ALL INDIA CO-ORDINATED RESEARCH PROJECT ON POULTRY HOUSING AND MANAGEMENT

MANNUTHY CENTRE

ANNUAL REPORT FOR THE YEAR 1991-92

CENTRE FOR ADVANCED STUDIES IN POULTRY SCIENCE
KERALA AGRICULTURAL UNIVERSITY
MANNUTHY-680 651
THRISSUR-KERALA.

GENERAL INFORMATION

Project Title	:	All India Co-ordinated Research Project on Poultry Housing and Management.
Sanction No.	:	F 20(1)/85-ASR II dated 13.1.1987
Date of start	:	1.3.1988
Period of Report	:	1.4.1991 - 31.3.1992
Sponsored by	:	Indian Council of Agricultural Research, Krishi Bhavan, New Delhi.
Division	:	Centre for Advanced Studies in Poultry Science, Kerala Agricultural University.
Location	:	Mannuthy, Thrissur.

STAFF POSITION

I SCIENTIST:

1. Scientist - S_2 (Associate Professor)	..	Dr.K.Narayanankutty from 1.5.1988
2. Scientist - S_1 (Assistant Professor)	..	Dr.Leo Joseph from 6.5.1989 to 29.2.1992 Dr.P.A.Peethambaran from 1.3.1992.

II TECHNICAL:

1. Lab.Assistant (T_1) Farm Assistant (vety) Grade II	..	Smt.P.Valsalakumari from 7.6.1988

III SUPPORTING:

Lab. Attendant (class IV)	..	vacant Casual labourers are engaged in lieu of Class IV

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STATEMENT SHOWING BUDGET ALLOTMENT, EXPENDITURE AND RECEIPT FOR THE PERIOD FROM 1-4-1991 to 31-3-1992.

I ALLOTMENT AND EXPENDITURE:

BUDGET HEAD	ALLOTMENT For 1991-92	EXPENDITURE upto 31.3.92
Salaries	1,20,000-00	1,33,426-00
T.A.	5,000-00	1,521-00
Recurring contingencies	1,15,000-00	1,09,136-50
Non-Recurring contingencies:		
Building	NIL	NIL
Equipment	NIL	NIL

II RECEIPTS:

Sale of birds	14,343-00
Sale of eggs	49,399-00
Sale of manure	1,220-00
Total	64,962-00

Objectives of the project:

1. To document information already available in shelter and shelter engineering for poultry in India.

2. To establish basic biological requirements in poultry houses for economic egg/broiler production

and

3. To initiate shelter and shelter engineering studies in poultry.

Technical programme for the year 1991-92 for Commercial Layers:

I A. On Farm Research (Outstation Research) - Survey of existing housing and management practices in and around the centre.

B. Documentation of Research on

a) Efficacy of different housing systems.

b) Floor space requirements on the above systems.

c) Macro-micro climatic studies and their effect on production performance.

II Experimentation at the Centre (Instation Research)

1. Effect of housing systems and density on production performance of commercial layers developed under AICRP on Poultry Breeding.

For the comparative study deep litter, slat floor, wire floor and cages will be considered.

During the year 1991-92, depending on the facilities available at Mannuthy centre, two systems, viz. deep litter and wire floor are to be tested covering minimum two different seasons.

Details:

1. Systems to be studied
   a. Deep litter
   b. Slat floor
   c. Wire floor
   d. Cages

2. Floor areas to be tested

   a. Deep litter : 1400 cm^2 (1.5sq.ft), 1630 cm^2 (1.75sq.ft), 1860 cm^2/bird (2.0 sq.ft)

   b. Slat floor : 470 cm^2 (0.5sq.ft) 700 cm^2 (0.75sq.ft) 930 cm^2 (1.0sq.ft)

      1170 cm^2/bird (1.25 sq.ft)

   c. Wire floor : same as slat floor

   d. Cages : 280 cm^2, (0.3sq.ft) 420cm^2, (0.45sq.ft) 560cm^2, (0.6sq.ft)

      700cm^2/bird (0.75 sq.ft)

3. Age at Housing :

   Commercial pullets of 20-22 weeks of age developed under AICRP.

4. No. of replicates:

Minimum of three replicates under each density.

5. No. of birds:

Depends on the size of the existing houses - minimum of 30 birds in each replicate.

6. Experimental duration:

180 days of egg production, through seasonwise identified and calculated.

7. Parameters to be considered:

a) Body weight at housing
b) Age at 50% production
c) Egg production - periodwise - each period of 28 days
d) Feed consumption - per bird/day (on an average)
e) Feed efficiency
f) Egg weight - last three days of each period throughout the production period under study.
g) Egg quality - At start, middle and at the end of experiment - all parameters including shell thickness.
h) Mortality - to be recorded and reported
i) Body weight - at the end of experimental period.
j) Micro environmental data on temperature and humidity in the sheds daily to be recorded.

8. Cost efficiency:

Each centre should maintain proper record on feed consumption and cost of feed to calculate the cost efficiency of population.

9. Dietary requirements:

In all the systems and density studies a common layer diet as per ISI should be employed. Frequent change of feed ingredients should be avoided. Feeds are to be analysed for their composition and reported along with ingredient composition. Diet should be formulated as far as possible with common feed ingredients.

10. Receipts:

Each centre should recover at least 60% of the feed cost through sale of eggs and meat.

Experiments conducted and completed from inception of the project till 31.3.1991.

1. Studies on housing systems:

An experiment was undertaken to study the comparative efficiency of deep litter, wire floor and cage rearing of broilers under the hot-humid climate of Kerala. The study indicated that performance wise cage rearing commercial broilers appeared better. Rearing of

broilers on wire floor did not confer any additional advantage over deep litter system. Nonetheless, better feed efficiency on wire floor offer scope further refinement in the systems for efficiency in production. (Detailed in Annual Progress Report - 1988-89)

2. Floor density studies with broilers:

An experiment was undertaken to study the effect of floor space levels on broiler performance under deep litter system of housing. Three levels of floor space viz. 1125, 900 and 675 cm^2 (1.25, 1.00 and 0.75 sq.ft.) per bird were studied (Details presented in Annual Progress Report for 1988-89) The study revealed that considering the better body weight, comparable feed efficiency, ready to cook yield and better litter condition a floor space allowance of 1125 cm^2/bird seemed preferable during summer for broilers in this part of the country.

3. Requirements of protein and energy for broilers during summer season.

Experiments using broilers during summer was undertaken to assess the requirements of protein and energy for broilers during the summer season in Kerala (the details presented in the Annual Progress Report for 1988-89, 89-90 and 90-91).

The results of the above study revealed that the ration did not influence the economic parameters, irrespective of whether the experiment was started or completed during peak summer. Further, the protein and energy levels of 22:2900 in starter and 19:3000 in finisher diets seems to be adequate for optimum performance during summer.

4. Effect of different methods to alleviate thermal stress on broilers during summer.

An experiment was taken up to study the effect of different methods to alleviate summer stress in broilers reared on deep litter. Three different treatments viz. supplying ice cubes, ascorbic acid (25mg/l.water) and probiosol(1g/l.water) in drinking water, were applied. (Details in the Annual Progress Report for 1989-90). The study revealed that the treatments were found to be not significant statistically. Considering the body weight at eight week of age, feed efficiency and feed consumption, broilers performed better with ascorbic acid treatment compared to those given ice cubes and probiosol.

5. Influence of bird density on the performance of white Leghorn (IWN X IWP) growers and layers:

An experiment was conducted to study the effect of floor space levels on the performance of growers (8-18 weeks of age) and layers white leghorn (IWN X IWP)

(18 weeks of age onwards) under deep litter system of housing. Three levels of floor space viz, 900, 675 and 1125 cm^2 per grower and three levels viz.1350, 1800 and 2250 cm^2 per layer were studied (Details reported in the Annual Report for 1989-90 and 90-91). Analysis of the data relating to grower phase revealed that 900 cut/grower (IWN X IWP, White Leghorn) was superior to the other two levels ie. 675 and 1125 cm^2 in terms of body weight, feed consumption and feed efficiency. In the case of layers it was found that 1800 cm^2 floor space per layer was superior to the other two levels ie. 1350 and 2250 cm^2 in terms of body weight, livability, egg weight and egg production.

6. Effect of housing systems on the performance of broilers in Summer:

A study was undertaken to quantamise the performance of broilers under three systems of rearing namely deep litter, deep litter with fanned environment and wire floor in a house with ACC roofing. The deep litter system of rearing broilers in a house with tile roofing was also studied and compared with the above systems. (Details in the Annual Report for 89-90 and 90-91). From the data 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.

Besides the above mentioned biological experiments, documentation of research on efficiency of different housing systems, floor space requirements in various housing systems, macro-micro climatic studies and their effect on production performance in broilers was presented in Annual Report 1988-89. The documentation of research on the above aspects in layers are presented in Annual Report 1991-92.

Also survey of 32 broiler farms in and around the centre (Thrissur) was conducted results of which were reported in the Annual Report for 1988-89.

Since there are no commercial layer farms not only in and around the centre but also in the state itself, it is very difficult to carry out the survey of commercial layer farms.

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The Documentation of research work done in India on effects of environmental stress, stocking density and housing system on layer performance as envisaged in the technical programme is furnished below:

a) Effect of environmental stress on layers:

Bhatnagar (1964) reported that an air temperature of 51 - 100°F did not significantly affect production and egg weight, but relative humidity of 70-80% at these temperatures had a deleterious effect on egg production and egg weight.

Reddy and Sharma (1965) found that relative humidity was the most important single factor influencing egg production in poultry and high temperature by itself doesn't have significant effect.

Lowering of relative humidity by increasing air velocity favourably influenced the egg production (Subbiah et al, 1978)

Rai et al (1981) concluded that prolonged exposure to thermal stress of 37°C causes a decrease in the size and weight of the oviduct and the effect of heat stress is more on the heavier breeds like White Cornish than on lighter breeds like White Leghorn.

The effect of season on egg production of White Leghorn hens of different age groups has been reported by Kansal and Gangwar (1983)

Gill and Gangwar (1984) reported significant (P 0.01) reduction in the egg production, egg weight, shell weight, shell thickness and Haugh unit scores in the heat stressed birds.

b) Influence of rearing systems and stocking density on layer production

Lower feed consumption in caged birds was reported by Sharma (1974) and Balachandran et al (1979) reported similar results but observed that litter floor was best for egg production.

Thiyagasundaram et al (1979) observed that cage pullets laid more number of eggs than birds kept on deep litter.

Johari et al (1981) observed similar results but the shell and yolk index were poorer than from the eggs laid by the birds kept on deep litter.

Reddy et al (1981) found no effect of rearing systems (slat, deep litter or cages) on the age at sexual maturity, egg production and livability. Feed consumption was lowest on deep litter and highest in cages. They also observed

that 1 sq. ft./bird floor space on slats, 2 sq.ft/bird on deep litter and 0.62 sq. ft. /bird floor space in cages were the best.

Rama Rao et al (1983) reported that layers at 1.6sq.ft. /bird on litter, 0.4sq.ft./bird in cage system and 0.8 sq.ft/bird on slats performed better than the birds with 2 sq.ft./bird on litter, 0.5sq.ft/bird in cages and /sq.ft/bird on slats. The system of housing and floor space allowance did not have any influence on feed consumption.

Bhat and Aggarwal (1989) reported that providing 450 cm^2/bird as compared to 900cm^2/bird floor space to White Leghorn pullets in cages decreased the feed consumption. They also observed that no effect of deck level on feed consumption.

Kothandaraman (1989) found that hen day production was better in cages than on floor in summer.

Mohan et al (1991) observed that higher floor space allowance to the birds significantly (P 0.01) increased the egg production.

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Johari, D.C., Remganathan, P, Garg, R.C., Thiyagasundaram, T.S. Ayyagari, V. and Mohapatra, S.C. (1981). Effect of housing systems on the performance of six strain crosses of White Leghorn. Indian J.Poult.Sci.19(3):171.76

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Sharma, S.K.(1974). Effect of floor and cage housing on the egg production and egg quality traits of White Leghorn. Indian J.Vet.Sci:51:333-336.

Subbiah, V., Michael, R.D. Kothandaraman, P. and Shanmugha-sundaram, S. (1978). The effect of environments on performance of White Leghorn layers. Indian J. Poult. Sci: 12 (6) : 65-71

Thiyagasundaram, T.S., Kothandaraman, P. and Kumaraswami, K. (1979). Effect of strain and housing on White Leghorn pullet performance. Indian J.Poult.Sci: 14:1-8.

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Progress of Research Work - 1991-92.

As outlined in the technical programme, an experiment was started during summer season in April 1991 to study the effect of bird density on performance of White Leghorn strain-cross, IWN x IWP (ILM-90) developed at AICRP on Poultry Breeding, Mannuthy. Based on the facilities available, studies on deep litter and wire floor systems were carried out at this centre during the year 1991-92.

Pullets at the age of 20 weeks were housed during April 1991 both in deep litter and wire floor systems. The birds were reared by providing three levels of floor spaces viz. 1400, 1630 and 1860 cm^2/bird (1.5, 1.75 and 2.0sq.ft/bird) in deep litter system. Each treatment consisted of five replicates. The size of the flock studied were 20, 17 and 15 with floor space of 1400, 1630 and 1860 cm^2/bird respectively. In wire floor system, two levels of floor space viz. 470 and 700 cm^2/bird (0.5 and 0.75 sq.ft./bird) were studied in three replicates each, with the flock size of 36 birds in the first group and 27 birds in the second group. The experiment started during summer was terminated in September 1991, when the birds completed 44 weeks of age. The duration of the study lasted for 168 days in five 28-day periods from 20 weeks of age.

The following parameters were recorded.

1. Micro-environment inside the house, in respect of ambient temperature and relative humidity were recorded daily.

2. Body weights at 20 and 44 weeks of age.

3. Age at 50 per cent production.

4. Periodwise hen-housed egg production.

5. Mean Daily feed consumption in each period.

6. Feed efficiency.

7. Mean egg weight in each period based on the weight of eggs laid during last three days in each period.

8. Egg quality traits viz.

   i) Shape index

   ii) Shell thickness

   iii) Albumen Index

   iv) Yolk Index and

   v) Haugh unit scores

9. Mortality:

The data collected in summer trial were analysed statistically and the results of the study are presented in tables 1 to 8.

The performance of the flock during first period 20 to 24 weeks of age was poor due to a mild attack of Ranikhet disease in the flock. The birds were given Lasota strain of R.D.Vaccine

and the out break was controlled and the experiment was continued.

As envisaged in the technical programme a second trial was started in winter during November 1991 both in deep litter and wire floor systems. This experiment is in progress and will be terminated at the end of April 1992. The data collected upto March 1992 in respect of Winter trial are furnished in Tables 9 to 14.

Results of the Summer trial

A Deep litter system:

Body weight:

The body weight of birds at 20 weeks and that at 44 weeks of age were not influenced significantly by variation in floor space allowances and bird densities.

Age at 50% production:

The age at 50% production did not differ statistically among treatment groups.

Hen housed egg production:

The overall per cent hen-housed production for the period from 25 to 44 weeks of age showed significant difference ($P<0.05$) between treatment groups of 20 and 15 birds (I and III). The egg production in the group of birds given floor space of 1860 cm^2 per bird (III) was significantly higher (61.90%) than those given

floor space of 1400 cm^2/bird (57.94%). The egg production in the group of 17 birds reared with floor space of 1630 cm^2 per bird was intermediary (59.34%) and were statistically comparable with other two groups. These results indicated that as floor space was increased from 1400 to 1860 cm^2/bird, the egg production increased progressively.

Feed consumption:

The overall mean daily feed consumption presented in Table 6 showed progressive and significant increase in feed intake in groups provided with higher levels of floor space ($P < 0.01$). This in turn indicated a marked increase in feed intake in lower flock densities - The mean feed intake registered with bird densities of 20, 17 and 15 were 109.32, 116.51 and 123.08 g respectively. The birds in the corresponding groups were provided with a floor space of 1400, 1630 and 1860 cm^2/bird.

Feed efficiency:

The overall feed efficiency did not reveal any significant variation among treatment groups. The numerical values ranged from 2.31 to 2.45 among groups (Table 6). However, the feed efficiency during the period from 24 to 28 weeks of age was significantly lower than those of other periods ($P < 0.01$).

Egg quality traits:

The egg quality traits viz., egg weight, shape Index, shell thickness, Albumen Index, Yolk Index and Haugh Unit score were comparable statistically among treatment groups. The variations in numerical values recorded in this study were normal and fall within the ranges.

Mortality:

The overall mortality in groups I, II and III were 1.36, 1.73 and 1.94 per cent respectively and were not statistically different among each other.

The results also showed that the egg production and feed consumption were lowered in periods when the ambient temperature increased. Based on the results it was concluded that layers reared with floor space of 1800 cm^2/bird is advantageous over floor space of 1400 and 1630 cm^2/bird.

B. Wire Floor System:

With the existing facilities now available, the Mannuthy centre could take up studies with two levels of floor spaces viz. 470 and 700 cm^2/bird in wire floor system. The other two levels as envisaged in the technical programme will be carried out during the year 1992-93. Hence valid conclusions can be drawn after completing the studies with four levels of floor spaces in wire floor system of rearing.

systems it

On the basis of results obtained in wire floor/was found that the overall mean hen-housed egg production was significantly higher ($P<0.05$) with birds reared with floor space of 700cm^2/bird (60.27 per cent) than those reared with floor space of 470 cm^2/bird (51.81 per cent). The mean daily feed consumption in the group reared with floor space of 700 cm^2/bird was also significantly higher ($P<0.05$) than those reared with floor space of 470cm^2/bird (127.90 vs 103.70g). Other parameters recorded in these two systems did not differ each other statistically.

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PROGRAMME OF WORK FOR 1992-1993

All trials envisaged in the technical programme on the influence of floor density and flooring systems on the performance of White Leghorn strain cross (ILM-90) could not be taken up during 1991.92 for want of full infrastructure facilities. Therefore during 1992-93 the following left over trials are planned to be taken up.

System	Floor density
a) Wire floor	930 and 1170 cm^2
b) Slat floor	470, 700, 930 & 1170 cm^2

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Table 1

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN X IWP) LAYERS - 25 TO 28 WEEKS OF AGE (SUMMER TRIAL)

Traits	Litter floor spaces(cm^2)			Wire floor spaces(cm^2)	
	1400 (1.5sq.ft)	1630 (1.75sq.ft)	1860 (2.0sq.ft)	470 (0.5sq.ft)	700 (0.75sq.ft)
Mean hen housed production(%)	38.5	35.67	41.52	28.68	39.68
Mean feed consumption (g/day/bird)	86.89	91.6	101.62	71.81	89.32
Mean feed efficiency	2.73	3.15	3.0	3.0	2.7
Mean mortality(%)	-	-	-	2.5	3.0
Egg quality traits: (Average)					
a)Egg weight(g)	48.94	48.38	47.09	47.55	48.64
b)Shell thickness(mm)	0.34	0.35	0.34	0.32	0.34
c)Yolk index	0.36	0.35	0.35	0.36	0.34
d)Albumen index	0.10	0.10	0.11	0.09	0.09
e)Haugh unit score	81	78	82	80	80

Table 2

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN X IWP) LAYERS - 29 TO 32 WEEKS OF AGE (SUMMER TRIAL)

Traits	Litter floor spaces(cm^2)			Wire floor spaces(cm^2)	
	1400 (1.5sq.ft)	1630 (1.75sq.ft)	1860 (2.0sq.ft)	470 (0.5sq.ft)	700 (0.75 sq.ft)
Mean hen housed egg production(%)	62.46	60.29	64.47	49.26	64.87
Mean feed consumption (g/day/bird)	104.61	112.86	120.62	93.18	131.23
Mean feed efficiency	2.03	2.28	2.26	2.27	2.43
Mean mortality(%)	5.0	-	3.13	6.45	4.55
Egg quality traits: (Average)					
a)Egg weight(g)	52.58	51.35	50.55	53.09	53.95
b)Shell thickness(mm)	0.34	0.34	0.32	0.32	0.34
c) Yolk index	0.34	0.36	0.36	0.34	0.34
d) Albumen index	0.11	0.12	0.09	0.10	0.11
e) Haugh unit score	82	84	79	79	80

Table 3

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN x IWP) LAYERS - 33-36 weeks of Age. (SUMMER TRIAL)

Traits	Litter floor space(cm^2)			Wire floor space(cm^2)	
	1400 (1.5sq.ft)	1630 (1.75sq.ft)	1860 (2.0sq.ft)	470 (0.5sq.ft)	700 (0.75 sq.ft)
Mean hen housed egg production(%)	64.57	69.16	68.57	60.79	69.27
Mean feed consumption (g/day/bird)	116.68	131.18	135.29	109.16	133.94
Mean feed efficiency	2.16	2.28	2.38	2.15	2.32
Mean mortality(%)	2	0	1.18	2.13	4.41
Egg quality traits (Mean)					
a) Egg weight(g)	54.85	54.09	54.76	56.27	54.82
b) Shell thickness (mm)	0.37	0.38	0.38	0.37	0.38
c) Yolk index	0.44	0.44	0.44	0.44	0.45
d) Albumen index	0.08	0.09	0.09	0.09	0.09
e) Haugh unit score	80	83	82	84	85

Table 4

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN x IWP) LAYERS - 37 TO 40 WEEKS OF AGE (SUMMER TRIAL)

Traits	Litter floor space(cm^2)			Wire floor space(cm^2)	
	1400 (1.5 sq.ft)	1630 (1.75sq.ft)	1860 (2.0sq.ft)	470 (0.5sq.ft)	700 (0.75sq.ft)
Mean hen housed egg production(%)	63.82	68.57	67.91	62.15	65.63
Mean feed consumption g/day/bird	124.75	123.78	136.05	122.13	139.81
Mean mortality (%)	1.00	2.35	2.67	0	4.17
Mean feed efficiency	2.35	2.17	2.41	2.36	2.56
Egg quality traits(Mean)					
a)Egg weight(g)	56.42	56.19	57.08	56.40	56.56
b)Shell thickness(mm)	0.39	0.40	0.39	0.39	0.39
c)Yolk index	0.43	0.43	0.43	0.44	0.43
d)Albumen index	0.08	0.08	0.08	0.08	0.08
e)Haugh unit score	80	79	78	84	80

Table 5

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN x IWP) 41-44 WEEKS OF AGE (SUMMER TRIAL)

Traits	Litter floor space(cm^2)			Wire floor space(cm^2)	
	1400 (1.5sq.ft)	1630 (1.75sq.ft)	1860 (2.05sq.ft)	470 (0.5sq.ft)	700 (0.75sq.ft)
Mean body weight at 44 weeks of age (g)	1411.80	1426.12	1400.80	1470.10	1489.86
Mean hen housed egg production (%)	60.36	62.98	67.05	58.19	61.88
Mean feed consumption g/bird/day	113.68	122.14	124.57	122.21	145.19
Mean feed efficiency	2.27	2.33	2.23	2.53	2.82
Mean mortality (%)	-	1.18	-	3.60	3.33
Egg quality traits (Mean)					
a)Egg weight(g)	56.51	56.33	57.06	58.86	57.44
b)Shell thickness (mm)	0.38	0.38	0.38	0.38	0.38
c)Yolk index	0.42	0.42	0.43	0.43	0.42
d)Albumen index	0.09	0.09	0.09	0.10	0.09
e)Haugh unit score	84	82	84	84	83

Table 6(a)

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN X IWP) LAYER - 24 TO 44 WEEKS OF AGE (SUMMER TRIAL)

Traits	Litter floor space (cm^2)		
	1400(1.5sq.ft)	1630(1.75sq.ft)	1860(2.0sq.ft)
Mean body weight at the time of housing (g)	886.9±7.27	382.5±15.35	886.27±10.43
Mean body weight at the end of experiment (g)	1411.8±20.14	1426.12±13.56	1400.80±18.73
Age at 1st egg laid (days)	151	152	157
Age at 50% egg production(days)	185	187	183
Mean feed consumption (g/bird/day)	109.32±2.96^a	116.51±3.15^b	123.08±3.21^c
Feed efficiency (feed(kg)/dozen eggs)	2.31±0.06^a	2.44±0.09^a	2.45±0.08
Hen housed egg production(%)	57.94±2.28^a	59.34±2.68^{ab}	51.81±3.34^a
Mortality (%)	1.36	1.73	1.94
Egg quality traits(Average)			
Egg weight(g)	53.86±0.64^a	53.27±0.68^a	53.31±0.86^a
Albumen index	0.091±0.003^a	0.090±0.003^a	0.091±0.003^a
Yolk index	0.431±0.002	0.432±0.002^a	0.432±0.002^a
Shell thickness(mm)	0.38±0.002^a	0.38±0.003^a	0.38±0.003^a
Haugh unit score	83.24±0.93^a	83.00±0.95^a	83.68±0.97^a
Shape index	73.48±0.28^a	93.88±0.31^a	73.64±0.30^a

Values bearing the same super script within the same row do not differ significantly.

Table 6(b)

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN X IWP) LAYER - 24 TO 44 WEEKS OF AGE - (SUMMER TRIAL)

Traits	Wire floor space (cm^2)	
	470(0.5sq.ft)	700(0.75sq.ft)
Mean body weight at the time of housing (g)	883.43±3.56	941.60±12.4
Mean body weight at the end of experiment (g)	1470.10±8.63	1489.86±14.63
Age at 1st egg laid (days)	153	150
Age at 50% egg production(days)	209	188
Mean feed consumption (g/bird/day)	103.70±5.88^a	127.90±6.03^b
Feed efficiency (feed(kg)/dozen eggs)	2.46±0.10^a	2.56±0.08^a
Hen housed egg production(%)	51.81±3.34^a	60.27±2.88^b
Mortality (%)	5.13	4.58
Egg quality traits(Average)		
Egg weight (g)	54.43±1.11^a	54.15±0.95^a
Albumen index	0.094±0.003^a	0.090±0.002^a
Yolk index	0.436±0.002^a	0.429±0.004^a
Shell thickness (mm)	0.38 ±0.003^a	0.39±0.002^a
Haugh unit score	84.2±1.12^a	82±0.92^a
Shape index	73.60±0.31^a	73.87±0.50^a

Values bearing the same superscript within the same row do not differ significantly.

Table 7

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN x IWP) LAYERS - MATERIOLOGICAL DATA DURING THE EXPERIMENTAL PERIOD - SUMMER TRIAL

Months	Temperature(^{o}C)		Relative humidity(%)		
	Maximum	Minimum	Morning	Afternoon	Mean
April 1991	34.0	27.0	73.44	55.43	67.0
May 1991	34.0	27.0	79.96	58.04	69.0
June 1991	28.5	25.0	89.12	81.67	85.0
July 1991	29.0	24.0	89.50	78.42	89.0
August 1991	28.0	24.0	89.71	78.89	84.5
September 91	29.9	24.3	86.41	64.38	82.6

Table 8

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN X IWP) LAYERS.

PRESENT COMPOSITION OF EXPERIMENTAL DIET

Ingredients	Percent
Yellow maize	47.0
Groundnut cake	16.0
Gingelly oil cake	5.0
Rice polish	23.0
Fish meal	5.0
Salt	0.25
Mineral mixture	1.76
Shell meal	2.00
Vitamin AB_2D_3(g)	30.0
Calculated Value	
Protein (%)	18.17
Energy (K cal ME/kg diet)	27.25
Lysine Hcl.	0.69
Dl.Methionine	0.37

Table 9

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN x IWP)LAYERS FOR THE FIRST 28 DAY PERIOD (21 TO 24 WEEKS OF AGE) (WINTER TRIAL)

Traits	Litter floor space(cm^2)			Wire floor space(cm^2)	
	1400 (1.5sq.ft)	1630 (1.75sq.ft)	1860 (2.0sq.ft)	470 (0.5sq.ft)	700 (0.75sq.ft)
Mean body weight at the time of housing (g)	1094.90	1066.59	1132.87	1134.63	1102.80
Mean hen housed egg production (%)	4.0	4.83	7.29	7.08	10.01
Mean feed consumption (g/bird/day)	78.47	86.13	75.47	70.98	82.85
Mean feed efficiency	31.67	27.79	18.66	12.01	10.04
Mean mortality (%)	--	--	--	--	--
Egg quality traits(average)					
a) Egg weight(g)	46.27	45.48	45.54	43.29	44.93
b) Shape index	72.0	73.0	74.0	71.0	69.0
c) Albumen index	0.10	0.10	0.11	0.11	0.12
d) Yolk index	0.46	0.44	0.43	0.46	0.44
e) Haugh unit score	86.0	87.0	91.0	87.0	91.0
f) Shell thickness(mm)	0.39	0.38	0.36	0.38	0.38
Age at first egg laid (days)	157.0	156.0	158.0	151.0	149.0

Table 10

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN X IWP) LAYERS - 25-28 WEEKS OF AGE (WINTER TRIAL)

Traits	Litter floor spaces(cm^2)			Wire floor spaces(cm^2)	
	1400 (1.5sq.ft)	1630 (1.75sq.ft)	1860 (2.0sq.ft)	470 (0.5sq.ft)	700 (0.75sq.ft)
Mean body weight at the time of housing(g)	1094.90	1066.59	1132.87	1134.63	1102.80
Mean hen housed egg production (%)	42.64	44.29	51.19	45.24	55.74
Mean feed consumption(g/bird/day)	88.79	83.78	92.81	64.82	78.31
Mean feed efficiency	2.58	2.39	2.37	1.72	1.68
Mean mortality(%)	1.00	1.18	1.00	2.0	1.25
Mean egg weight(g)					
Shape index (average)	72.0	73.0	74.0	71.0	69.0
Yolk index (average)	0.46	0.44	0.43	0.46	0.44
Albumen index (average)	0.10	0.10	0.11	0.11	0.12
Shell thickness (mm)	0.39	0.38	0.36	0.38	0.38
Haugh unit score (average)	86.0	87.0	91.0	87.0	91.0
Age at first egg laid (average)	157.0	156.0	158.0	151.0	149.0

Table 11

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN X IWP) LAYERS - 29 TO 32 WEEKS OF AGE (WINTER TRIAL)

Traits	Litter floor spaces (cm^2)			Wire floor spaces (cm^2)	
	1400 (1.5sq.ft)	1630 (1.75sq.ft)	1860 (2.0sq.ft)	470 (0.5sq.ft)	700 (0.75sq.ft)
Mean hen housed egg production(%)	47.43	48.99	57.57	67.23	65.21
Mean feed consumption (g/bird/day)	93.21	112.44	84.71	88.16	104.45
Mean feed efficiency	2.48	2.80	1.78	1.58	1.83
Mean mortality %	2.0	1.0	1.25	1.25	1.16
Mean egg weight (g)	53.37	53.67	51.92	52.21	54.87

Table 12

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN X IWP) LAYERS - 33 TO 36 WEEKS OF AGE - (WINTER TRIAL)

Traits	Litter floor spaces (cm^2)			Wire floor spaces(cm^2)	
	1400 (1.5sq.ft)	1630 (1.75sq.ft)	1860 (2.0sq.ft)	470 (0.5sq.ft)	700 (0.75sq.ft)
Mean hen housed egg production(%)	69.39	81.93	76.90	66.47	63.80
Mean feed consumption (g/bird/day)	105.20	123.49	125.86	91.20	98.77
Mean feed efficiency	1.94	1.81	1.97	1.65	1.87
Mean mortality (%)	1.0	-	-	1.0	1.0
Mean egg weight(g)	53.13	54.0	52.63	54.48	53.71

Table 13

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN X IWP) LAYERS - 39 TO 40 WEEKS OF AGE - (WINTER TRIAL)

Traits	Litter floor space(cm^2)			Wire floor space(cm^2)	
	1400 (1.5sq.ft)	1630 (1.75sq.ft)	1860 (2.0sq.ft)	470 (0.5sq.ft)	700 (0.75sq.ft)
Mean hen housed egg production (%)	69.02	76.68	77.33	63.03	64.83
Mean feed consumption (g/bird/day)	103.54	111.74	110.05	96.43	102.12
Mean feed efficiency	1.82	1.75	1.71	1.92	1.93
Mean mortality (%)	1.00	1.25	1.0	1.00	2.00
Egg quality traits(average)					
a) Egg weight (g)	54.54	54.02	56.39	53.1	55.0
b) Shape index	75.0	75.0	78.0	77.0	76.0
c) Albumen index	0.09	0.08	0.12	0.13	0.11
d) Yolk index	0.44	0.41	0.46	0.47	0.46
e) Haugh unit score	89.0	81.0	91.0	93.0	91.0
f) Shell thickness (mm)	0.38	0.37	0.39	0.39	0.39

Table 14

INFLUENCE OF BIRD DENSITY ON THE PERFORMANCE OF WHITE LEGHORN (IWN X IWP) LAYERS - METERIOLOGICAL DATA DURING THE EXPERIMENTAL PERIOD - WINTER TRIAL

Months	Temperature(^{o}C)		Relative humidity(%)		
	Maximum	Minimum	Morning	Afternoon	Mean
October 1991	28.9	23.5	56.0	72.0	64.0
November 1991	30.2	24.8	64.0	60.0	62.0
December 1991	30.7	23.0	71.0	54.0	62.0
January 1992	31.0	22.2	76.0	48.0	62.0
February 1992	32.8	23.3	75.0	54.0	64.5
March 1992	35.20	24.9	83.0	49.0	66.0