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## Impact of stocking density on gait score and mortality in broiler chickens

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**Abstract**

The research was conducted to investigate the impact of stocking density (i.e., I.C.A.R., Venky's and Amrit recommendations) on gait score & mortality in broiler chickens. A 500 day-old straight run commercial broiler strain "VENCOB" chicks were divided in two batches. Each batch was subdivided in 3 equal groups namely Gr 1 (I.C.A.R.), Gr 2 (Venky's) and Gr 3 (Amrit). All the birds were raised on pucca floor with saw dust as litter material providing equal managerial practices. Walking ability was accessed at weekly interval up to 6 weeks of observation. The gait scoring system followed in the present study was Modified gait scoring system developed by Garner *et al.* (2002). Daily mortality of birds was recorded in morning hours & mortality rate was calculated weekly. The lowest and highest% of birds showing GS 0 under I.C.A.R. recommendation of stocking density have been found to be 83.93±0.64% (week 4) and 92.86±0.40% (week 6) respectively. Similarly the corresponding proportion of birds showing GS 1 were 6.07±0.78% (week 1) and 13.93±0.64% (week 4) respectively. Comparatively lesser % of birds show GS 2 and the lowest and highest L.S. means % of this were 0.00±0.40% (week 6) and 3.21±0.82% (week 3) respectively. Venky's & Amrit's observation were also similar as I.C.A.R. recommendation has been observed. Overall it has been observed that% of birds showing GS 0 was significantly more in I.C.A.R. followed by Amrit and Venky's during this study. However, highest% of birds showing GS 1 was recorded in Venky's recommendation followed by Amrit and I.C.A.R. Whereas, less than 5% birds exhibited GS 2 in this study in respective of stocking densities. There was no significant difference regarding% of birds with GS 2 in three stocking densities during all the weeks except at week 4. The overall mortality (%) was less than 5% over weeks under each placement densities. No significant difference was observed among mortality rates of broiler chickens under these three stocking densities during all the weeks studied. From present study, this can be concluded that leg health and walking ability was comparatively better under I.C.A.R. recommendation followed by Amrit and Venky's. However, effect of stocking density on mortality was non significant among three stocking.

**Keywords:** gait score, foot pad lesions, stocking density, mortality and walking ability

**Introduction**

The total poultry population in India is 729.2 million, which is 12.39 percent higher than numbers in the previous census (Livestock Census, 2012) [21]. Poultry is one of the fastest growing sectors of Indian agriculture today, with annual growth rates of 5.57 percent and 11.44 percent in egg and broiler production, respectively. The value of output from the poultry sector was US\$10 billion in 2014 (Rajendran *et al.*, 2014) [25]. Broiler production has been more vibrant than layer production within the poultry sector, with an annual growth rate of 11.44 percent, production of 3.725 million tons and employment of 4.29 million people (Index Mundi, 2015) [15]. India is the fourth largest producer of poultry meat in the world, valued at US\$ 6.6 billion. Poultry production accounts for about 0.66 percent of India's GDP and 7.72 percent GDP from the livestock sector (Rajendran *et al.*, 2014) [25]. Poultry meat production increased from 0.069 million tons in 1961 to 3.725 million tons in 2014. The per capita availability of poultry meat is 2.8 kg; against recommended level of 11 kg (Rajendran *et al.* 2014 [25]; Index Mundi, 2015 [15]). The main reasons for improved broiler poultry production (Kalamkar, 2012; SAPPLPP, 2009) [17, 29] are: modernization of production practices; import of pure lines/grandparent stock; least-cost feed formulation; vaccines against major diseases; provision of EAS and other input services; improved quality breeder management; developments in poultry processing; and private sector partnerships through Contract Broiler Farming. It is estimated that 37 percent of broiler production in India is under contracts, and about 78 percent of those contracts are concentrated in southern India (Rajajwani, 2012) [26]. Gait scores (GS), a parameter used to evaluate walking ability (Kestin *et al.*, 1992; Garner *et*

al., 2002) [18, 11], became increasingly poor in response to increased density. In particular, the proportion of birds with scores 4 and 5 (which indicate severely compromised walking ability) were significantly higher when space allowance was equal to or lower than 0.0625m<sup>2</sup>/bird (Sorensen *et al.*, 2000) [33] and when comparing a wider set of density ranges (Sanotra *et al.*, 2001b) [28]. Also, broilers at higher densities in Sorensen *et al.* (2000) [33], Arnould and Faure (2003) [2], and Dozier *et al.*, (2005b) [6] had an elevated incidence of foot and hock burns, and both parameters correlated with poor GS (Sorensen *et al.*, 2000) [33]. Poorer GS may be related to a reduction in exercise as seen by the decline in distance traveled by broilers at high densities (Lewis and Hurnik, 1990; Andrews *et al.*, 1997; Estevez *et al.*, 1997) [20, 1], or may be a result of the rapid decline in litter quality associated with high densities, which is known to affect leg health (Ekstrand, 1993; Wang *et al.*, 1998) [7, 35], or a combination of both factors. Thus high gait score birds (lame birds) show elevated self-selection of analgesic (Pickup *et al.*, 1997; Mc Geown *et al.*, 1999; Danbury *et al.*, 2000) [24, 22, 5]; take longer to reach food and traverse obstacles (Mc Geown *et al.*, 1999) [22]; have higher body weight, a higher incidence of hock burns (Kestin *et al.*, 1999) [19]; and tend to perform behaviors (such as feeding) while sitting where possible (Weeks *et al.*, 1998; 2000; Mench *et al.*, 2001). Singh *et al.* (2017) [36, 23, 31] indicated that higher the stocking density higher the incidence of foot pad lesions in broiler chickens.

A majority of published studies have noted no effects of stocking density on mortality, even at levels that should be regarded as extreme (Shanawany, 1988) [30]. However, mortality figures are believed to be of limited value when evaluating animal welfare, although reduced life expectancy can be regarded as an indicator of poor animal welfare (Broom, 1996). Feddes *et al.* (2002) [3, 10] concluded that stocking density had no effect on mortality. However, Dozier *et al.* (2005b) [6] concluded that mortality was higher for densities above 30 kg/m<sup>2</sup> (3.6 vs. 7.5%) but was not significantly different. Hall (2001) [12] reported that there was significantly higher daily mortality at the largest density toward the end of rearing but no differences in total mortality.

**Materials and Methods**

The aim of the present investigation is to examine the impact of stocking density on gait score and mortality in broiler chickens. The study was carried out at the poultry unit of Livestock Farm Complex, College of Veterinary Science and Animal Husbandry, A.N.D.U.A.T. Kumarganj, Ayodhya U.P. To carry out the present investigation, 500 day old straight run, commercial broiler strain “VENCOB” chicks were divided in two batches. Each batch was sub divided in 3 equal groups namely Gr 1, Gr 2 and Gr 3 randomly distributed among 3 pens. All the birds were raised on pucca floor with saw dust as litter material. Walking ability was accessed at weekly interval up to 6 weeks of observation. The Gr 1

follows as per I. C. A. R. recommendation of floor space (I.C.A.R. bulletin on animal housing and equipment; IS 5309, Part-II) where as Gr 2 and Gr 3 follow the recommendation of hatchery companies namely Venkateshwara Hatcheries Pvt. Ltd. (www.venkys.com) and Amrit Hatcheries Pvt. Ltd. (www.amritgroup.in, www.amritfeeds.com) respectively (Table 1).

**Table 1:** Floor space provided to three different groups during study period

Weeks	Floor Space (Square feet / Bird)		
	I. C. A. R.	Venky's	Amrit
1	0.50	0.25	0.25
2	0.50	0.33	0.50
3	0.50	0.50	0.75
4	0.50	1.00	1.00
5	2.25	2.50	1.25
6	2.25	1.50	1.50

The gait scoring system followed in the present study was Modified gait scoring system developed by Garner *et al.* (2002) [11]. This is a six point scale of the gait score of the birds according to a visual appraisal of their walking ability. Briefly the Modified Gait Score System has been described in the Table 2. Daily mortality of birds was recorded in morning hours in each pen and each batch. The mortality rate was calculated weekly.

**Table 2:** Modified Gait Score System of broiler chickens (Garner *et al.* 2002) [11]

Gait score	Degree of impairment/ walking ability
0	Normal with no detectable gait abnormality
1	Detectable, but unidentifiable abnormality
2	Identifiable abnormality, that has little impact on overall function
3	Identifiable abnormality which impairs function
4	Severe impairment of function, but still capable of walking
5	Complete lameness

**Statistical analysis**

The recorded data of gait score was analyzed as per standard statistical procedure outlined by MMLS and ML computer programme PC-2, Harvey (1990) [23]. Least squares means were compared by Critical Difference Test. Mortality data of chicks were analysed by Chi-Square test.

**Results and Discussion**

Gait score (GS) was accessed at weekly interval up to 6 weeks of observation and they have been grouped in to GS 0, 1 and 2. The proportions of bird scored 0, 1 or 2 are shown in the Table 3. It should be noted that no bird was observed with GS 3 and above throughout observation period in the present study.

**Table 3:** Least squares means ± S. E. of % of broiler chickens showing different gait scores among three stocking densities

Group with scores Week	I.C.A.R.			Venky's			Amrit		
	Gait Score 0	Gait Score 1	Gait Score 2	Gait Score 0	Gait Score 1	Gait Score 2	Gait Score 0	Gait Score 1	Gait Score 2
WK 1	92.50+0.78 <sup>a</sup>	6.07+0.78 <sup>b</sup>	1.43+0.78 <sup>c</sup>	92.86+0.91 <sup>a</sup>	6.07+0.91 <sup>b</sup>	1.07+0.91 <sup>c</sup>	92.86+0.85 <sup>a</sup>	5.36+0.85 <sup>b</sup>	1.78+0.85 <sup>c</sup>
WK 2	85.36+0.57 <sup>a</sup>	11.43+0.57 <sup>b</sup>	3.21+0.57 <sup>c</sup>	79.28+0.79 <sup>a</sup>	15.36+0.79 <sup>b</sup>	5.36+0.79 <sup>c</sup>	83.57+0.58 <sup>a</sup>	12.50+0.58 <sup>b</sup>	3.93+0.58 <sup>c</sup>
WK 3	87.14+0.82 <sup>a</sup>	9.64+0.82 <sup>b</sup>	3.21+0.82 <sup>c</sup>	80.00+0.77 <sup>a</sup>	16.43+0.77 <sup>b</sup>	3.57+0.77 <sup>c</sup>	83.21+0.76 <sup>a</sup>	13.21+0.76 <sup>b</sup>	3.57+0.76 <sup>c</sup>
WK 4	83.93+0.64 <sup>a</sup>	13.93+0.64 <sup>b</sup>	2.14+0.64 <sup>c</sup>	81.78+0.57 <sup>a</sup>	17.50+0.57 <sup>b</sup>	0.71+0.57 <sup>c</sup>	85.71+0.51 <sup>a</sup>	14.28+0.51 <sup>b</sup>	0.00+0.51 <sup>c</sup>
WK 5	87.86+0.49 <sup>a</sup>	11.78+0.49 <sup>b</sup>	0.71+0.49 <sup>c</sup>	85.36+0.63 <sup>a</sup>	14.28+0.63 <sup>b</sup>	0.36+0.63 <sup>c</sup>	84.64+0.56 <sup>a</sup>	15.00+0.56 <sup>b</sup>	0.36+0.56 <sup>c</sup>
WK 6	92.86+0.40 <sup>a</sup>	7.50+0.40 <sup>b</sup>	0.00+0.40 <sup>c</sup>	90.00+0.43 <sup>a</sup>	10.00+0.43 <sup>b</sup>	0.00+0.43 <sup>c</sup>	90.71+0.59 <sup>a</sup>	9.28+0.59 <sup>b</sup>	0.00+0.59 <sup>c</sup>

N= 20 under each observation; Means having dissimilar superscripts within row differ significantly (P<0.01\*\*).

### Gait scores under different stocking densities

Table 3 shows the proportion of broiler chickens showing different gait scores among three stocking densities. This is evident from the table that there was highly significant ( $P < 0.01$ ) difference among gait scores in I.C.A.R. placement density of birds. Percentage of birds showing GS 0 was significantly higher than GS 1 and 2 which also differed significantly each other. The lowest and highest% of birds showing GS 0 under I.C.A.R. recommendation of stocking density have been found to be  $83.93 \pm 0.64\%$  (week 4) and  $92.86 \pm 0.40\%$  (week 6) respectively. Similarly the corresponding proportion of birds showing GS 1 were  $6.07 \pm 0.78\%$  (week 1) and  $13.93 \pm 0.64\%$  (week 4) respectively. Comparatively lesser% of birds show GS 2 and the lowest and highest L.S. means% of this were  $0.00 \pm 0.40\%$  (week 6) and  $3.21 \pm 0.82\%$  (week 3) respectively. Venky's & Amrit's observation were also similar as I.C.A.R. recommendation has been observed. Most of the birds show GS 0, followed by GS 1 and 2. In general the proportion of birds showing GS 0 under three recommendations of stocking densities have been more at week 1 and 6 than other weeks. On the other hand the proportion of birds showing GS 1 in three stocking densities have been recorded to be more during 2<sup>nd</sup> to 5<sup>th</sup> week of age. Regarding the L.S. means% of broiler chickens showing GS 2 in three recommendations were higher during 1<sup>st</sup> three weeks of observations.

### Comparison of gait scores with different stocking densities

The proportion of birds showing GS 0, 1 & 2 among three recommended densities under this study have been presented in the Table 4. During 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> week of age the% of birds under GS 0 varied significantly with different stocking rates. At week 2<sup>nd</sup> no significant difference was observed between I.C.A.R. and Amrit; however they both significantly ( $P < 0.01$ ) higher than that of Venky's. At week 3 the% of birds with GS 0 was significantly ( $P < 0.01$ ) higher in I.C.A.R. than both Venky's and Amrit respectively which, however did not vary statistically each other. At week 4 the% of GS 0 birds under Amrit recommendation was not significantly different from that of I.C.A.R., however this (Amrit) was differed statistically ( $P < 0.05$ ) from the% of GS 0 birds under Venky's recommendation. During 2<sup>nd</sup> week to 5<sup>th</sup> week of age the proportion of birds with GS 1 have been significantly differed among three stocking densities. Overall it has been observed that highest% of birds showing GS 1 was recorded in Venky's recommendation followed by Amrit and I.C.A.R. Whereas, less than 5% birds exhibited GS 2 in this study in respective of stocking densities. There was no significant difference regarding% of birds with GS 2 in three stocking densities during all the weeks except at week 4. The L.S.

means of % GS 2 under I.C.A.R. recommendation at this week was significantly higher than other two recommendations which did not differ each other. The more number of GS 2 birds were found during first three weeks of age than rest of the weeks in three stocking densities under study.

In the present trial the birds appeared overtly healthy and at the lower densities grew well. The distribution in GS and prevalence of severely lame birds (having a GS of 4 or 5) were similar to commercial flocks (Kestin *et al.*, 1992)<sup>[18]</sup> and those in previous studies (Sorensen *et al.*, 1999)<sup>[19]</sup>; Su *et al.*, 1999<sup>[34]</sup>; and Kestin *et al.*, 1999)<sup>[22]</sup>. The findings from these trials were reasonably consistent. Walking ability deteriorated with age at 4 week of age, the broilers had good walking ability, less than 1% of birds had a GS of 4 or 5. By 6 weeks of age, the walking ability of the birds had also showed substantially similar walking ability. Because the number of birds and feeder space per bird in each pen were the same in all stocking density groups, some of the effects of high stocking density on live body weight might have been a function of the difficulty birds had in accessing the feeders. Because of the strong correlation between GS and body weight, it would normally be expected that birds at the lower densities, which were heavier, would have poorer walking ability, however this was not the case. Birds at lower density had almost similar walking ability as that in higher density, despite higher live weight. This result meant that, when the observations were adjusted for differences in body weight, the differences in walking ability between densities became larger. Birds with higher score were light because they could not access feed easily which resulted in a nonlinear relationship between body weight and GS. Because there were few birds with a higher gait score 3 and above during study period. At 4<sup>th</sup> week of age, from casual observation, there appeared to be adequate space for all birds to move around, even at the higher densities. At 6<sup>th</sup> and 7<sup>th</sup> week of age, it was clear that at higher densities, bird movement was more constant. The improved walking ability in birds kept at lower densities might have been due to their greater level of overall activity. There is preliminary evidence that greater exercise is associated with improved walking ability (Reiter and Bessei, 1995)<sup>[27]</sup>. Whether deterioration in walking ability could be limited by encouraging the birds to exercise by, for example, increased lighting levels, which is believed to increase activity (FAWC, 1992)<sup>[9]</sup>, or by placing the feeders and drinkers some distance apart to encourage activity remains to be investigated. Based on the findings of the present study, a thorough investigation of the role of bird activity and exercise at different ages on the development of leg weakness is merited.

**Table 4:** Least squares means  $\pm$  S. E. of % of broiler chickens showing different stocking densities among three gait scores

Score with groups Weeks	Gait Score 0			Gait Score 1			Gait Score 2		
	I.C.A.R.	Venky's	Amrit	I.C.A.R.	Venky's	Amrit	I.C.A.R.	Venky's	Amrit
WK 1	92.50 $\pm$ 1.55	92.86 $\pm$ 1.55	92.86 $\pm$ 1.55	6.07 $\pm$ 1.16	6.07 $\pm$ 1.16	5.35 $\pm$ 1.16	1.43 $\pm$ 0.75	1.07 $\pm$ 0.75	1.78 $\pm$ 0.75
WK 2	85.36 $\pm$ 1.24 <sup>a</sup>	79.28 $\pm$ 1.24 <sup>b</sup>	83.57 $\pm$ 1.24 <sup>a</sup>	11.43 $\pm$ 0.72 <sup>c</sup>	15.36 $\pm$ 0.72 <sup>a</sup>	12.50 $\pm$ 0.72 <sup>b</sup>	3.21 $\pm$ 0.76	5.36 $\pm$ 0.76	3.93 $\pm$ 0.76
WK 3	87.14 $\pm$ 1.26 <sup>a</sup>	80.00 $\pm$ 1.26 <sup>b</sup>	83.21 $\pm$ 1.26 <sup>b</sup>	9.64 $\pm$ 0.93 <sup>c</sup>	16.43 $\pm$ 0.93 <sup>a</sup>	13.21 $\pm$ 0.93 <sup>b</sup>	3.21 $\pm$ 1.11	3.57 $\pm$ 1.11	3.57 $\pm$ 1.11
WK 4	83.93 $\pm$ 0.94 <sup>ab</sup>	81.78 $\pm$ 0.94 <sup>b</sup>	85.71 $\pm$ 0.94 <sup>a</sup>	13.93 $\pm$ 0.95 <sup>b</sup>	17.50 $\pm$ 0.95 <sup>a</sup>	14.28 $\pm$ 0.95 <sup>b</sup>	2.15 $\pm$ 0.48 <sup>a</sup>	0.71 $\pm$ 0.48 <sup>b</sup>	0.00 $\pm$ 0.48 <sup>b</sup>
WK 5	87.86 $\pm$ 0.99	85.36 $\pm$ 0.99	84.64 $\pm$ 0.99	11.78 $\pm$ 0.88 <sup>b</sup>	14.28 $\pm$ 0.88 <sup>ab</sup>	15.00 $\pm$ 0.88 <sup>a</sup>	0.71 $\pm$ 0.40	0.36 $\pm$ 0.40	0.36 $\pm$ 0.40
WK 6	92.86 $\pm$ 0.83	90.00 $\pm$ 0.83	90.79 $\pm$ 0.83	7.50 $\pm$ 0.83	10.00 $\pm$ 0.83	9.28 $\pm$ 0.83	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00

N= 20 under each observation; Means having dissimilar superscripts within row differ significantly ( $P < 0.01$  \*\*)

### Mortality rates under different stocking densities

The weekly mortality rates of broiler chickens under three

stocking densities have been presented in Table 5. The overall mortality (%) was less than 5% over weeks under each

placement densities. No significant difference was observed among mortality rates of broiler chickens under these three stocking densities during all the weeks studied. Iscan *et al.* (1996) [16] reported that mortality for 15 and 20 birds/m<sup>2</sup> was 7.1 and 6.4%, respectively. As in the present study, stocking density in broilers had no significant effect on mortality, which was also similarly suggested by Cravener *et al.*, 1992 and Heckert *et al.*, 2002 [4, 14]. Increasing mortality can be explained by decreased animal welfare, such as bad air and litter quality, poor immune response and poor feed intake.

**Table 5:** Week wise mortality (%) of birds under different stocking densities

Weeks	Stocking density			Total
	I.C.A.R.(n=168)	Venky's(n=166)	Amrit(n=166)	
WK 1	1.19	1.81	1.81	4.81
WK 2	0.60	1.23	1.23	3.06
WK 3	1.21	1.24	0.62	3.04
WK 4	1.23	0.63	0.62	2.48
WK 5	0.00	0.00	0.00	0.00
WK 6	0.00	0.00	0.00	0.00

Figures in the parentheses represent respective no. of birds under each density

### Conclusion

The% of birds showing GS 0 was significantly more in I.C.A.R. followed by Amrit and Venky's during this study. The% of birds showing GS 1 was significant during week 2<sup>nd</sup> to 5<sup>th</sup> and more number of birds showing GS 1 was observed under Venky's followed by Amrit and I.C.A.R. recommendation of floor space. The% of birds showing GS 2 was significant only at week 4 where more% of birds was observed under I.C.A.R. than Venky's and Amrit. The mortality (4.25%) of chicks during study period was non significant among three stocking densities. From present study, this can be concluded that leg health and walking ability was comparatively better under I.C.A.R. recommendation followed by Amrit and Venky's. However, effect of stocking density on mortality was non significant among three stocking.

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