency in the above systems were numerically poor indicating that the environment with these systems were neither congenial for higher feed intake nor ideal for efficient conversion of feed. The birds reared on wire floor in the house with asbestos roof, consumed less feed but resulted in gains equal to those of other systems in the same house, with a better conversion ratio (2.28) at the end of third week. However, with all systems of rearing the feed intake as well as feed efficiency at third week were statistically non-significant among theselves.

At fourth week, the change in R.H. in the house with tiled roof resulted in numerically lower feed intake (58.18 g) than those chicks reared on deep litter floor wtih ACC roof (65.30 g per chick). The environment with a low relative humidity of 78 per cent in the house with tile roof was found ideal for efficient feed utilisation as evidenced by significantly better cumulative feed efficiency in this house (2.7).

In the house with ACC roofing the feed intake were uniform with the three groups. The conversion efficiency was better with chicks reared on wire floor (2.82) than litter floor with fanned environment (2.99) which registered the poorest efficiency of conversion at the end of fourth week. However, the efficiency of conversion with chicks reared on litter floor under ACC roofing (2.91) was found statistically comparable with those of other two systems in the same house. These results indicated that the environment in the wire floor system was more favourable for better feed conversion in the house with asbestos roof. This is anticipated in view of equal feed intake and comparatively better gains (Table 4) during fourth week with chicks reared on wire floor. The significant differences in maximum temperature during fourth week prevented higher feed intake with all systems of rearing. The overall mean daily feed intake per bird was only 62.97 g during fourth week.

At fifth week, the feed consumption of chicks in various systems of rearing were statistically comparable. Moreover, the feed intake of chicks reared on wire floor and that with litter floor having fanned environment situated in the house with asbestos roof were almost equal (61.32 and 60.66 g) and were numerically higher than those of others. The cumulative conversion efficiency was better only with chicks reared on wire floor (2.90) due to significantly higher weight gains recorded in this system during fifth week (Table 4). Seriff and Kothandaraman (1987) reported better feed efficiency for crowded groups of broilers. This is in agreement with results obtained with wire floor system where the floor space given was less in comparison with other rearing systems studied. The ambient temperature fluctuations being same, the variation of lower relative humidity (79 per cent) with chicks reared on litter floor with fanned environment might be due to increased air movement. The chicks reared on litter floor under tiled roof consumed less feed during fifth week resulting in lowest gain during this age.

The feed consumption during sixth week in chicks reared on litter floor (58.82) was numerically lower than those reared on litter floor with fanned environment (69.22 g) in the house with asbestos roofing. Significantly better cumulative feed conversion was noticed in the former group (3.14) than the latter group (3.41). However, the result did not show any definite trend in favour of any particular system. But nonetheless, it indicated that the conversion efficiency will be better at high ambient temperature. At the same time the increased air movement in fanned environment might have resulted in higher heat loss and consequently poor cumulative efficiency in this group.

Likewise, at seventh week the feed consumption in chicks reared on litter floor in the house with asbestos roofing was numerically low (62.12 g). It resulted in significantly better cumulative feed efficiency (2.98). Among other treatment groups, the differences in feed intake as well as feed efficiencies were not significant. These findings agree with the observation of Andrews et al. (1990) who reported significantly superior feed conversion rate in broilers grown on litter floor than those reared on raised floors.

The eighth week feed consumption was significantly low with birds reared on litter floor in the asbestos roofed house (62.94 g). The feed consumption of birds in the other three systems of rearing were almost equal ranging from 67.46 to 68.72g during eighth week. However the cumulative feed efficiency at eighth week was significantly poor in birds reared on deep litter system with fanned environment (3.75) in the house with asbestos roofing. The birds in the other groups exhibited relatively better efficiency. It ranged from 3.21 to 3.41 and the differences among them were non-significant.

The overall assessment of the cumulative feed efficiency data revealed that there is shift in statistical significance at intermediary ages among the different systems of housing. Finally at eighth week, the numerical value of cumulative feed efficiency in birds reared on deep litter system under tiled roof showed a superior value of 3.21. Likewise, the birds reared on deep litter system in the house with asbestos roof showed a conversion ratio (3.27) better than those birds reared on wire floor (3.41). However those birds grown on deep litter floor with fanned environment registered significantly poor cumulative feed efficiency (3.75). This trend is obvious when we examine the data on cumulative feed intake (Table 7) and cumulative weight gain (Table 6) in the reespective system of housing.

Cloacal Temperature

The mean weekly cloacal temperature of birds during third and fourth week of age were not influenced by the housing systems (Table 9). On the other hand at fifth week of age, the cloacal temperature was 41.9°C in birds reared on litter floor in the house with tile roof and was significantly lower than those reared in the house with ACC roofing excepting wire floor reared birds (42.2°C). Among the birds reared on various floor types in the house with asbestos roof, it was statistically comparable and were same in birds reared on litter floor with and without fan ventilation (42.3°C).

At sixth week, the cloacal temperature of birds reared on litter floor under tile roof averaged 41.6°C and was significantly lower than those reared in the house with asbestos roof, where it averaged 42.1°C with birds reared on different floor types. The birds reared in the house with tile roof showed a reduction in cloacal temperature by 0.3°C during sixth week in comparison with fifth week.

At seventh week, the cloacal temperature of birds reared on litter floor in the house with tile roof averaged 41.6°C and was significantly lower than that of birds reared on litter floor with fan ventilation in the house with asbestos roof where it averaged 42.0°C. This was significantly higher than those birds reared on wire floor (41.6°C) but was comparable with those birds reared on deep litter system (41.8°C) in the same house. The difference in cloacal temperature between birds reared on deep litter and wire floor in the same house was non-significant.

At eighth week, the cloacal temperature was statistically comparable in all groups of birds reared in the two houses. The lowest being in birds reared on deep litter under tiled roof (41.9 °C) and the highest with birds reared on deep litter with fan ventilation in the house with asbestos roof (42.1°C). Sykes and Fataftah (1986) reported that acclimatisation of broilers were characterised by a progressive reduction in cloacal temperature.

Thus, the results from three to eight weeks of age clearly showed that the cloacal temperature of birds reared on deep litter systems in the house with tile roofing were lower than those under asbestos roofing, consistently at all ages studied. This might be due to a lowered radiation of heat from tile roof in comparison with higher radiation from asbestos roof.

Ambient Temperature

The maximum and minimum temperature recorded in various housing systems presented in Table 10 revealed statistical significance in respect of maximum temperature only. This indicated that the housing systems influenced maximum temperature inside the house. Whereas none of these systems could make marked variations in minimum temperature inside the house. Huston (1965), and Morrison and Mcmillan (1986) also reported significant influences in production performance of broilers due to variations in maximum temperature inside the house.

At third week, the maximum temperature showed least variation between housing systems where in ranged from 35 to 35.4°C with an overall mean of 35.2°C. This was the lowest in comparison with subsequent ages. However, the litter floor under tile roofing with a temperature of 35°C resulted in significantly higher weight gain and weekly body weight at third week.

At fourth week, significant increase in temperature was observed from 35.6 to 37.9°C among the various housing systems. A progressive increase in temperature was observed from 35.5°C with litter floor under tile roofing. Higher temperature with wire floor, litter floor with fan and without fan ventilation averaged as 36.6, 37.5 and 37.9°C respectively under ACC roofing.

However, the influence due to temperature did not reflect significantly in production traits of weight gain and weekly body weight at fourth week of age.

The overall maximum temperature at fourth and fifth week means were comparable. At sixth and seventh week the overall maximum temperature of all housing systems put together were comparable. But at seventh week, the temperature showed significant variation among housing systems similar to that observed at fourth week. At eighth week, no statistical significance was observed among rearing systems. The overall mean for three to eight week in each system showed that the maximum temperature significantly increased from 35.5 to 36.8°C, lowest being with Deep Litter in the tiled house and highest with the Deep Litter in the house with asbestos roof.

The overall effect of temperature in respect of body weight and feed intake were comparable among housing systems. But significantly poor conversion efficiency was recorded with fan ventilation under ACC roofing. The weekly mean of maximum temperature showed statistical signifiance as the age advanced. The temperature at third week (35.2°C) was significantly lower than that at eighth week (37.5°C).

Relative Humidity

Relative humidity inside the pens recorded were statistically comparable among housing systems. It was found to be high in the morning and low in the afternoon.

The relative humidity recorded at the level of birds using Whirling Psychrometer showed significant differences in the morning and afternoon R.H. per cent. The relative humidity in the morning was significantly lower with litter floor under tile roofing than those of other systems under ACC roofing where in it was comparable among themselves. Relative humidity in the afternoon was significantly lower with litter floor under tile roofing. Significantly higher relative humidity was observed with litter floor under ACC roofing in comparison with wire floor under ACC roofing.

Livability

The overall livability recorded (Table 13) during the period from three to eight weeks of age was 96.7 per cent. When treatment groups were considered separately, the livability was high with birds reared on deep litter system (99.3 per cent) and the lowest in birds reared on litter floor with fan ventilation (95 per cent), in the house with asbestos roof. Thus it can be surmised that the system of housing employed in the study has not influenced livability adversely.

Ammonia

The ammonia levels in the pens were judged by using multi-coloured litmus paper and the corresponding pH values were arrived. The level of ammonia corresponding to the colour reaction and pH presented in Table 14 indicated that the pH values were in the range of 7 to 8 among various housing systems and corresponding ammmonia concentration in the houses were 20 to 50 ppm. None of the values were influenced significantly by the housing systems. These results indicated that the floor types and roof types studied did not result in ammonia levels reaching beyond 50 ppm in the houses. Sainsbury (1980) reported that ammonia levels upto 15-20 ppm in poultry houses did not affect the broiler performance adversely. He stated that, levels beyond 40 ppm resulted in reduction in feed intake and levels above 50 ppm affected the respiratory mucosal lining of birds. However, decline in feed intake was observed in the present study.

Processing Yields and Losses

The data on processing yields and losses presented in Table 15 showed that the losses due to shrinkage, blood and feather were not significantly influenced by the housing systems and are within the normal values reported for broilers, except for feather loss. Syam Sunder et al. (1988) reported loss of feather as 4.88 per cent. The lower percentage of feather observed in all groups of birds in the present study might be due to the adverse effects of summer leading to poor feather growth.

The total losses which ranged from 25.86 to 27.82 per cent among groups were found significantly influenced by housing systems. Among the groups of birds reared in the house with asbestos roof, the total loss was significantly higher in birds reared on deep litter floor (27.82) than those reared on litter floor with fan ventilation and wire floor. Huggins and Lewis (1980) reported that high temperature caused a reduction in edible yield from broilers. In the absence of statistically significant differences due to housing systems in respect of shrinkage, blood and feather losses, the differences noticed in total loss can be due to the differences in losses due to head, shank or viscera. These losses were not studied separately in this experiment. The total losses in broilers reared on litter floor under tile roofing was statistically comparable with those rearing systems in the house with asbestos roof. Eventhough, the eviscerated yield and giblet yields were not statistically significant among housing systems, the ready-to-cook yield showed statistical significance among the experimental groups. The edible yield was significantly lower from birds reared on deep litter system in the house with asbestos roof (72.18 per cent) than other systems of rearing in the same house.

The ready-to-cook yield from birds reared on litter floor in the tiled roof house (73.27 per cent) was statistically comparable with those of other systems in the asbestos roofed house. The trend of results observed with total losses and edible yields were similar as expected scientifically. Nonetheless, the overall ready-to-cook yield in this experiment was within the range of values reported by Narayanankutty et al. (1982). Mohapatra et al. (1984) reported that the total per cent meat yield was not affected by housing systems. Syam Sunder et al. (1988) observed ready-to-cook yield in broilers ranging from 70.80 to 73.64 per cent, is in agreement with the results of the present study.

Economics

The cost of feeding broilers from zero to eight weeks of age and the returns over the feeding cost were used to assess economic efficiency of each system of housing. The comparison of returns over feed cost (Table 16) indicated a return of Rs7.99 per bird being the highest from broilers reared on litter floor in the house with tile roof. The return was the lowest (Rs5.68) with birds reared on litter floor with fan ventilation in the house with asbestos roof. Apart from this, the additional costs involved in providing fanned environment reduces profit and it can be seen that this system is highly disadvantageous due to poorest feed conversion efficiency.

The returns over cost of feeding broilers raised on deep litter floor and wire floor in the house with asbestos roof were Rs7.57 and 7.36 respectively. Both these values were lower than that returned from birds reared on litter floor under tiled roof. When we consider the cost of asbestos roofing in poultry houses and the additional cost of wire floor it can be seen that the rearing systems are less economical under ACC roofing. The results of the study revealed that the rearing of broilers on litter floor in a house with tile roof is more advantageous and economical during summer under hot humid environment.

Summary

SUMMARY

An experiment was carried out to quantamise the performance of broilers in summer reared on different housing systems namely Deep litter system (DL), Deep litter with fan ventilation (DLF) and wire floor (WF) systems under Asbestos Cement Concrete (ACC) roofing; and deep litter system under tile roofing (DLT), during summer. Attempts were made to record environmental variables particularly ambient temperature and relative humidity in each of the housing systems.

Six hundred, day old commercial broiler chicks were brooded together initially for two weeks. At the end of second week 560 healthy chicks were selected and divided into four treatment groups of 140 each consisting of five replicates of 28 chicks in each group. Standard managemental practices were followed routinely in all experimental groups identically. Dried wood shavings were used as litter material in deep litter system. Hexagonal polymer mesh were used in wire floor system. Pedestal fans kept at a height of 90 cm were used to provide fanned environment. The experiment lasted for eight weeks. Broiler starter diet was fed during zero to six weeks and finisher diet from seven to eight weeks of age. Feed and water were provided <u>ad libitum</u> throughout the experiment.

The following observations were made in this investigation.

1. The eighth week body weight of broilers reared on deep litter, deep litter with fan ventilation and wire floor systems in the house with ACC roofing averaged 811.15, 753.85 and 830.05 g respectively. The mean body weight of broilers reared on deep litter system under tile roofing was 843.65 g. The statistical analysis revealed that the body weight of broilers reared on different systems were comparable statistically.

2. Mean daily feed consumption of broilers were statistically non-significant among housing systems, until eight weeks of age. The cumulative feed consumption per broiler during zero to eight weeks ranged from 2.65 to 2.82 kg among different housing systems were statistically non-significant among themselves.

3. The mean cumulative feed efficiency was significantly poor with broilers reared on deep litter system with fan ventilation under ACC roofing (3.75). The mean cumulative feed efficiency with deep litter system (3.27) and wire floor systems (3.41) of rearing in the house with ACC roofing were comparable with that of deep litter system in the house with tile roofing (3.21).

4. The cloacal temperature of broilers showed statistical differences among rearing systems during fifth, sixth and seventh week of age and were significantly low in broilers reared in the house with tile roofing (P <0.05).

5. The maximum temperature recorded in the house during the period of experimentation differed significantly among the different rearing systems as well as at different ages. The overall mean values were 36.8, 36.5 and 36.1°C with broilers reared on deep litter, deep litter with fan ventilation and wire floor systems under ACC roofing respectively. The maximum temperature in the house with tile roofing was 35.5°C. The overall mean maximum temperature in the house during third week was 35.2°C and during eighth week was 37.5°C.

6. The relative humidity inside the house averaged 82.5 per cent in the morning and 49.1 per cent in the afternoon. Both were statistically non-significant among rearing systems as well as between ages. The per cent relative humidity at the level of birds measured using whirling psychrometer was significanty lower both in the morning (82.6) and in the afternoon (47.8) with deep litter system of rearing under tile roofing.

7. The per cent livability was not adversely affected by any of the housing systems studied.

8. The ammonia levels inside the houses ranged from 20 to 50 ppm and were not statistically significant among the rearing systems.

9. At eighth week, the ready-to-cook yield from broilers were significantly low with deep litter system of rearing (72.16 per cent) in comparison with other rearing systems in the house with ACC roof. The ready-to-cook yield from broilers reared in the house with tiled roof (73.27 per cent) was comparable with those systems in the house with ACC roof. Similar trend of results were observed in respect of total losses studied.

10. The economics of rearing broilers under different housing systems during summer season revealed that returns over feeding cost were numerically higher with deep litter systems of rearing in the house with tile roof (Rs7.99 per broiler)

On the basis of above findings, it was concluded that the rearing of broilers on deep litter system in the house with tiled roof is preferable over deep litter system with or without fan ventilation; and wire floor systems of rearing in the house with ACC roofing, during summer season under hot humid environment.

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EFFECT OF HOUSING SYSTEMS ON PERFORMANCE OF BROILERS IN SUMMER

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ABSTRACT OF A THESIS

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ABSTRACT

A study was undertaken to quantamise the performance of broilers during three to eight weeks of age under three systems of rearing namely deep litter (DL), deep litter with fanned environment (DLF) and wire floor (WF) in a house with ACC roofing. The deep litter system of rearing broilers in a house with tile roofing (DLT) was also studied and compared with the above systems. Each system consisted of five replicates of 28 chicks each. Wood shavings were used as litter material in deep litter system. Plastic hexagonal mesh was used in wire floor system. Pedestal fans were used for providing fanned environment. Dry mash was fed throughout the study. Feed and water were provided <u>ad libitum</u>. Standard managemental practices were followed identically in all systems of rearing.

It was observed that the eighth week body weight and cumulative feed efficiency were numerically better with broilers reared in the house with tile roof. The cumulative feed intake per broiler during the period from zero to eight weeks of age was low during summer with all rearing systems studied. The cumulative feed efficiency was adversely affected by rearing broilers on DL with fanned environment. A marked reduction in maximum temperature inside the house, per cent relative humidity at the level of birds and cloacal temperature of birds were

noticed in broilers reared with deep litter system in the house with tile roofing. The overall mean per cent relative humidity inside the house was found to be 82.5 per cent in the morning and 49.0 per cent in the afternoon during summer. Livability was not affected by any of the housing system. Among the different rearing systems, a reduction in ready-to-cook yield was observed in broilers reared with deep litter system in the house with ACC roofing. The returns over cost of feeding broilers revealed that it was Rs 7.99 per broiler with deep litter system of rearing in the house with tiled roof. In the house with ACC roofing, the returns over feeding cost in various systems were comparatively lower.

From the above findings, it was concluded that rearing of broilers on deep litter system in a house with tiled roof was preferable in comparison with deep litter and wire floor systems of rearing in a house with asbestos roofing, during summer season under hot humid environment.